Creativity
A Handbook for Teachers

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World Scientific

Dedication

I would like to dedicate this book to the late Prof. Takanori Akiyama (1929–2003), who was one of the pioneers in the study of creativity in Japan.

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Encouraging Creativity in Education

Mark A. Runco

Creativity is a fascinating topic. Creative individuals often lead interesting lives, especially when they are immersed in their work, and of course the work itself (i.e., art, inventions, books, and insights) is by definition original and unusual. No wonder there is a growing body of both basic and applied research on creativity and various correlates of it (e.g., innovation, talent, achievement and genius). The basic research often focuses on the creative process. The applied research looks to the environments and experiences that support (and sometimes inhibit) creative potentials and expression.

Education may represent the most important area of applied research. After all, most children receive formal education, at least in Western culture, and they are educated for a number of years. Therefore teachers are responsible for many of the experiences which can dramatically influence the creative expression. This should not be taken lightly, given the benefits of creativity for individuals and for society as a whole. There are many positive effects, including benefits for learning, self-expression, evolution, and health. Indeed, if creative potentials are fulfilled, the world will be a dramatically different, and better, place.

Fortunately, there are several reasons to be optimistic. First is the optimism implied by the attention currently devoted to the creativity research. Along the same lines, studies of creativity have become more robust and result more reliable. Studies of creativity are truly scientific, though the scientific method used to study creativity is not identical with that which is used to study other phenomena (Runco, 2004). But that of course is one message of creative studies: It is good to be

different, at least some of the time. Optimism is also implied specifically by applied research, including the educational research. Clearly, much can be done to encourage creativity.

Each kind of optimism is apparent in the chapters presented in this volume. They show clearly the great advances being made toward our understanding of creativity, and they pinpoint particular methods and strategies, which can be used to enhance creativity and fulfill creative potentials.

This handbook is primarily for teachers. Its emphasis is on education, though it contains a wide variety of perspectives. These include biological and neurophysiologic perspectives, psychometric chapters covering identification and measurement techniques, specific chapters devoted to special education and the future, several state of the art perspectives, including those discussing positive psychology, leadership, mental health, and technology enhanced creativity, as well as the chapter devoted specifically to classroom perspectives.

This volume not only takes stock of the past but also looks ahead. The past is obvious and the amount of high-quality research, which is summarized and evaluated in the various chapters. The future is obvious in Part Four of this volume, with six chapters devoted to new frontiers. Notice also the chapter devoted to "Education toward the future" as well as the possibility of working toward the future and developing assessments with predictive validity.

It is especially helpful to have a chapter devoted to the Torrance Tests of Creative Talent. There is a kind of renewed interest in divergent thinking, evidenced by three recent Special Issues of the *Creativity Research Journal* (one devoted to divergent thinking, one devoted to the research of J. P. Guilford, and one devoted to the research of E. Paul Torrance), and the Torrance Tests are probably the most commonly used indicator of divergent thinking and creative potential. They of course do not provide a perfect index of creativity, but they do provide very useful estimates of the potential for creative problem-solving. This is an important difference, because, there is an assumption that creativity can be captured with paper and pencil tests. Of course that is not true. That is why this volume is fortunate to have chapters devoted

to motivation and contextual influences. Even if an individual has the potential to be creative, he or she still needs to be motivated and receive support for it. The Torrance Tests are relatively comprehensive, and scores from them are related to results provided by other tests of divergent thinking. But again, all tests of divergent thinking merely provide estimates of the potential for creative thought.

This volume also contains fascinating discussions of what creativity is not, such as the chapter devoted to habit, which is typically antithetical or diametric to original and creative thought. Other chapters explore relationships between creativity and puzzles and various forms of problem-solving. The chapters devoted to what creativity is not, and how it relates to puzzles, problem-solving, and other human capacities, round out our understanding of creativity and have specific implications for education. Educators should, after all, both encourage the behaviors that are related to creative expression, and at the same time discourage those which lead to blind conformity and other antitheses of creative efforts. At the very least, it would be useful for educators to provide opportunities for creative self expression, appropriately reward creative behavior, model creative behavior, and avoid overemphasizing blind conformity and the rigid thinking that might preclude creative behavior. The present volume will be enormously helpful in this, and in many other ways.

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Creating a World of Possibilities: Indigenous and Cultural perspectives

Uichol Kim

Creativity is a hallmark of humanity that separates human beings from other animals. While animal behavior can be explained in terms of instincts and genetic programming, human beings are agents of our action who pursue goals that are meaningful and fulfilling (Bandura, 1997). Creativity is an individual and cultural phenomenon that allows us to transform possibilities into reality. When an individual discovers insights or produces new art forms and they are accepted by others, they become a part of cultural tradition, recorded, and transmitted to subsequent generations.

In modern classrooms, teaching methods have become increasingly routine and objective in the transfer of knowledge. We seem to impart knowledge objectively but we do not necessarily let students experience the process through which discoveries are made and how they transformed our world. We teach our students to be consumers of knowledge rather than encouraging them to participate in the creation of knowledge. To encourage creativity, we need to let them experience the creative process in which possibilities are made into reality.

Possibility 1: Transforming the Physical World

We can take our students to the beginning of time, without the modern comforts and technology, without the knowledge that we take for granted, and take them through a journey of how civilization came into

being. Early in history, human beings were frail and vulnerable: We cannot run as fast as a deer, soar through the sky like an eagle, navigate in the dark like the bat and have the prowess of a tiger. As a physically weak species, we were at a constant mercy of predators and nature. The first major transformation came with the understanding of the fire.

Like all animals, we would have been in awe at the destructive forces of the fire. Instead of instinctively fearing fire, we began to understand the nature of fire. We observed that wood fuels fire and water can extinguish it. With this understanding, fire was no longer viewed as a threat. We used the power of fire to protect us from predators. As long as the fire was kept burning, no animal, however, fierce or strong, would dare to attack us.

We transformed the destructive forces of fire and used it to create adaptive. We discovered that by cooking food over the fire, the kind and type of food that we could eat increased. Fire was used to shape clay or wood into cups, utensils, boats, weapons, and bricks. Clay was transformed into a pottery, which can be used to cook food evenly and to store water. It was also transformed into bricks, which allowed us to build houses. Weapon, such as spear, was invented to make hunting more efficient. How can we use formless clay to make something that did not exist in nature? A cup could be made from formless clay since we had a symbolic understanding of an idea of a container. Later in civilization, we learned to use bronze, iron, and now silicon to manage our world tools (Kim, Helgesen and Ahn, 2002).

We also developed an understanding of nature. Animals, such as, cow, pigs, and chickens, existed in the wild, and it would be our natural instinct to hunt, kill, and consume them. We have, however, learned to domesticate them as a way of storing and producing food. Similarly, we have discovered that if we plant the seeds and cultivate them, we could produce food from the land. We have domesticated the instincts of predators, such as wolves and lions, so that they serve as our protectors, workers or as our companions as dogs or cats. With the basic subsistence problems resolved, we began to question meaning of life, the cause of life, and death and the world beyond our borders.

Possibility 2: Advancing the World of Knowledge

Religion, philosophy, and science were constructed to answers these basic questions. When Socrates asked his students to "know thyself," it was a revolutionary concept. Greeks believed that our lives were controlled by whims of gods and we could only appease them through religious rituals. Socrates wanted his students to use critical reasoning to discover the Truth by questioning existing values, beliefs, and knowledge. This type of free-thinking threatened the religious leaders and he was sentenced to death in 399 B.C. His revolutionary ideas, however, did not die but became refined and extended by succeeding generations, such as Plato and Aristotle, and in modern life.

In mathematics, Pythagoras discovered that all right-angled triangles followed the Pythagoras Theorem. Although human beings were imperfect, we could discover universal truth through the use of our reason. In natural sciences, when Archimedes discovered the Law of Displacement, he ran outside excited shouting "eureka!" At this time common sense told us that all matters had unique property, but Archimedes discovered a universal property call mass. In the field of medicine, Hippocrates rejected superstitious temple medicine and developed a more rational, naturalistic medicine.

Religions played a central role in advancing knowledge. In modern world, we do not equate Islam with advancing science, mathematics, philosophy and democracy, but it played a major role in the past. Prophet Muhammad stated: "The search after knowledge is obligatory for every Muslim" and "the ink of the scholars is worth more than the blood of the martyrs" (Kim, Aasen and Ebadi, 2003). Muslim scholars first translated and recorded the Greek philosophy and science into Arabic, through which they were introduced to the rest of the world. For them, God (*Allah*) represented the Truth and human beings were endowed with rationality to know the Truth and the search for Truth was inseparable from religion.

Muslim scholars developed the Arabic numerals, including zero and made arithmetic and complex mathematics possible (Kim *et al.*, 2003). They introduced algebra, decimals, negative numbers, logarithms, and algorithms, which became the language for developing

computer software. They pointed out that the earth was spherical and not flat and explained the movement of the stars, turning of the earth on its axis, and earth circling the sun, centuries before Copernicus. The word chemistry is originally an Arabic word. Muslim scholars have developed the field of chemistry. They have developed the encyclopedia of medicine, *al-Qanun*, which became one of the chief medical books.

Possibility 3: Openness to Cultural Diversity

Philosophy, religions, arts, and sciences provide a different way of viewing the world and a culture provides a coherent way of understanding and managing the world for its members. Culture represents *the collective utilization of natural and human resources to achieve desired outcomes* (Kim, 2001). We have to understand the goals and aspiration of people in a particular culture, the process by which they achieve these goals and the natural and human resources that are used to reach these goals. Without culture, we would be like other animals, reduced to basic instincts. Culture allows us to know who we are, define what is meaningful, communicate with others and manage our environment.

Cultures differ in what people develop and contribute to the world civilization (Kim, Yang and Hwang, 2006). The basic difference between two cultures is a variation in emphasis rather than quality. In the West, there is an emphasis on the individual and rationality: Socrates asked his students to *know thyself* and Déscartes summarized his existence through *I think, therefore I am*. In East Asia, Confucianism emphasizes human relationships and emotion that binds individuals together. To understand the self, we need to understand our past and future. Our parents and ancestors represent our past and our children represent our future. The human world is interconnected and intertwined with relationships and emotions (such as affection, loyalty, sacrifice, and care). In schools, Confucianism taught about universal laws, values, and ethics, which are essential for developing a broad understanding of humanity, compassion, and justice.

Buddhism takes a step further. It is through understanding of relatedness of individuals, nature and the world that we develop a universal

sense of compassion, justice and understanding. It is not through satisfying our needs, as Maslow's (1999) theory states, but detachment and control of our basic needs that Buddhists are able to self-actualize. Buddhism provides an alternative view of how creativity is achieved by rejecting individualism and hedonism and by affirming the relatedness of the self to others, nature, and the universe.

Taoism takes another approach to creativity. It states that modern knowledge can act as a barrier to our natural curiosity and creativity. Children are naturally curious and creative but socialization and education can destroy it. For example, children can play for hours bouncing a ball back and forth to an adult, while adults can become bored within minutes. This is because the adult conceptualize the outcome: The ball will be sent back and forth. However, children experience the ball bouncing and they are excited since the ball never bounces the same. Moreover, the most important part of reality (e.g., a room) is not what we see (i.e., walls and ceiling), but what we do not see (i.e., the empty space surrounded by the walls). Without the empty space, a room would be useless. Science teaches us to focus on what we see and verify, but Taoism teaches us to focus on what is invisible but important.

Finally, the culture that we have created for ourselves and that we hold dear can have a different meaning for others and our children. If the culture that is created by and for adults is imposed on our children, then it can be perceived as a prison. If adults' culture is incompatible with the life children want to lead, then they will rebel and change it. Generational conflicts arise since adults use the past to understand the present and shape the future using the past. Adolescents, on the other hand, do not share the same past, and they focus on the future — on what is not real but possible. The same is true when we impose our culture on others who do not share the same beliefs, values, or skills. For society and civilization to change progressively, we must allow our children to participate in the creative and building process. The right answer that we know with certainty may not be the right answer for them. Children must be allowed to uses their creativity to transform society that is able to suit their needs and goals.

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The Multiple Roles of Educators in Children's Creativity

Thomas B. Ward

Introduction

As I began writing this preface in the summer of 2006, two interesting computer technology anniversaries were approaching. Fifty years ago this Fall, IBM brought to the world the first computer with a magnetic disk drive, a gigantic unit that weighed in at a ton and stored about 5 MB of information. By comparison to today's standards, that's enough storage space for about seven photos from my digital camera. Twenty-five years later, in 1981, IBM introduced its PC, which was designed to fit on a desktop, and whose slightly more sophisticated XT cousin a couple years later sported a 10 MB hard drive. Though far from the first personal computer, the IBM PC nevertheless represents one of the important milestones in modern technological progress. In roughly 25 years from the introduction of the first disk drive, innovations in the computer industry made it possible for individuals to have twice the storage of the original hard disk drive in a package only a tiny fraction of its original size.

As we all know, the trend toward greater storage and processing power not only continued but also accelerated over the subsequent 25 years. I will not give examples of specific contemporary devices because the examples would be outdated before this book even went into print, but a simple consideration of the physical size, storage capacity, and sophistication of generic devices such as cell phones, PDAs, digital

cameras, and MP3 players makes clear that enormous technological changes have occurred in a very short time in the way we store and process information, and consequently in the way we live our lives.

The progress described in the preceding paragraphs highlights three important points about creativity and innovation. The first is the simple observation that humans are enormously creative. The mind-boggling technological advancements over the last 50 years mirror on a much smaller time-scale our stunning achievement over about 2 million years of going from chipping away at rocks to form our first tools, all the way to building spacecraft to travel to other bodies in our solar system to examine and retrieve the rocks there. It is in our nature to innovate. And technological progress captures only a small portion of our creative output, which extends to literature, art, music, science, medicine, business, and countless other domains. We do not all use our creative potential, and sometimes it is used for harmful rather than helpful purposes, but we nevertheless share a capacity to use our minds creatively to improve the human condition and to operate in greater harmony with the world around us. Educators, who get a close-up, first-hand look at the way children use their minds are in a unique position to observe and encourage that creative capacity, and the knowledge contained in this book can help them in that endeavor.

The second point is that there is an ever-escalating competition among corporations and countries for economic preeminence. Success is heavily dependent on the capacity of an organization to innovate, which in turn is dependent on having highly creative workers capable of envisioning the next generation of products and bringing those visions to fruition. Consequently, our educational systems and the way they train future innovative thinkers are key to competitive success.

The third point has been made repeatedly in recent years, but nevertheless bears restating. The pace of societal change has accelerated tremendously and continues to do so. Regardless of any drive for economic stature, countries will need to have citizens who are capable of adapting to continued and accelerated change. Again, schools as institutions and teachers as individuals are crucial.

So what role do you as a teacher have in recognizing and fostering the creative capacities of the future adults under your guidance who will inhabit this highly competitive, ever changing world? The chapters in this book provide a broad yet detailed look at the nature of creativity. They can help you to develop an understanding of the richness and complexity of the phenomenon. But perhaps more importantly, they can also help you achieve a perspective on your role as an educator in the creative development of the children who come into your classrooms.

Understanding the Nature of Creativity

In some ways, it may seem a daunting task to foster creativity in young people. But, understanding the nature of creativity can help in at least three ways. First, it can help you to adopt more creative approaches yourself, so that you can then model those approaches for your students. The more you know about the factors that provoke or inhibit your own creativity, the more you should be able to overcome blocks and recognize and pursue creative opportunities in your own life. Second, it can help you to see where and how you might be able to have the most impact on the students you encounter. The more you understand about creativity, the more potential you will have to recognize and foster it in those around you. Finally, it can help you to recognize that you are but one of many factors that together shape the mentality of your students. That is, you need not feel too heavy a burden as the sole determiner of the creativity of your charges.

To provide a perspective on this last point, in an adolescent psychology course I was teaching, during a discussion of sex education, a teacher who was taking the class for continuing education credit commented that she felt a responsibility to help children develop healthy approaches to sexuality, but also a concern that if educators took on the responsibility for that task, they would then set themselves up to be blamed for any subsequent problems, such as increased rate of teen pregnancy. In her view, it was a specific instance of a broader problem for educators. Parents, and society in general want schools to impart knowledge on a host of topics, and to foster citizenship, values, intellectual skills and so on, and are they are inclined to blame it on teachers

if children do not excel on all those fronts. So it would not be surprising if you, as a teacher, had some reluctance about taking on the challenge of helping to make the next generation more creative. If that becomes an explicit goal of the educational system, any shortcomings in their creative thought may be blamed on teachers, regardless of the true source of the difficulty.

Componential or confluence models of creativity are particularly helpful in gaining some perspective on the role of educators in students' creative functioning. Consider just one example, Robert Sternberg and Todd Lubart's classic investment theory, which links creative accomplishment to recognizing and pursuing ideas that have potential before they become popular, and then developing and pushing them so that others begin to see their value (Sternberg and Lubart, 1991, 1999). Like stock market investing, the best approach is to buy low and sell high. But the six main component ingredients of creativity specified in the theory are even more telling than the buy-low-sell-high principle. Creativity is assumed to result from the interactive combination of knowledge, intellectual skills, thinking style, personality, motivation, and the environment.

So where do educators fit into this bigger picture painted by the investment model? For one thing, they are clearly an important part of the child's environment. Historiometric analyses reviewed by Dean Keith Simonton (1999) suggest that, among other factors, eminent creators often have had the benefit of other eminent creators as mentors and role models. The ability to closely observe creativity in action seems to foster creativity. Although the effects of mentors generally refer to those involved in high-level, specialized training in specific domains, the broader point is that teachers, as one component of the child's environment, can serve as models of creative action. But, the environment refers to all the external forces acting on the child. Thus, it is critical to recognize that although you can exert an influence on children through your actions, there may be limits to what you can reasonably expect (and be expected to) accomplish. Children are also susceptible to influences from their families, teams, clubs, religious groups and other cultural and social settings in which children operate. All of those influences can either add to or detract from your efforts

to encourage creative thought. So, it would be an unfair burden to assume that a given teacher is the sole environmental determinant of a child's creative successes or failures.

What about the component of motivation as a contributing factor? Teresa Amabile and her colleagues have distinguished between intrinsic motivation for a particular creative activity and extrinsic motivation from expectations and contingencies (Amabile, 1983; Amabile *et al.*, 1994; Collins and Amabile, 1999). Most would agree that creative products come from those who love what they do. Without that strong internal motivation and drive, it would be difficult to sustain the effort needed to achieve meaningful creative outcomes. But, the sources of that intrinsic motivation are somewhat mysterious. Teachers can certainly present topics in more or less interesting ways, that will make students more or less likely to care about the topic, but the reasons a child might gravitate toward and become obsessed with a topic to the point of loving it are not always clear and they may be largely out of your control as a teacher. Likewise, the factors that determine a child's standing on two other components of the investment model, creative thinking style and a persistent, risk-taking, ambiguity-tolerant personality, are many and not always clear.

Thus, in the bigger picture, developing engaging lessons might contribute to a child's appreciation or even love of a topic, modeling creative thinking styles could conceivably boost the development of similar styles in children, and providing a tolerant classroom atmosphere might encourage even students with risk-averse personalities to come out a bit more, but potentially more progress can be made by educators by a focus on the components of knowledge and intellectual skills. Sternberg and Lubart's distinction between knowledge and skills also may help in clarifying your goals as an educator. You may be reading this book because you want to *teach more creatively* or because you want to *teach creativity*. My assumption is that most readers of this book will be more concerned with teaching creatively than with teaching creativity, though the latter may be a happy, incidental consequence of former.

Teaching Creatively

In the case of teaching creatively, adopting creative approaches to developing lesson plans and engaging students with the material can reasonably be expected to lead to better learning. Knowledge is sometimes overlooked as an ingredient of creativity, perhaps because there has been a strong emphasis in some circles on overcoming or breaking away from prior knowledge as being important to creativity. But, the fact is that nobody has ever made a meaningful creative advance in any domain about which they had no prior knowledge. Knowledge is a key building block of creative accomplishment. So, simply by imparting knowledge from your content area to your students, you are actually providing them with some of the raw materials they will need for creative thought on their own part. Clearly, the more effectively you can do that, the better they will learn, and so seeing how to develop creative teaching strategies that help students to establishing richer understandings of the topic may be one concrete goal you can set for yourself in reading this book.

But focusing on how much knowledge students gain from creative forms of instruction also highlights another concern that some teachers have. Some teachers, who value creativity and want to use it and encourage it in their classrooms, see a conflict between that goal and the pressures and expectations from school administrations and external groups. Nowhere is this more evident than in elementary and middle schools in the US operating under the pressures of the "no child left behind" (NCLB) movement. Although the NCLB principle that all children deserve a good education is laudable, and the fact that schools should be held accountable for providing that education is indisputable, the means of determining accountability in NCLB has the unfortunate, unintended consequence of stifling creative teaching. The near exclusive focus on the percentage of children who pass a basic test at a minimum level of performance has led to forms of instruction geared toward getting the most students to that minimum test performance rather than encouraging students to develop beyond that point and acquire a rich understanding, true domain mastery and love of learning. It also encourages the relative neglect of bright students who

show that they can pass the tests early in the school year. Since they will pass no matter what, schools have little incentive to give them the attention they need to become even better thinkers. In other words, the specific implementation of accountability in NCLB encourages NCGA, "no child gets ahead."

There are two ironies in this situation that are relevant to educators concerned with creativity. One is that while the US educational system seems mired in this well-intentioned, but creativity-stifling approach, Singapore among others seems on the path toward more and more emphasis on creativity at all levels of education. Thus, many societies may be concerned, ultimately, with competitiveness, but they seem to be taking quite different approaches to getting there, some of which appear to have a lower probability of success.

The other irony is that rote, test-focused approaches are not even necessary as responses to the accountability asked for in NCLB. John Schacter and his colleagues (Schacter, Thum and Zifkin, 2006), in their recent article in the *Journal of Creativity Behavior* found woefully few instances of creative teaching strategies among not only elementary school teachers, but also found that the few creative strategies that were used were associated with *larger* gains over the school year. In other words, rather than shunning creative teaching strategies out of fear that they will detract from time for test preparation, teachers, and school systems might be better served by adopting the most creative teaching approaches possible.

Becoming a Creative Teacher

So how can you become a more creative teacher? This book is full of useful advice in that regard, and absorbing its content and spirit is a good first step. Returning to the six components in Sternberg and Lubart's model as an organizing framework, there may be little you can do about your environment other than to try to select one that allows you to function as creatively as you can, and to encourage change when those in your environment try to impose unnecessary limitations. It also helps to be motivated by the love of your topic and the opportunity to help shape young minds. Choosing a topic that you really care about

or learning to love the one you have chosen is important. Without that obsession, it may be difficult to maintain a generative, creative thinking style, and to develop the personal traits of persistence and risk-taking in the face of adversity.

But, as with your students' creativity, concentrating on increasing your own content knowledge and developing the intellectual skills to use that knowledge effectively may yield great benefits. The creative cognition approach, as developed by Ronald Finke, Steven Smith and myself (Finke, Ward and Smith, 1992; Ward, Finke and Smith, 1999) provides an organizing framework for thinking about the interplay between knowledge and skills. Within that approach, creativity is assumed to emerge from the application of ordinary, fundamental cognitive processes to existing knowledge structures which results in ideas that are novel and useful. It is important to note that the processes, which are most involved in producing such ideas are ones that are within the capabilities of most, if not all, normal people. In effect, the potential for creative thought is normative, rather than rare for humans, which is why we have made the incredible innovative progress described in the open paragraphs of this preface. Many species use and even modify tools, but none other than humans have manipulated and built upon their knowledge about early versions of tools to develop new ones that ultimately lead them to escape the physical bonds of our home planet.

This is not to say that we all use our creative capabilities productively most of the time, nor does it imply that there are no individual differences in creative capacity. But it does say that most people can use the basic processes needed to produce novel and useful ideas. In addition, however, the creative cognition approach does not claim that there is nothing different about creative and noncreative thought. Although the same basic processes may be used, they are applied differently to produce different types of outcomes.

Of course most theorists, including the authors of the chapters in this book, would agree with the claim that novel and useful ideas emerge from mental operations performed on existing knowledge. Indeed, there is a sense in which this must be true because ideas

will not simply develop in a mental vacuum. But the creative cognition approach goes beyond that generality to talk about very specific processes and very specific interactions with existing knowledge, thereby providing concrete possibilities for deliberately behaving more generatively.

The creative cognition approach also differentiates between phases of creative activity. In the Geneplore model, for example, most creative accomplishments are seen as involving a generative phase in which candidate ideas are brought to mind, and an exploratory phase in which those ideas are evaluated, expanded, revised or otherwise developed. The initial candidate ideas, sometimes called preinventive ideas, are not seen as either creative or noncreative, but merely as having more or less creative potential. It is only through exploration that the potential in preinventive ideas is brought to fruition. The production of a truly creative idea may require several iterations between the generative and exploratory phases.

I will illustrate some aspects of the creative cognition approach by focusing on the basic process of information retrieval. Both creative and noncreative activities rely on retrieving stored knowledge, but some ways of retrieving may be more conducive than others to original, creative idea development. In particular, I will highlight a very general approach to retrieving information that I have called abstraction, because it reveals the interplay between existing knowledge and skill in accessing that knowledge. I also focus on abstraction because it serves to illustrate a favored topic of mine that old knowledge is a friend, not an enemy of creativity. As an educator, it is useful to keep in mind that most of what you know is valuable, and that the trick to being a creative teacher is not to abandon everything you have learned, but rather to use the best types of mental operations to access that knowledge in a way that makes it easier to apply creatively.

Prior knowledge may get some of its negative reputation in the creativity realm because people have a tendency to get trapped by the details of the specific earlier problem solutions they are familiar with. When trying to solve a new problem, it is easy to retrieve very specific examples of solutions to earlier problems. The result is that your new solution is not as creative as you would like it to be, because you

become fixated on the details of those earlier solutions. Examples of this abound, but here are two interesting cases. As detailed in John White's (1978) book on passenger trains, in the 1830s, when passenger rail travel was just getting started in the US, designers seem to have patterned the first passenger cars directly on horse-drawn stagecoaches, including the fact that conductors had to sit on the outside of the car. This approach was efficient in the sense that railway passenger cars became available quickly, but because they were seated on the outside, several conductors fell off and were killed. Another example is that, according to Joel Barker (1993) in his book, *Paradigms*, Sony initially abandoned development of music CDs because they did not think it was economically sensible to put 18 hours of music on a single CD. Why 18 hours? Because they were thinking that the CD would be 12 inches in diameter, just like vinyl LPs of the day. Clearly Sony caught up and overtook many competitors, but the initial narrow thinking about specific prior ideas appears to have slowed their initial entry into the market.

In each of the cases mentioned in the previous paragraph, retrieving specific earlier knowledge got in the way of innovation. Similarly nearly every teacher has encountered the difficulty of having to do things a certain way because "that's the way we've always done it," and even without such pressure, you may have just found it easier to develop new lessons by adapting old ones. If those old lessons are great, that approach may be fine, but if they have flaws or properties that are inappropriate for the new situation, it may result in unnecessary constraints on what you do in the classroom.

Conclusion: Abstraction Strategies

Abstraction is a procedure that helps people to avoid those kinds of traps to see new solutions. But, it does not just say "throw out everything you know." Instead, it encourages people to use their knowledge, but to represent their problems and access their knowledge at a very general level of abstraction. In fact, research from my own laboratory shows that when people are encouraged to take abstract approaches

to using their imagination, they produce products that end up being rated as more original (Ward, Patterson and Sifonis, 2004).

Here I will illustrate these concepts with two particular uses of abstraction, called the "Know Your Principles Strategy" and the "In Common Strategy." In using the "Know Your Principles Strategy," you take your abstract knowledge of the principles of your content area and use it to see as many real-world examples of those principles as possible. Of course, the more you know about the principles you want to teach, the better off you are, so constantly increasing the depth and breadth of your understanding of your topic is crucial. But also critical is to begin to develop both the "attitude" of looking around the world for examples of the principles in action and the skill of recognizing and exploiting those examples in lessons. By tying your ever-expanding abstract domain knowledge to concrete, even mundane aspects of the world that might otherwise go unnoticed, you may be able to develop more creative lessons that engage student interest and lead to more effective learning.

For example, if you teach geometry and love and obsess over it, if you think a lot about geometry and geometric principles, you can begin to look around your world and "see geometry everywhere." You can begin to recognize instantiations of abstract geometric principles in the simplest situations in the world around you. For example, consider the concept of slope. I once visited my niece, Amy, in Utah. She was taking geometry and learning (or rather trying to learn) about slope. She was working through problem after problem without any idea of how slope might matter in her world. She had no appreciation for what she was doing, the calculations were drudgery, and she kept making simple mistakes that would not be expected of a child as bright as she is. She was thoroughly bored, and her boredom was getting in the way of her mastering the material. It was odd too, because there we were in Utah, about to head up into the mountains to go skiing. Amy was very much afraid of going too fast on skis and always stuck to the "Bunny Slopes." Slope mattered very much in her life right then, but she did not know it. Why, in a state like Utah, where there is so much good skiing, did it not occur to her teacher to get children thinking about ski

slopes as a way to make the concept real to them? What slopes might scare them, what slopes would be just fine? Anyway, I think if Amy's teacher had looked at the world from the point of view of slope and other abstract geometric principles, if she lived and deeply "knew her principles," she might have been in the habit of seeing the principle in action everywhere.

To push this example just a bit further, how does slope come into play in designing a playground? What is the best slope for the slides? How high versus how long can a slide be and still be safe and fun? What would be different if you constructed a playground for adults, or bugs, or put it on the moon where there is less gravity? Maybe you could get students to learn about a lot of interrelated concepts by getting them to do these types of design tasks. Again, this is just an example. It may or may not be a good one from your perspective. The broader point is that by knowing your principles intimately you can apply the skill of noticing those everyday things that allow you to capture students' attention.

So, concretely, regardless of your topic area, try to see whatever abstract principles you teach about in action everywhere. Every time you see it, write it down. That is, keep a journal the way novelists do when they see something that they think they might want to use in a future story. If you just notice, but don't write it down, you're likely to forget. But with a notebook handy, you can always jot down the good examples you notice. You should end up with a big collection of ways to get kids thinking about the topic.

Returning briefly to the Geneplore model, the initial ideas you think of may be preinventive and have potential for creativity, but they may also need to be explored, evaluated and modified before they are worth bringing into the classroom. Share your collection with others to see if they are as captivated by the examples as you are. Keep the good ones and use exploratory thinking to work them into scenarios for your students to learn from.

Whereas the "Know Your Principles Strategy" uses your abstract knowledge in going from the general to the specific, the "In Common Strategy" goes from the specific to the general. In your own experience,

you have probably encountered a wide range of approaches to teaching a given lesson. Even if you have not, you can always go to the internet, which is overflowing with lesson plans that other teachers have posted on how to get across particular topics. Some of them will strike you as useful, and other may seem silly or misguided. Using the "In Common Strategy" your task is to abstract from them the general principles that hold across those that seem most effective. Do they rely on helping students to see day-to-day objects and events in new ways? Do they have particular ways of grabbing students' attention? Do they encourage learning indirectly through interaction with materials rather than directly through memorization? Whatever the principles are, your next task is to then use those abstractions as guides to develop new lessons. Again, that development may involve iterating between generating candidate ideas and then exploring and developing their potential. Along the way, the creativity emerges, not from rejecting any of your existing knowledge, but by accessing and manipulating it at abstract levels.

One reason for discussing the "In Common" version of the abstraction approach is to highlight one last crucial point. A trite, but nevertheless true adage is that giving a person a fish will feed them for a day, but teaching them how to fish will feed them for a lifetime. So it is with creative teaching approaches. If you find particularly creative and effective lessons that have been developed by others, by all means use them. Accept those fish gratefully. However, if you can generate abstractions from those lessons that help you know how to develop more creative lessons on your own, that will be even better. You will have learned to fish for your own creative ideas, and the skills can stay with you throughout your teaching career.

Abstraction is just one of many types of basic cognitive processes that you are capable of using and that you can exploit to become a more effective teacher. Others include conceptual combination, analogy, mental imagery, problem finding and problem definition, idea valuing and evaluating, and so on. The more you think about and deliberately apply these types of processes, the more likely it is that you will expand your creative potential.

Returning to the question of the role of educators in children's creativity, it is clear that there are multiple roles. These include motivator, supporter, lover of knowledge, source of inspiration and encouragement, highly knowledgeable partner in collaborative learning, and modeler of creative thinking styles and creative strategies. May this book be a useful guide for you!

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Creativity for Teachers

Ai-Girl Tan

Introduction

This handbook is compiled for teachers who have experienced challenges in undertaking multiple roles and responsibilities (Ward, Preface, this volume) including exploring what creativity is and how creativity can be enhanced. The volume is titled "*Creativity: A Handbook For Teachers*" to delimit the scope it covers and to remind us that the contents possibly pose more questions than provide answers to teaching creatively and nurturing creativity. Specifically, we attempt to inform teachers about the contemporary views of the nature of creativity (yet incomplete but with some forms of consensus) can become a platform for them to engage confidently in exploring creative ways to deliver knowledge and values to children and thus scaffold them in their journey of growing up to become excellent citizens, happy persons, and competent learners. Specifically, we share some experiences of nurturing creativity of children of various age groups and abilities. We also include some experiences of teaching creative techniques and skills with adults and from different cultural contexts. "Teacher" is a term used generally referring to professionals who share and deliver knowledge and who empower others to unfold and develop their abilities. In the knowledge-based, information technological era, teachers are challenged to deliver their knowledge and inculcate values in formal and informal, individual and social, and face-to-face and electronic settings. Teachers are expected to be open in accepting diversity and

uniqueness of children of all backgrounds, to develop their talents and explore their potential competencies in a psychologically safe and socio-culturally enriched environment.

In education, activities such as teaching, clinical supervision and thesis direction involve a creative process (Sarason, 1993; Keily, 1998). Creative teachers are knowledgeable and expert professionals. They are granted creative autonomy in their classroom. They establish purposes and intentions, build basic skills, encourage acquisition of domain-specific knowledge, stimulate curiosity and exploration, build motivation, encourage confidence and risk taking, focus on mastery and self competition, promote supportable beliefs, provide balance and opportunities for choice and discovery, develop self-management or meta-cognitive skills, teach techniques and strategies for facilitating creative performance and construct environment conducive for creativity and encourage imagination and fantasy (Nickerson, 1999; Schacter, Thum and Zikfin, 2006). Student and teachers engage in creative collaboration (Sawyer, 2004; Barrett, 2006). Last but not least, teachers may like to know ways to facilitate excellent teaching and effective learning.

In this handbook, we address essential themes related to creativity such as what is creativity? How can creativity be enhanced? In addition, we deem as important for teachers to get some insights into identifying talents and nurturing creativity of children with diversified backgrounds and age groups (i.e., high ability, special needs, elementary and high school, and adults). Other relevant questions (Sternberg, 2006) include what are the cognitive, personality, and motivational constituents of creativity? How can environment be designed to support creativity? What is the relation of creativity to knowledge and expertise? What role can technology and social context play in understanding and enhancing creativity?

The social importance of creativity has been widely recognized by researchers, educators, societal leaders, and laypersons alike (Guilford, 1950). What exactly creativity is? Briefly, creativity is the production of *novel* and *appropriate* ideas or works (Amabile, 1983a, b, 1996; Sternberg and Lubart, 1999). Creativity is a prerequisite for invention, innovation, and discovery (Draeger, 1991). In all facets of life, throughout the human history and civilization creativity is recognized

as one of the driving forces for change, progress, and transformation. "Creativity is certainly among the most important and pervasive of all human activities" (Simonton, 2000, p. 151). It is "a useful and effective response to evolutionary changes" (Runco, 2004, p. 658). Creative teaching enhances school students' performance (Schacter, Thum and Zikfin, 2006). Well-designed creativity training programs induce gains in performance (Scott, Leritz and Mumford, 2004). Creativity in academic departments can provide flexibility of output, process or structure that enables survival and growth (Heaton, 2005). Creative thinking can be a predictor of teacher effectiveness (Nitza and Migram, 2006).

Furthermore, there has been an increasing commitment of East Asians in the studies of creativity (Choe, 2006, the Koreans; Niu, 2006, the Chinese; Misra, Srivastava and Misra, 2006, the Indians; Mpofu *et al.*, 2006). New journals were inaugurated: *Thinking Skills and Creativity* (2006), *The Psychology of Aesthetics, Arts and Creativity* (2006). An international handbook of creativity was released (Kaufman and Sternberg, 2006). Another handbook of creative writing is in preparation (Kaufman and Kaufman). Special issues on creativity were compiled: *Gifted and Talented International* (2005, volume 20, issue 1)," *The Korean Journal of Thinking and Problem Solving* ("work and creativity", volume 15, issue 2, 2005), *The International Journal of Human-Computer Studies* (2005, volume 63), *International Journal of Early Years Education* (volume 14, issue 3, 2006). Educators and researchers begin to discuss and *formulate evaluation* on the use information technologies (IT) of as tools to support learning and creativity (e.g., Schneiderman *et al.*, 2006).

Today, we know more about the nature of creativity than we did in 1950, the year when Guilford (1950) devoted his presidential address to creativity before the fellow American psychologists. Creativity is different from intelligence (Sternberg and O'Hara, 1999). Creativity often refers to the process of bringing something novel and useful. Intelligence can be defined as the ability to purposefully adapt to, shape and select environments. Average intelligence, sufficient knowledge of the discipline (Weisberg, 1999), passion in task or intrinsic motivation (Collins and Amabile, 1999), and supportive environments are

essential for creative behavior. Simonton (2000) recorded that psychologists have established a secured profile of creative personality characteristics that include independent, greater openness to new experiences, having wide interests, more risk-taking, and a more conspicuous behavioral and cognitive flexibility. He observed the shift of psychologists from the traditional investigations on superior intelligence (Galton and Terman) to a minimal relation of intelligence with creative work (Barron and Harrington) and further to *multiple* perspectives for all. Examples of multiple intelligences theories are Guilford's (1956) structure of intellect (i.e., five operations, four contents and six products, hence a total of 160 factors), Sternberg's (1985) triarchic theory of intelligence (i.e., practical, analytical, and creative), and Gardner's (1983, 1993) theory of multiple intelligences (i.e., linguistic, logico-mathematical, interpersonal, intrapersonal, bodily-kinesthetic, musical, and spatial).

To understand creativity *multiple* perspectives and contexts are suggested (Rhodes, 1961). Confluence approaches that highlight *multiple* components of creativity are recommended (Sternberg and Lubart, 1999). For instance, Sternberg and Lubart (1991) suggest six recourses: Intellectual abilities, knowledge, thinking styles, personality, motivation, environment (supportive and rewarding), and confluence of various components discussed above. The componential theory of creativity proposed by Amabile (1983a, b, 1996) includes three *intrapersonal* components, namely the creativity relevant processes (personality characteristics, cognitive styles, work habits that promote creativity), domain-specific skills (i.e., technical skills), and task commitment (e.g., love, passion, intrinsic motivation). According to Amabile (2001), creativity is beyond talent or gift, but demands support by intrinsic motivators (e.g., passionate love) and some extrinsic motivators or social environment (e.g., for competence development and deep involvement in the work, Amabile, 1996). Csikszentmihalyi (1988) conceptualizes the creativity in the personal and socio-cultural milieu. The individual, society (field), and culture (domain) are three interactive, open systems. Creativity is when a *person* has a new idea or sees a pattern and when this novelty is selected by the appropriate *field* (with the individuals act as gatekeepers to the domain who decide the inclusion

of a new idea, performance, or product) for inclusion in the relevant *domain* (e.g., mathematics or biology). *Flow* is the state of mind when a person engages in creative tasks (Csikszentmihayi, 1996).

Similarly, educators and researchers develop confluence models to for high ability (Renzulli, 1986; Heller, 2005). As the goal of education is growth (Dewey, 1937/1997) or full human development (Freire, 2002). Confluence approaches to identifying and developing talents are highlighted here. For instance, Renzulli's (1986) implicit theory of giftedness is represented by the components of intelligence, creativity and motivation. Giftedness is the overlap of these components. There has been some discussion on life span talent and creativity development and the social contexts of creativity (interpersonal environment, disciplinary environment, and socio-cultural environment) (Simonton, 2000). Dean Keith Simonton uses *historiometric* method to analyze extensive archive data to support theories of eminence, creativity and talent development that is multi-dimensional, social psychological, and evolutionary (Simonton, 1988; Simonton, 1999). The Munich Model of Giftedness (MMG) and its revised version the Munich Dynamic Model of Giftedness (MDMG) (Heller, 1992) is an example of confluence model with developmental and educational dimensions (Heller, Perleth and Lim, 2005). After more than half a century of creativity research and decades of engagement in talent development, it is a continuous challenge for educators and researchers to refine and further invent models and instruments sound theories and vigorous research to uncover abilities and develop talents of all children. Some experts' views are mentioned here. Winner (2000) reviews that the prodigy does not always end in becoming creators, some might display little 'c' (Craft, 2000) or become experts. Furthermore, Simonton (2003) regards it important to study creativity beyond either correlational studies (person-environment) or experimental studies (process) but from three perspectives, integrating the product, person and process into a unified view of scientific creativity. Reis (1989) calls for educational policy that benefits the bright and the double at-risk (the gifted with learning disabilities, Reis and Ruban, 2005). Van Tassel-Baska (2005) proposes and documents benefits of differentiated curricula and instruction. Renzulli (2005) suggests the school-wide enrichment

model that gifted education pedagogy shall be employed for total talent development of all students.

Creativity research uses data such as archives, surveys, and tests (Runco, 2004). There seems to be a renewed interest in Torrance's tests which have a significant predictive validity for creative achievement (Renzulli, 2003; Cramond *et al.*, 2005; Fryer, 2006). Some interests in cognitive processes are observed in the areas of creative insights especially during the incubation period (Dijksterhuis and Meurs, 2006), creative cognition (emergence of creativity from ordinary cognitive processes) (Finke, Ward and Smith, 1992; Smith, Ward and Finke, 1995; Ward, Smith and Vaid, 1997), and the use of computers to test explicit cognitive models of the creative process.

The advent of the neuro-imaging has provided new evidence to the query if creativity has a biological base. Martin Reuter and team, for instance were able to postulate first candidate genes (i.e., the DRD2 gene and the TPH gene) for creativity (Reuter *et al.*, 2005, 2006). The neuroscience technological research may suggest, though premature, an underlying biological base for complex, psychological, or intellectual competencies (e.g., intelligence, wisdom and creativity) (Kalbfleisch, 2004). Flaherty's (2005) three-factor anatomical model of idea generation and creative drive predicts interactions among the temporal lobes, frontal lobes and the limbic system for high cognitive functioning replacing the tradition neuro-scientific models (e.g., the left brain–right brain hemispheric model) of creativity.

Organization of the Volume

The chapters in this volume are organized into three parts.

Part One: Exploring the Nature of Creativity

The theme selected for part one is 'Exploring the Nature of Creativity.' A relevant question for teachers is thus, 'What is creativity?' Other relevant questions include 'What are components of creativity?,' and 'How to identify them?' Ten chapters are lined up in three parts: 'Conceptions and Theories of creativity,' 'Research in creativity,' and 'Identification and assessment.' The chapters attempt to provide teachers

some insights into the nature of creativity from the perspectives of theoretical, best evidence-based and scientific discourses and investigations, successful programs in developing excellence in education (e.g., giftedness), and promising means to develop creative potentials (e.g., assessment).

Section I '*Conceptions of Creativity*' comprises four chapters.

In Chapter 1, Robert Sternberg begins with what creativity is not, i.e., habit or an attitude toward life. He proposes that the habit of creativity should to be cultivated through means such as redefining problems, questioning and analyzing assumptions, selling creative ideas, encouraging generation of idea, encouraging children to identify and surmount obstacles, encouraging sensible risk-taking, encouraging tolerance of ambiguity, helping children build self-efficacy, helping children find what they love to do, and providing an environment that fosters creativity. The author describes the investment theory of creativity, which he developed with Tudd Lubart comprising a confluence of six resourses: Intellectual abilities (the synthetic ability, the analytic ability, and the practical-contextual ability), knowledge, thinking styles (legislative), personality (willingness to take sensible task, willingness to tolerate ambiguity, self-efficacy), motivation (intrinsic, task-focused), environment (supportive and rewarding), confluence of the components discussed above.

In Chapter 2, the social psychological theory of creativity is presented by Beth A. Hennessey, a student and co-author of the creativity scholar, Teresa Amabile. In this chapter, Hennessey narrates her journey into investigating creativity and motivation. She is aware of cultural uniqueness and diversity, and poses questions related to relevance of her studies across cultures. She shares in this chapter over 30 years of her research conducted in Western settings that demonstrates that creative behavior stems from more than just a deep conceptual understanding of a discipline or unusually high levels of skill. According to her, numerous empirical investigations have demonstrated that if individuals working and learning in the West are to reach their creative potential, they must approach a task with intrinsic motivation—they must engage in that task for the sheer pleasure

and enjoyment of the activity itself rather than for some external goal. Intrinsic motivation is an especially delicate and fleeting entity. The chapter reviews studies grounded in a social psychological tradition in the American educational setting, from kindergarten to high school, which is characterized by teaching practices and curricular features that are especially detrimental to intrinsic motivation. Expected reward, expected evaluation, competition, and deadlines have all been shown to be powerful killers of intrinsic motivation and creativity. But can these findings be applied to students living and learning in non-Western cultures? Hennessey poses a thesis that the social construction of intrinsic motivation and creativity is far from universal. Instead, she claims that cultural background serves to shape our understanding of these constructs as well as the way that investigators frame their research questions or construct and conduct experiments.

In Chapter 3, Kurt A. Heller clarifies the conceptions of creativity and high ability. Like most researchers and educators (e.g., Paul Torrance, Joseph Renzulli, and Klaus Urban) Kurt Heller and colleagues adopt a comprehensive approach to identify and uncover high ability and creativity. In this chapter, the Munich Model of Giftedness (MMG) has multiple components, such as talent factors or predictors (e.g., intelligence and creativity in multiple domains, and social competence), environmental conditions and personality characteristics as moderators, and performance areas as criteria variables. In addition, the chapter presents how creativity is a determinant in developing scientific abilities, and inclusion of divergent production and convergent production in technical creativity.

In Chapter 4, Jiannong Shi and colleagues are national scientists and educational leaders in the field of excellence. They propose a confluence framework of cultivating creativity. The chapter begins with the description of the bio-psycho-social model of human beings. It then follows by the illustration on how creativity is conceptualized within a systemic context. Finally, the chapter discusses a model of creativity training program, and some preliminary findings of the children.

Section II '*Research in Creativity*' comprises of three chapters.

Recently with the advancement in technologies, researchers have the opportunities to study the creativity from the biological perspective. Martin Reuter and colleagues are among them. Classroom-based research on creativity is rare. Ronald Beghetto in this chapter encourages teachers and classroom-based researchers to overcome pitfalls and maximize students' potentials.

Chapter 5 presents an overview on the research on the biological basis of creativity. According to Martin Reuter, there exist countless studies in the literature investigating the genetic, neuronal and biochemical underpinning of intelligence whereas research with respect to creativity in this area is scarce. Reuter analyzes reasons for the neglect of biological oriented creativity research and reviews studies on biological oriented creativity research. He outlines in this chapter different approaches from electrophysiology, endocrinology, and discusses molecular genetics and future research on creativity.

Chapter 6 presents pitfalls and potential to conduct creativity research in the classroom. The pitfalls include viewing creativity and originality as synonymous, believing that the only creativity that counts are contributions on the level of major breakthroughs, and believing that only certain students have creative potentials. In this chapter Ronald Beghetto suggests the following steps to encourage teachers to take part in creativity research: Becoming familiar with one's beliefs about creativity, helping address misconceptions held by students, colleagues and parents, and considering whether educational environments are supportive of creative expression.

Section III '*Identification and assessment*' comprises two chapters.

E. Paul Torrance (1915–2003) designed numerous tests to identify talents. He conducted research to verify and validate these tests. Chapter 7 reports creativity tests developed by Torrance, the 'Father of Creativity.' Kyung-Hee Kim reviews the Torrance Tests of Creative Thinking (TTCT) and Thinking Creatively in Action and Movement (TCAM). The TTCT can be administered as an individual or group test over a wide age range from kindergarteners to adults. The

TTCT has two versions, the TTCT-Verbal and the TTCT-Figural. TTCT-Verbal is designed to measure Fluency, Originality, and Flexibility. The TTCT-Figural is designed to measure Fluency, Originality, Elaboration, Abstractness of Titles, Resistance to Premature Closure, and Creative Strengths. The TCAM can be administered only as an individual test for pre-school and primary aged children ranging from ages 3 to 8. The TCAM is designed to measure Fluency, Originality, and Imagination.

Chapter 8 provides an overview of methods and ways of identification of talents, drawing upon experiences and learning points from the gifted education research and education. Christoph Perleth and Annett Wilde present the Dynamic model of giftedness, an integrative and developmental model of giftedness. This chapter discusses how giftedness is identified using psychometric tests, teacher checklists, and nomination by parents and peers.

Chapter 9 refers to a componential model of creativity and its assessment proposed by Urban. Urban's (2003) confluence model comprises general knowledge and thinking, domain-specific knowledge and special skills, task commitment, motivation, divergent thinking, and affective characteristics such as openness, tolerance, and ambiguity. Referring to the components, Urban develops tests of creativity and measuring criteria. He also recommends ways to stimulate and nurture creativity in schools and other settings.

Part Two: Nurturing Creativity

Part two 'Nurturing Creativity' focuses on reporting experiences of researchers and educators who have nurtured children with different abilities and people of varying age groups. In doing so, different aspects of nurturing creativity are highlighted by different researchers and teachers, each of them is useful. Some consider the importance of sequencing different types of questions (e.g., Erika Landau, Ching-Chin Kuo), others grading or assessment (Arthur Cropley and David Cropley), thinking (Anna Craft, Gerard Puccio and Susan Keller-Mathers, and Siew Lang Kong) and creative activities for stimulating learning environments (Horst Kasper, Subramanium, Goh and Chia).

In total, nine chapters are organized into two sections.

Section IV '*Experiences with Children with Different Abilities*' comprises six chapters.

Chapter 10 outlines the importance of asking questions in promoting creative thinking. Erika Landau highlights the importance of asking questions and its significance in developing cognitive and non-cognitive abilities. The types of questions and their sequence are discussed and shared.

In Chapter 11 Ching-Chih Kuo presents a program comprises the following components: a course which combined with multiple intelligences and problem-solving ability; group activity, which provides opportunities for children to do social intercourse and play; talent development, which includes six different areas to develop the strength of each child, i.e., mathematics, natural science, linguistics, music, art, and bodily-kinesthetic. Finally, self-chosen activity which allows each child to choose different corners to explore his(her) interests and progress in self-choosing ability and learning. Cases are included to illustrate the learning processes of the gifted or talented children with disabilities.

Chapter 12 discusses the fundamental problem of fostering creativity in the school, namely assessing creative products and grading creative performance. Arthur Cropley and David Cropley delineate criteria for assessing creative products such as relevance, effectiveness, elegance, and generalibility for routine, original, elegant, and innovative products. Indicators for assessing the above-mentioned products are outlined. A *routine* solution calls for the students to satisfy requirements in the problem statement. The indicators for routine solution include correctness, effectiveness and appropriateness which main criterion for the routine solution. An *original* solution is featured by novelty, which include the criterion problematization, adding to existing knowledge, and developing new knowledge. For each criterion, there are multiple indicators. For instance, indicators for problematization are diagnosis, prescription and relication; indicators for adding to existing knowledge redefinition, combination, and reconstruction; and indicators for developing new knowledge redirection, reinitiation and generation. An elegant solution is featured by the external elegance

or effect on other people indicated by recognition, convicingness and pleasingness; and by internal elegance indicated by completeness and harmoniousness. A generalizable solution refers to ideas that go beyond the immediate problems. Its indicators include foundationality and transferability.

Chapter 13 introduces the notion of possibility thinking at the heart of everyday creativity, relevant across the curriculum. Drawing the conceptual and empirical work from the last ten years in England, Anna Craft, suggests the following for teachers and learners to work collaboratively: posing questions, play, immersion, innovation, being imaginative, self-determination and risk-taking. The author discusses possibility thinking in the enabling context in the classroom.

Chapter 14 reports on Horst Kasper's experiences as an educator in Germany who created programs and designed activities to improve environments of teaching and learning in the school he led. Teacher beliefs are regulated toward supporting creative learning, and methods such as associative thinking for creative learning.

Chapter 15 focuses on the use of word puzzles in stimulating interest in creative thinking. V. Subramanium, Ngoh-Khang Goh and Lian-Sai Chia document their self-designed or adopted word puzzles in various classrooms. They believe that word puzzles can be used as stimuli to increase interests in learning. Word puzzles can be introduced in between changes of themes and before learning of new concepts or themes.

Section V "*Experiences with Adults in Enhancing Thinking Skills for Creative Problem Solving*" comprises three chapters.

Chapter 16 provides an overview of thinking skills and their relations with creative problem solving. Gerard J. Puccio and Susan Keller-Mathers give a brief introduction to the theme, define the skills and relate them to creative problem-solving processes. Supporting their standpoint is some research evidence. The chapter concludes with the possibility to integrate the skills into leadership programs.

In Chapter 17, Siew-Lang Kong describes how critical and creative thinking skills are enhanced for creative problem solving.

In Chapter 18, M. Takahshi presents creative techniques used frequently in Japan and discusses two techniques invented by the Japanese, i.e., the KJ- and NM methods for solving problems creatively. The chapter also outlines studies on habits of creative idea generation of adults working in the Japanese enterprises.

Part Three: Creativity in Contexts

Part three "Creativity in Contexts" includes chapters related to interdisciplinary creativity, the use of computer or information technologies (IT) to enhance creativity (e.g., in mathematics), and other perspectives.

Section VI "*Disciplinary Perspectives*" comprises five chapters.

In Chapter 19, Don Ambrose discusses academic and global contexts for creativity from the interdisciplinary perspectives. According to him, very broad contexts confine and shape the manifestation of creativity. He explores several contexts including the structure and dynamics of various academic disciplines on creative scholarship and the nature of neoliberal globalization on creative thought and action worldwide. Implications of the latter influences include the need to enhance the potency of altruistic creativity by capitalizing on the emergence of motley coalitions in global networks, and by replacing egoistic-individualistic exemplars of creative work with relational altruists. Ultimately, emerging new cultural myths could strengthen self-fulfillment globally while diminishing the barriers to aspiration development among the deprived.

Chapter 20 discusses creativity that can be enhanced by technology. Lai-chong Law coins the term "technology-enhanced" creativity referring to the use of recent sophisticated information and communication technologies (ICT) or its enhanced interfaces which encourage users to be more productive and creative. The chapter provides an overview of major theoretical models of creativity and human computer interactions (HCI), and how the basic tenets of cognitive theories endorsed in HCI and their implications for the design of creative support tools (CST). Law discusses practical issues related to teaching creativity in

the CST contexts: technical competence of users, environment conducive to creativity, ICT resources for teaching creativity, evaluation of ICT for enhancing creativity.

Chapter 21 is related to domain specific creativity. In this chapter, Gary Greenfield refers artificial creativity to the creativity (or lack thereof) in individual or collective autonomous agents such as; software bots, simulated swarms, or autonomous co-operating robots. Programmer creativity refers to the mental constructs implemented as computer programs (i.e., software objects) that give rise to the creative artifacts of individual programmers. Both of these creativity domains are contentious and misunderstood. The key to the former resides in the ownership of the creativity; the key to the latter resides in intent of the creativity. After carefully differentiating between the two, we show, by example, how programmer creativity plays a role in artistic endeavors.

Nava I. Livne, Oren E. Livne and Charles A. Wight in Chapter 22 report an innovative mathematics learning creative environment using information technology. What distinguishes creative thinkers from dogmatic thinkers in mathematics? It is their ability to generate multiple and original solutions to real-world problems. In the current study, a new method is described for assessing the creativity of student responses to the multiple choice and open-ended questions in a completely automated online learning and assessment Web site (http://ruready.net). The site was constructed for the purpose of promoting college readiness. The initial focus is on preparing students to take introductory college math courses such as Calculus. The strategy for assessing creativity of student responses is based on question items that have more than one correct solution (e.g., brute force vs. elegant solutions). A sophisticated math parsing software tool evaluates each student response, determines if it is a legal mathematical expression or equation, and determines if the response is mathematically equivalent to one or more of the "correct" answers in the site database. An advanced scoring algorithm provides continuous scores based on the degree of similarity of the student's responses to the correct solutions. The strategy also is used to evaluate the validity of multiple-choice question items, to score multiple-choice responses in cases where more

than one correct answer is possible, and to assist instructors to create new multiple-choice questions with effective distractor items. The new technique presented here provides a unique automated assessment tool for mathematics teachers to measure and track the level of creativity of their students.

Section VII "*Self and Other Perspectives*" comprises five chapters.

Chapter 23 explores the literature on self-regulation and its possible benefits to fostering creativity in the classroom. Wan-Har Chong begins the chapter by introducing what self-regulation is and its three key component skills, that is self-monitoring and self-evaluation, goal setting and strategic planning, and environmental restructuring. She further conceptualizes motivation of creative thinking from the perspectives of the role of self in self-regulatory processing, metacognitive processes, cognitive processes, and affective processes. Finally, the author proposes how self-regulation can be important in fostering creativity in the classroom.

In Chapter 24, Albert Liau attempts to conceptualize how positive psychology can benefit children's learning. Creativity is seen as a character-strength; and creative thinking is part of problem solving ability. The case for schools to foster individual attributes that go beyond developing children's intellectual ability has become increasingly evident. Researchers have argued for the importance of nonintellectual strengths for children's development by using terms such as emotional, social, successful, and practical intelligence as well as terms such as non-cognitive abilities and resilience. In this chapter, in line with the positive psychology movement, it is proposed that a framework of personal strengths is useful for schools to conceptualize the skills that children need to overcome adversities and succeed in life. In this framework, resilience consists of the following components: emotional awareness, self-control, self-efficacy, problem-solving ability, empathy, and social competence. These components are described and their links to creativity are illustrated. This chapter ends with a discussion of strategies to promote personal strengths in schools.

Chapter 25 presents creativity in cross-sub-disciplinary knowledge. Specifically, Chih-Chin Chou, Julie Chronistor and Fong Chan discuss

creativity in rehabilitation psychology. Social psychological theories, clinical interviewing, psychological testing, and treatment plan development are extended to the contexts of rehabilitating chronic illness and disabilities (CID). This chapter illustrates such extension of knowledge further with reference to clinical psychology and behavioral medicine. To conclude, the authors outline some challenges in rehabilitation psychology.

Chapter 26 records an attempt to relate psychological principle to teacher educational programs in encouraging teachers to be creative and to nurture creativity. Psychology, a scientific discipline has been consciously developing interdisciplinary relationships with education especially for espousing knowledge of and applying it in learning, thinking, creativity, and well-being (James, 1899; McGovern *et al.*, 1991). The advent of positive psychology during Martin Seligman's presidency in 1998 commits to strength and virtue-based development. Creativity at the personal level is thus regarded as a strength (Bacon, 2005) complementing other strengths such as wisdom, intelligence and kindness for well-being and optimal functioning (Simonton, 2000). Positivity broadens and builds cognitive and emotional repertoire of skills for health, coping and resilience (Fredrickson and Branigan, 2005; Fredrickson and Joiner, 2002; Fredrickson and Losada, 2005; Fredrickson *et al.*, 2000). The authors Ai-Girl Tan and Shyn-Shin Wong highlight the importance of full development, regulating affects, and positive coping using creative techniques.

Chapter 27 introduces a neuro-cognitive approach to higher cognitive functions that bridges the gap between psychological and neural level of description. Wlodzislaw Duch summarizes relevant facts about the brain, working memory and representation of symbols in the brain. He describes putative brain processes responsible for problem solving, intuition, skill learning and automatization. The role of non-dominant brain hemisphere in solving problems requiring insight is conjectured. Duch suggests that two factors seem to be essential for creativity: imagination constrained by experience, and filtering that selects most interesting solutions. In this chapter, experiments with paired-word association are analyzed in details and evidence for stochastic resonance effects is found. Brain activity in the process of invention of novel

words is proposed as the simplest way to understand creativity using experimental and computational means. Perspectives on computational models of creativity are discussed.

Chapter 28 presents the relation of culture and creativity in organization. Keith James and Jacob Eisenberg outline in the chapter commonalities, divergences and levels of culture and creativity. They discuss about individual versus cultural creativity.

Conclusion

To develop creativity, teachers needs to be encouraged to be creative (Cermin, 2006), to support children's creative behavior (Honig, 2006) and to foster creativity with wisdom (Craft, 2006).

After half a century of efforts, we likely agree (Sternberg, 2006) that, creativity involves thinking aimed at producing ideas or products relatively novel and useful. Creativity has domain-specific and domain general elements. Creativity to some degree can be measured. Creativity to a certain degree can be developed or nurtured. Creativity in practice as it is supposed to be in the theory is yet to be highly rewarded. Yet, creativity faces challenges in many ways. According to Sternberg (2006), there are at least five reasons why creativity around the world is relatively poorly systematized. Creativity research is not mainstream! In psychology and education, creativity is still at the margin. "Creativity as a problem of study is large, unwieldy and hard to grasp" (Sternberg, 2006, p. 3). It takes too much time to complete a project on creativity. Creativity has been the subject of popularized programs and commercialization, little incentive for rigorous testing. Mentoring favors more students' contributions to mentors' research than students' productions of own creative ideas. Policymakers might face the challenges to balance their efforts in promoting critical and creative thinking and to maintain their authorities.

As a matter of fact, not all teachers including those who are expected to develop creative potentials of learners possess a comprehensive view of creativity. Evidently, most science teachers (Seo, Lee and Kim, 2005) and elementary school teachers (Lee and Seo, 2006) in gifted education who participated in the studies possessed a bias view of creativity. Many

of them conceptualized creativity merely with reference to cognitive perspectives such as thinking skills, problem solving and the quality of originality. Very few of them considered personality characteristics and environmental factors that foster or hinder creative performances.

There remain questions for teachers, educators and researchers to search for more answers: How to resolve cultural paradoxes (i.e., high academic achievement and obedience) might undermine teacher competence and beliefs in fostering creativity (Ng, 2003; Ng and Smith, 2004; Chan, 2005)? In what social contexts would different types of creativity such as historical *versus* psychological (Boden, 1991), big "C" *versus* little "c" (Craft, 2000), and Asian *versus* Westerners (Ng, 2001) be unfolded? How to precise the inclusive view for IQ and creativity (Kim, 2005)? How to evaluate creative problem solving programs by Parnes (1967, 1988, 1992) and Isaken and colleagues (Isaken and Treffinger, 1985; Isaken, Dorval and Treffinger, 2000)? How to provide environments to support changes in stylistic expression after illness (Bogousslavsky, 2005)? Would the indigenous cultures foster creative behavior (Kim, Preface, this volume)? Can teachers adopt techniques such as meditation (Lazar *et al.*, 2005) to regulate the state of relaxation that support unfolding of creative ideas? How to ensure that creativity is constructive for personal well-being (Maslow, 1954; Maslow, 1968; Maslow, 1971) as well as able to construct meaning in life (Frankl, 1969/1988)? How to nurture the twice exceptional children with giftedness and disabilities (e.g., Ruban and Reis, 2005; Milsom and Peterson, 2006)? How ready are teachers in working with researchers and conducting research on creativity?

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Creativity as a Habit

Robert Sternberg

Introduction

What is Creativity?

Creativity is a habit. The problem is that schools sometimes treat it as a bad habit. And the world of conventional standardized tests we have invented does that. Try being creative on a standardized test, and they will get slapped down just as soon as get their score. That will teach you not to do it again.

It may sound paradoxical that creativity—a novel response—is a habit—a routine response. But creative people are creative largely not by any particular inborn trait, but rather, because of an attitude toward life: They habitually respond to problems in fresh and novel ways, rather than allowing themselves to respond mindlessly and automatically.

Like any habit, creativity can either be encouraged or discouraged. The main things that promote the habit are: (a) opportunities to engage in it; (b) encouragement when people avail themselves of these opportunities; and (c) rewards when people respond to such encouragement and think and behave creatively. You need all three. Take away the opportunities, encouragement, or rewards, and we will take away the creativity. In this respect, creativity is no different from any other habit, good or bad.

For example, if you want to encourage good eating habits among students, you can do so by (a) providing opportunities to eat well in school and at home, (b) encouraging students to avail themselves of these opportunities, and then (c) praising young people who do in fact use the opportunities to eat well. Or suppose you want to discourage

smoking, you can do so by (a) taking away the opportunities for engaging in it (e.g., by prohibiting it in various places or by making prices of cigarettes so high one can scarcely afford to buy them), (b) discouraging smoking (e.g., advertisements showing how smoking kills), and (c) rewarding people who do not smoke (e.g., with praise or even preferred rates for health- and life-insurance policies).

This may sound too simple. It is not. Creative people routinely approach problems in novel ways. Creative people habitually (a) look for ways to see problems that other people don't look for, (b) take risks that other people are afraid to take, (c) have the courage to defy the crowd and to stand up for their own beliefs, and (d) seek to overcome obstacles and challenges to their views that other people give in to, among other things.

Educational practices that may seem to promote learning may inadvertently suppress creativity for the same reasons that environmental circumstances can suppress any habit. These practices often take away the opportunities for, encouragement of, and rewards for creativity. The increasingly massive and far-reaching use of conventional standardized tests is one of the most effective, if unintentional, vehicles this country has created for suppressing creativity. I say "conventional" because the problem is not with standardized tests, per se, but rather, with the kinds of tests that we use. And teacher-made tests can be just as much of a problem

Conventional standardized tests encourage a certain kind of learning and thinking—in particular, the kind of learning and thinking for which there is a right answer and many wrong answers. To create a multiple-choice or short-answer test, you need a right answer and many wrong ones. Problems that do not fit into the right answer— wrong answer format do not well lend themselves to multiple-choice and short-answer testing. Put another way, problems that require divergent thinking are inadvertently devalued by the use of standardized tests. This is not to say knowledge is not important. On the contrary, one cannot think creatively with knowledge unless one has the knowledge with which to think creatively. Knowledge is a necessary, but in no way sufficient condition for creativity. The problem is that schooling

often stops short of encouraging, being content if students have the knowledge.

Examples are legion. If one is studying history, one might take the opportunity to think creatively about how can we learn from the mistakes of the past to do better in the future. Or one might think creatively about what would have happened had a certain historical event not come to pass (e.g., the winning of the Allies against the Nazis in World War II). But there is no one "right" answer to such questions, so they are not likely to appear on conventional standardized test. In science, one can design an experiment, but again, designing an experiment does not neatly fit into a multiple-choice format. In literature, one can imagine alternative endings to stories, or what the stories would be like if they took place in a different era. In mathematics, students can invent and think with novel number systems. In foreign language, students can invent dialogues with people from other cultures. But the emphasis in most tests is on the display of knowledge, and often, inert knowledge that may sit in students' heads but may at the same time be inaccessible for actual use.

Essay tests might seem to provide a solution to such problems, and they might, but as they are typically used, they don't. Increasingly, essay tests can be and are scored by machine. Often, human raters of essays provide ratings that correlate more highly with machine-grading than with the grading of other humans. Why? Because they are scored against one or more implicit prototypes, or models of what a "correct" answer should be. The more the essay conforms to one or more prototypes, the higher the grade. Machines can detect conformity to prototypes better than humans, so essay graders of the kind being used today succeed in a limited form of essay evaluation. Thus, the essays that students are being given often do not encourage creativity—rather they discourage creativity in favor of model answers that conform to one or more prototypes.

Oddly enough, then, "accountability" movements that are being promoted as fostering solid education are, in at least one crucial respect, doing the opposite: It is discouraging creativity at the expense of conformity. The problem is the very narrow notion of accountability

involved. But proponents of this notion of accountability often make it sound as though those who oppose them oppose any accountability, whereas, in fact, they instead may oppose only the narrow form of accountability conventional tests generate. The tests are not "bad" or "wrong," per se, just limited in what they assess. But they are treated as though they assess broader ranges of skills than they actually do assess. Curiously, governments may have a stake in such narrow, but not broad, forms accountability.

Governments often wish to encourage conformity—after all, they see themselves as promoting order, usually order with respect to themselves—and so they inadvertently may prefer an educational agenda that promotes a model of an educated person that minimizes or excludes creative (i.e., nonconforming) thinking. Their goal is not necessarily to punish creativity, but rather to ensure their own stability and longevity. The punishment and extinction of creativity is merely a byproduct. Thus, they may promote education, but not a kind of education that fosters creative thinking. They may also fail to promote active critical thinking, which also potentially puts their longevity at risk. Sometimes, they will allow creative or critical thinking, so long as it is not applied to their own policies. It is easy for a government or other powerful organization to slip into the view that critics are "traitors" who must be ridiculed or punished. Inert knowledge is much safer to stability, because it gives the appearance of education without most of the substance.

Governments sometimes go the other way. In order to enhance economic competitiveness a program is initiated to encourage creativity in citizens. Did this initiative, however, result in sharp increases in creativity? It is doubtful. Why? Because it is one thing for an authority to encourage creativity, and quite another to get people to believe that enhancing creativity will lead to better outcomes in school or in life. Creativity is socialized through thousands upon thousands of acts of teachers, parents, and other authority figures. So is conformity. If people have been socialized over the years to think in conforming ways, and if they have been rewarded for conforming, no single governmental initiative is likely to change the way people think and act. Conformity

may be so much a part of the social fabric that people give it up only reluctantly.

Whereas creativity is seen as departure from a mean, conformity is seen as adherence to that mean. Societies often speak of the "tall-poppy" phenomenon, whereby tall poppies—those that stick out—are cut down to size. If one grows up in a society that cuts down the tall poppies, or does what it can to ensure that the poppies never grow tall in the first place, it will be difficult to generate creative behavior. People in such societies will be so afraid of departure from the mean that the will be unwilling to be creative, whatever their creative abilities might be.

Why is creativity even important? It is important because the world is changing at a far greater pace than it ever has before, and people need constantly to cope with novel kinds of tasks and situations. Learning in this era must be life-long, and people constantly need to be thinking in new ways. The problems we confront, whether in our families, communities, or nations, are novel and difficult, and we need to think creatively and divergently to solve these problems. The technologies, social customs, and tools available to us in our lives are replaced almost as quickly as they are introduced. We need to think creatively to thrive, and, at times, even to survive.

But this often is not how we are teaching children to think—quite the contrary. So we may end up with "walking encyclopedias" who show all the creativity of an encyclopedia. In a recent bestseller, a man decided to become the smartest person in the world by reading an encyclopedia cover to cover. The fact that the book sold so well is a testament to how skewed our conception has become of what it means to be smart. Someone could memorize that or any other encyclopedia, but not be able to solve even the smallest novel problem in his or her life.

If we want to encourage creativity, we need to promote the creativity habit. That means we have to stop treating it as a bad habit. We have to resist efforts to promote a conception of accountability that encourages children to accumulate inert knowledge with which they learn to think neither creatively nor critically.

How Can We Develop Creativity in Children?

Consider 12 keys for developing the creativity habit in children.

Redefine Problems

Redefining a problem means taking a problem and turning it on its head. Many times in life individuals have a problem and they just do not see how to solve it. They are stuck in a box. Redefining a problem essentially means extricating oneself from the box. This process is the synthetic part of creative thinking.

There are many ways teachers and parents can encourage children to define and redefine problems for themselves, rather than—as is so often the case—doing it for them. Teachers and parents can promote creative performance by encouraging their children to define and redefine *their own* problems and projects. Adults can encourage creative thinking by having children choose their own topics for papers or presentations, choose their own ways of solving problems, and sometimes having them choose again if they discover that their selection was a mistake. Teachers and parents should also allow their children to pick their own topics, subject to the adults' approval, on projects the children do. Approval ensures that the topic is relevant to the lesson and has a chance of leading to a successful project.

Adults cannot always offer children choices, but giving choices is the only way for children to learn how to choose. Giving children latitude in making choices helps them to develop taste and good judgment, both of which are essential elements of creativity.

At some point everyone makes a mistake in choosing a project or in the method they select to complete it. Teachers and parents should remember that an important part of creativity is the analytic part—learning to recognize a mistake—and give children the chance and the opportunity to redefine their choices.

Question and Analyze Assumptions

Everyone has assumptions. Often one does not know he or she has these assumptions because they are widely shared. Creative people

question assumptions and eventually lead others to do the same. Questioning assumptions is part of the analytical thinking involved in creativity. When Copernicus suggested that Earth revolves around the sun, the suggestion was viewed as preposterous because everyone could see that the sun revolves around Earth. Galileo's ideas, including the relative rates of falling objects, caused him to be banned as a heretic.

Sometimes it is not until many years later that society realizes the limitations or errors of their assumptions and the value of the creative person's thoughts. The impetus of those who question assumptions allows for cultural, technological, and other forms of advancement.

Teachers can be role models for questioning assumptions by showing children that what they assume they know, they really do not know. Of course, children should not question every assumption. There are times to question and try to reshape the environment, and there are times to adapt to it. Some creative people question so many things so often that others stop taking them seriously. Everyone must learn which assumptions are worth questioning and which battles are worth fighting. Sometimes it is better for individuals to leave the inconsequential assumptions alone so that they have an audience when they find something worth the effort.

Teachers and parents can help children develop this talent by making questioning a part of the daily exchange. It is more important for children to learn what questions to ask—and how to ask them—than to learn the answers. Adults can help children evaluate their questions by discouraging the idea that the adults ask questions and children simply answer them. Adults need to avoid perpetuating the belief that their role is to teach children the facts, and instead help children understand that what matters is the children' ability to use facts. This can help children learn, how to formulate good questions and how to answer questions.

Society tends to make a pedagogical mistake by emphasizing the answering and not the asking of questions. The good student is perceived as the one who rapidly furnishes the right answers. The expert in a field thus becomes the extension of the expert student—the one who knows and can recite a lot of information. As John Dewey recognized, how one thinks is often more important than what one thinks. Schools

need to teach children how to ask the right questions (questions that are good, thought-provoking, and interesting) and lessen the emphasis on rote learning.

Do Not Assume That Creative Ideas Sell Themselves: Sell Them

Everyone would like to assume that their wonderful, creative ideas will sell themselves. But as Galileo, Edvard Munch, Toni Morrison, Sylvia Plath, and millions of others have discovered, they do not. On the contrary, creative ideas are usually viewed with suspicion and distrust. Moreover, those who propose such ideas may be viewed with suspicion and distrust as well. Because people are comfortable with the ways they already think, and because they probably have a vested interest in their existing way of thinking, it can be extremely difficult to dislodge them from their current way of thinking.

Thus, children need to learn how to persuade other people of the value of their ideas. This selling is part of the practical aspect of creative thinking. If children do a science project, it is a good idea for them to present it and demonstrate why it makes an important contribution. If they create a piece of artwork, they should be prepared to describe why they think it has value. If they develop a plan for a new form of government, they should explain why it is better than the existing form of government. At times, teachers may find themselves having to justify their ideas about teaching to their principal. They should prepare their children for the same kind of experience.

Encourage Idea Generation

As mentioned earlier, creative people demonstrate a "legislative" style of thinking: They like to generate ideas. The environment for generating ideas can be constructively critical, but it must not be harshly or destructively critical. Children need to acknowledge that some ideas are better than others. Adults and children should collaborate to identify and encourage any creative aspects of ideas that are presented. When suggested ideas do not seem to have much value, teachers should not just criticize. Rather, they should suggest new approaches, preferably ones that incorporate at least some aspects of the previous ideas that

seemed in themselves not to have much value. Children should be praised for generating ideas, regardless of whether some are silly or unrelated, while being encouraged to identify and develop their best ideas into high-quality projects.

Recognize That Knowledge Is a Double-Edged Sword and Act Accordingly

On the one hand, one cannot be creative without knowledge. Quite simply, one cannot go beyond the existing state of knowledge, if one does not know what that state is. Many children have ideas that are creative with respect to themselves, but not with respect to the field because others have had the same ideas before. Those with a greater knowledge base can be creative in ways that those who are still learning about the basics of the field cannot be.

At the same time, those who have an expert level of knowledge can experience tunnel vision, narrow thinking, and entrenchment. Experts can become so stuck in a way of thinking that they become unable to extricate themselves from it. When a person believes that he or she knows everything there is to know, he or she is unlikely to ever show truly meaningful creativity again.

The upshot of this is that I tell my students and my own children that the teaching-learning process is a two-way process. I have as much to learn from my students and my children as they have to learn from me. I have knowledge they do not have, but they have flexibility I do not have—precisely because they do not know as much as I do. By learning from, as well as teaching to, one's children, one opens up channels for creativity that otherwise would remain closed.

Encourage Children to Identify and Surmount Obstacles

Buying low and selling high means defying the crowd. And people who defy the crowd—people who think creatively—almost inevitably encounter resistance. The question is not whether one will encounter obstacles; that obstacles will be encountered as a fact. The question is whether the creative thinker has the fortitude to persevere. I have often wondered why so many people start off their careers doing creative

work and then vanish from the radar screen. I think, I know at least one reason why: Sooner or later, they decide that being creative is not worth the resistance and punishment. The truly creative thinkers pay the short-term price, because they recognize that they can make a difference in the long term. But often it is a long while before the value of creative ideas is recognized and appreciated.

Teachers can prepare children for these types of experiences by describing obstacles that they, their friends, and well-known figures in society have faced while trying to be creative; otherwise, children may think that they are the only ones confronted by obstacles. Teachers should include stories about people who were not supportive, about bad grades for unwelcome ideas, and about frosty receptions to what they may have thought were their best ideas. To help children deal with obstacles, teachers can remind them of the many creative people whose ideas were initially shunned and help them to develop an inner sense of awe of the creative act. Suggesting that children reduce their concern over what others think is also valuable. However, it is often difficult for children to lessen their dependence on the opinions of their peers.

When children attempt to surmount an obstacle, they should be praised for the effort, whether or not they were entirely successful. Teachers and parents alike can point out aspects of the children's attack that were successful and why, and suggest other ways to confront similar obstacles. Having the class brainstorm about ways to confront a given obstacle can get them thinking about the many strategies people can use to confront problems. Some obstacles are within oneself, such as performance anxiety. Other obstacles are external, such as others' bad opinions of one's actions. Whether internal or external, obstacles must be overcome.

Encourage Sensible Risk-Taking

When creative people defy the crowd by buying low and selling high, they take risks in much the same way as do people who invest. Some such investments simply may not pan out. Moreover, defying the crowd means risking the crowd's wrath. But there are levels of sensibility to keep in mind when defying the crowd. Creative people take sensible

risks and produce ideas that others ultimately admire and respect as trend-setting. In taking these risks, creative people sometimes make mistakes, fail, and fall flat on their faces.

I emphasize the importance of sensible risk-taking, because I am not talking about risking life and limb for creativity. To help children learn to take sensible risks, adults can encourage them to take some intellectual risks with courses, with activities, and with what they say to adults—to develop a sense of how to assess risks.

Nearly every major discovery or invention entailed some risk. When a movie theater was the only place to see a movie, someone created the idea of the home video machine. Skeptics questioned if anyone would want to see videos on a small screen. Another initially risky idea was the home computer. Many wondered if anyone would have enough use for a home computer to justify the cost. These ideas were once risks that are now ingrained in our society.

Few children are willing to take many risks in school, because they learn that taking risks can be costly. Perfect test scores and papers receive praise and open up future possibilities. Failure to attain a certain academic standard is perceived as deriving from a lack of ability and motivation and may lead to scorn and lessened opportunities. Why risk taking hard courses or saying things that teachers may not like when that may lead to low grades or even failure? Teachers may inadvertently advocate children to only learn to "play it safe" when they give assignments without choices and allow only particular answers to questions. Thus, teachers need not only to encourage sensible risk-taking, but also to reward it.

Encourage Tolerance of Ambiguity

People often like things to be in black and white. People like to think that a country is good or bad (ally or enemy) or that a given idea in education works or does not work. The problem is that there are a lot of grays in creative work. Artists working on new paintings and writers working on new books often report feeling scattered and unsure in their thoughts. They often need to figure out whether they are even on the right track. Scientists often are not sure whether the theory

they have developed is exactly correct. These creative thinkers need to tolerate the ambiguity and uncertainty until they get the idea just right.

A creative idea tends to come in bits and pieces and develops over time. However, the period in which the idea is developing tends to be uncomfortable. Without time or the ability to tolerate ambiguity, many may jump to a less than optimal solution. When a student has almost the right topic for a paper or almost the right science project, it is tempting for teachers to accept the near miss. To help children become creative teachers need to encourage them to accept and extend the period in which their ideas do not quite converge. Children need to be taught that uncertainty and discomfort are a part of living a creative life. Ultimately, they will benefit from their tolerance of ambiguity by coming up with better ideas.

Help Children Build Self-Efficacy

Many people often reach a point where they feel as if no one believes in them. I reach this point frequently, feeling that no one values or even appreciates what I am doing. Because creative work often does not get a warm reception, it is extremely important that the creative people believe in the value of what they are doing. This is not to say that individuals should believe that every idea they have is a good idea. Rather, individuals need to believe that, ultimately, they have the ability to make a difference.

The main limitation on what children can do is what they think they can do. All children have the capacity to be creators and to experience the joy associated with making something new, but first they must be given a strong base for creativity. Sometimes teachers and parents unintentionally limit what children can do by sending messages that express or imply limits on children' potential accomplishments. Instead, these adults need to help children believe in their own ability to be creative.

I have found that probably the best predictor of success among my children is not their ability, but their belief in their ability to succeed. If children are encouraged to succeed and to believe in their own ability to succeed, they very likely will find the success that otherwise would elude them.

Help Children Find What They Love to Do

Teachers must help children to find what excites them to unleash their children's best creative performances. Teachers need to remember that this may not be what really excites them. People, who truly excel creatively in a pursuit, whether vocational or avocational, almost always genuinely love what they do.

Helping children find what they really love to do is often hard and frustrating work. Yet, sharing the frustration with them now is better than leaving them to face it alone later. To help children uncover their true interests, teachers can ask them to demonstrate a special talent or ability for the class, and explain that it does not matter what they do (within reason), only that they love the activity.

In working with my children and my students, I try to help them to find what interests *them,* whether or not it particularly interests me. Often, their enthusiasm is infectious, and I find myself drawn into new areas of pursuit simply, because I allow myself to follow my children rather than always expecting them to follow me.

I often meet students who are pursuing a certain career interest not because it is what they want to do, but because it is what their parents or other authority figures expect them to do. I always feel sorry for such students, because I know that although they may do good work in that field, they almost certainly will not do great work. It is hard for people to do great work in a field that simply does not interest them.

Teach Children the Importance of Delaying Gratification

Part of being creative means being able to work on a project or task for a long time without immediate or interim rewards. Children must learn that rewards are not always immediate and that there are benefits to delaying gratification. The fact of the matter is that, in the short term, people are often ignored when they do creative work or even punished for doing it.

Many people believe that they should reward children immediately for good performance, and that children should expect rewards. This style of teaching and parenting emphasizes the here and now and often comes at the expense of what is best in the long term.

An important lesson in life—and one that is intimately related to developing the discipline to do creative work—is to learn to wait for rewards. The greatest rewards are often those that are delayed. Teachers can give their children examples of delayed gratification in their lives and in the lives of creative individuals and help them apply these examples to their own lives.

Hard work often does not bring immediate rewards. Children do not immediately become expert baseball players, dancers, musicians, or sculptors. And the reward of becoming an expert can seem very far away. Children often succumb to the temptations of the moment, such as watching television or playing video games. The people who make the most of their abilities are those who wait for a reward and recognize that few serious challenges can be met in a moment. Children may not see the benefits of hard work, but the advantages of a solid academic performance will be obvious when they apply to college.

The short-term focus of most school assignments does little to teach children the value of delaying gratification. Projects are clearly superior in meeting this goal, but it is difficult for teachers to assign home projects, if they are not confident of parental involvement and support. By working on a task for many weeks or months, children learn the value of making incremental efforts for long-term gains.

Provide an Environment That Fosters Creativity

There are many ways teachers can provide an environment that fosters creativity. The most powerful way for teachers to develop creativity in children is to *role model creativity*. Children develop creativity not when they are told to, but when they are shown how.

The teachers most people probably remember from their school days are not those who crammed the most content into their lectures. The teachers most people remember are those teachers whose thoughts and actions served as a role model. Most likely they balanced teaching content with teaching children how to think with and about that content.

Occasionally, I will teach a workshop on developing creativity and someone will ask exactly what he or she should do to develop creativity.

Bad start. A person cannot be a role model for creativity unless he or she thinks and teaches creatively him- or herself. Teachers need to think carefully about their values, goals, and ideas about creativity and show them in their actions.

Teachers also can stimulate creativity by helping children *to cross-fertilize in their thinking* to think across subjects and disciplines. The traditional school environment often has separate classrooms and classmates for different subjects and seems to influence children into thinking that learning occurs in discrete boxes—the math box, the social studies box, and the science box. However, creative ideas and insights often result from integrating material across subject areas, not from memorizing and reciting material.

Teaching children to cross-fertilize draws on their skills, interests, and abilities, regardless of the subject. If children are having trouble understanding maths, teachers might ask them to draft test questions related to their special interests. For example, teachers might ask the baseball fan to devise geometry problems based on a game. The context may spur creative ideas because the student finds the topic (baseball) enjoyable and it may counteract some of the anxiety caused by geometry. Cross-fertilization motivates children who are not interested in subjects taught in the abstract.

One-way, teachers can enact cross-fertilization in the classroom is to ask children to identify their best and worst academic areas. Children can then be asked to come up with project ideas in their weak area based on ideas borrowed from one of their strongest areas. For example, teachers can explain to children that they can apply their interest in science to social studies by analyzing the scientific aspects of trends in national politics.

Teachers also need to *allow children the time to think creatively.* This society is a society in a hurry. People eat fast food, rush from one place to another, and value quickness. Indeed, one way to say someone is smart is to say that the person is *quick*, a clear indication of our emphasis on time. This is also indicated by the format of the standardized tests used—lots of multiple-choice problems squeezed into a brief time slot.

Most creative insights do not happen in a rush. People need time to understand a problem and to toss it around. If children are asked to

think creatively, they need time to do it well. If teachers stuff questions into their tests or give their children more homework than they can complete, they are not allowing them time to think creatively.

Teachers also should *instruct and assess for creativity*. If teachers give only multiple-choice tests, children quickly learn the type of thinking that teachers value, no matter what they say. If teachers want to encourage creativity, they need to include at least some opportunities for creative thought in assignments and tests. Questions that require factual recall, analytic thinking, and creative thinking should be asked. For example, children might be asked to learn about a law, analyze the law, and then think about how the law might be improved.

Teachers also need *to reward creativity*. It is not enough to talk about the value of creativity. Children are used to authority figures who say one thing and do another. They are exquisitely sensitive to what teachers value when it comes to the bottom line—namely, the grade or evaluation.

Creative efforts also should be rewarded. For example, teachers can assign a project and remind children that they are looking for them to demonstrate their knowledge, analytical and writing skills, and creativity. Teachers should let children know that creativity does not depend on the teacher's agreement with what children write, but rather with ideas they express that represent a synthesis between existing ideas and their own thoughts. Teachers need to care only that the ideas are creative from the student's perspective, not necessarily creative with regard to the state-of-the-art findings in the field. Children may generate an idea that someone else has already had, but if the idea is an original to the student, the student has been creative.

Teachers also need *to allow mistakes*. Buying low and selling high carries a risk. Many ideas are unpopular simply because they are not good. People often think a certain way because that way works better than other ways. But once in a while, a great thinker comes along—a Freud, a Piaget, a Chomsky, or an Einstein—and shows us a new way to think. These thinkers made contributions because they allowed themselves and their collaborators to take risks and make mistakes.

Although being successful often involves making mistakes along the way, schools are often unforgiving of mistakes. Errors on schoolwork

are often marked with a large and pronounced X. When a student responds to a question with an incorrect answer, some teachers pounce on the student for not having read or understood the material, which results in classmates snickering. In hundreds of ways and in thousands of instances over the course of a school career, children learn that it is not all right to make mistakes. The result is that they become afraid to risk the independent and the sometimes-flawed thinking that leads to creativity.

When children make mistakes, teachers should ask them to analyze and discuss these mistakes. Often, mistakes or weak ideas contain the germ of correct answers or good ideas. In Japan, teachers spend entire class periods asking children to analyze the mistakes in their mathematical thinking. For the teacher who wants to make a difference, exploring mistakes can be an opportunity for learning and growing. Another aspect of teaching children to be creative is teaching them *to take responsibility for both successes and failures.* Teaching children how to take responsibility means teaching children to (1) understand their creative process, (2) criticize themselves, and (3) take pride in their best creative work. Unfortunately, many teachers and parents look for—or allow children to look for—an outside enemy responsible for failures.

It sounds trite to say that teachers should teach children to take responsibility for themselves, but sometimes there is a gap between what people know and how they translate thought into action. In practice, people differ widely in the extent to which they take responsibility for the causes and consequences of their actions. Creative people need to take responsibility for themselves and for their ideas.

Teachers also can work *to encourage creative collaboration.* Creative performance often is viewed as a solitary occupation. We may picture the writer writing alone in a studio, the artist painting in a solitary loft, or the musician practicing endlessly in a small music room. In reality, people often work in groups. Collaboration can spur creativity. Teachers can encourage children to learn by example by collaborating with creative people.

Children also need to learn how *to imagine things from other viewpoints.* An essential aspect of working with other people and getting the most out of collaborative creative activity is to imagine oneself in other

people's shoes. Individuals can broaden their perspective by learning to see the world from different points of view. Teachers and parents should encourage their children to see the importance of understanding, respecting, and responding to other people's points of view. This is important, as many bright and potentially creative children never achieve success because they do not develop practical intelligence. They may do well in school and on tests, but they may never learn how to get along with others or to see things and themselves as others see them.

Teachers also need to help children recognize person–environment fit. What is judged as creative is an interaction between a person and the environment. The very same product that is rewarded as creative in one time or place may be scorned in another.

By building a constant appreciation of the importance of person–environment fit, teachers prepare their children for choosing environments that are conducive to their creative success. Encourage children to examine environments to help them learn to select and match environments with their skills.

Creativity, then, is in large part a habit that adults can encourage in children or in themselves. It remains only for teachers to help foster this habit.

The Investment Theory of Creativity

Together with Todd Lubart, I have proposed an *investment theory of creativity* as a means of understanding the nature of creativity (Sternberg and Lubart, 1991). According to this theory, creative people are ones who are willing and able to "buy low and sell high" in the realm of ideas. Buying low means pursuing ideas that are unknown or out of favor but that have growth potential. Often, when these ideas are first presented, they encounter resistance. The creative individual persists in the face of this resistance, and eventually sells high, moving on to the next new, or unpopular idea.

Research within the investment framework has yielded support for this model. This research has used tasks such as (a) writing short-stories using unusual titles (e.g., the octopus' sneakers), (b) drawing pictures with unusual themes (e.g., the earth from an insect's point of

view), (c) devising creative advertisements for boring products (e.g., cufflinks), and (d) solving unusual scientific problems (e.g., how could we tell if someone had been on the moon within the past month?). This research showed creative performance to be moderately domain-specific, and to be predicted by a combination of certain resources, as described below.

According to the investment theory, creativity requires a confluence of six distinct but inter-related resources: intellectual abilities, knowledge, styles of thinking, personality, motivation, and environment. Although levels of these resources are sources of individual differences, often the decision to use the resources is the more important source of individual differences.

Intellectual Abilities

Three intellectual skills are particularly important: (a) the synthetic ability to see problems in new ways and to escape the bounds of conventional thinking; (b) the analytic ability to recognize which of one's ideas are worth pursuing and which are not; and (c) the practical-contextual ability to know how to persuade others of—to sell other people on—the value of one's ideas. The confluence of these three abilities is also important. Analytic ability used in the absence of the other two abilities results in powerful critical, but not creative thinking. Synthetic ability in the absence of the other two abilities results in new ideas that are not subjected to the scrutiny required to make them work. And practical-contextual ability in the absence of the other two may result in the transmittal of ideas not because the ideas are good, but rather, because the ideas have been well and powerfully presented. To be creative, one must first *decide* to generate new ideas, analyze these ideas, and sell the ideas to others.

Knowledge

Concerning knowledge, on the one hand, one needs to know enough about a field to move it forward. One cannot move beyond where a field is if one doesnot know where it is. On the other hand, knowledge about a field can result in a closed and entrenched perspective,

resulting in a person's not moving beyond the way in which he or she has seen problems in the past. Thus, one needs to decide to use one's past knowledge, but also decide not to let the knowledge become a hindrance rather than a help.

Thinking Styles

With regard to thinking styles, a legislative style is particularly important for creativity, that is, a preference for thinking and a decision to think in new ways (Sternberg and Wagner, 1993). This preference needs to be distinguished from the ability to think creatively: Someone may like to think along new lines, but not think well, or vice versa. It also helps, to become a major creative thinker, if one is able to think globally as well as locally, distinguishing the forest from the trees and thereby recognizing which questions are important and which ones are not.

Personality

Numerous research investigations have supported the importance of certain personality attributes for creative functioning. These attributes include, but are not limited to, willingness to overcome obstacles, willingness to take sensible risks, willingness to tolerate ambiguity, and self-efficacy. In particular, buying low and selling high typically means defying the crowd, so that one has to be willing to stand up to conventions if one wants to think and act in creative ways. Note that none of these attributes are fixed. One can *decide* to overcome obstacles, take sensible risks, and so forth.

Motivation

Intrinsic, task-focused motivation is also essential to creativity. The research of Teresa Amabile and others has shown the importance of such motivation for creative work, and has suggested that people rarely do truly creative work in an area unless they really love what they are

doing and focus on the work rather than the potential rewards. Motivation is not something inherent in a person: One decides to be motivated by one thing or another.

Environment

Finally, one needs an environment that is supportive and rewarding of creative ideas. One could have all of the internal resources needed to think creatively, but without some environmental support (such as a forum for proposing those ideas), the creativity that a person has within him or her might never be displayed.

Confluence

Concerning the confluence of components, creativity is hypothesized to involve more than a simple sum of a person's level on each component. First, there may be thresholds for some components (e.g., knowledge) below which creativity is not possible regardless of the levels on other components. Second, partial compensation may occur in which strength on one component (e.g., motivation) counteracts a weakness on another component (e.g., environment). Third, interactions may also occur between components, such as intelligence and motivation, in which high levels on both components could multiplicatively enhance creativity.

Creative ideas are both novel and valuable. But, they are often rejected because the creative innovator stands up to vested interests and defies the crowd. The crowd does not maliciously or willfully reject creative notions. Rather, it does not realize, and often does not want to realize, that the proposed idea represents a valid and advanced way of thinking. Society generally perceives opposition to the status quo as annoying, offensive, and reason enough to ignore innovative ideas.

Evidence abounds that creative ideas are often rejected. Initial reviews of major works of literature and art are often negative. Toni Morrison's *Tar Baby* received negative reviews when it was first published, as did Sylvia Plath's *The Bell Jar*. The first exhibition in Munich of the work of Norwegian painter Edvard Munch opened and closed

the same day because of the strong negative response from the critics. Some of the greatest scientific papers have been rejected not just by one, but by several journals before being published. For example, John Garcia, a distinguished biopsychologist, was immediately denounced when he first proposed that a form of learning called classical conditioning could be produced in a single trial of learning.

From the investment view, then, the creative person buys low by presenting a unique idea and then attempting to convince other people of its value. After convincing others that the idea is valuable, which increases the perceived value of the investment, the creative person sells high by leaving the idea to others and moving on to another idea. People typically want others to love their ideas, but immediate universal applause for an idea usually indicates that it is not particularly creative.

Creativity is as much a habit in and an attitude toward life as it is a matter of ability. Creativity is often obvious in young children, but it may be harder to find in older children and adults because their creative potential has been suppressed by a society that encourages intellectual conformity. Yet, anyone can decide to adopt the creativity habit. Start right now!

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Creativity and Motivation in the Classroom: A Social Psychological and Multi-Cultural Perspective

Beth A. Hennessey

Introduction

Personal Experience

About 26 years ago, I moved across the US from Massachusetts to Colorado and assumed my first teaching position. My classroom was spacious and colorful and filled with wonderful art materials, math "manipulatives", and books. This was a mixed-age class composed of 5-, 6-, and 7-year-old children. The idea was that children would stay with me for 3 years. I would get to know them very well; they would get to know me; older students would help to "teach" and "serve" as an example for younger students; and the entire learning experience would be enhanced. I was certain that I had made the right career choice. There was nowhere on earth that I would rather have been, and I was convinced that I would teach forever. But after a few years, I found that the same nagging problem kept coming back to haunt me. I knew that my colleagues and I were successful at teaching reading, maths and science. Our students were building essential writing skills and knew the important facts. But what was not developing the way that I had hoped was their motivation and creativity.

Because I had kindergartners, first-, and second-graders all in one classroom, it was all too apparent to me what was happening slowly but surely, day in and day out. My kindergartners arrived at the start of the school year bursting with enthusiasm. They were ready to tackle almost any challenge, and their energy knew no bounds. They were

overflowing with wild and fanciful ideas, and their artwork and stories were fantastic. But by the time these same children reached second grade, many had lost their excitement about learning, and they were reticent to take a risk or try something new. "If these 8-year-old children have already lost their natural curiosity, their creativity, and their love of learning", I thought, "how will they ever make it through high school or beyond?"

Fairly quickly, my worries as a teacher began to shift from issues of neat handwriting, the mastery of multiplication tables and reading fluency to the realization that my students' motivation and creativity were dying right before my eyes. were it something I was doing? Were there some better ways to set up my classroom routines? Present my lessons? Structure my curriculum? I decided that I would not be satisfied until I found the answer to one fundamental question: how can we keep students' motivation and creativity alive? At first glance, this question seemed fairly simple. I assumed that there were a number of experts working on this problem. But the more I talked with other teachers and administrators and the more I read, the more discouraged I became. I began to realize that while virtually everyone seemed to think that the maintenance of student motivation and creativity was an important goal, no one had the answers I was looking for.

I believed that in order for deep, long-lasting learning to occur, students had to be motivated. I also believed that motivation led to high quality, and sometimes even creative performance. Like most of my colleagues, as a classroom teacher, I had incorporated a variety of incentive systems into the school day. Charts bearing gold, silver, and blue stars next to children's names lined my classroom walls. Students who completed high quality work before the deadline were rewarded with extra recess time, and everyone hoped that their short story, poem, or most recent artwork would be chosen as one of the "best" to be displayed on the bulletin board in the hall. My intentions were good. I was trying my best to boost the children's motivation by loading on incentives. But was I instead doing these children a disservice? I decided to return to school myself to find out.

Although I had not studied much psychology in college, I had great hopes that this was the discipline that would lead me to the answers I

needed. It was 1981, before the days of electronic searches on the Internet. I spent hours in the Denver Public Library perusing the psychology literature. Eventually, I came across research spearheaded by McGraw suggesting that in the classroom, intrinsic motivation is almost always preferable to an extrinsic motivational orientation. I found research evidence showing that intrinsic motivation leads to better problem solving and a deeper level of conceptual understanding (e.g., McGraw, 1978) and learned that, in the classroom, extrinsic motivation will consistently lead to better performance only on tasks requiring rote recitation, precise performance under strong time pressure, and the completion of familiar, repetitive procedures. Research psychologists and educational experts appeared to agree with my hunch that school environments fraught with rewards, competition, and frequent evaluation do not offer the best situations for students' overall learning. And the studies I found also suggested that such classrooms might not be the best environments for promoting students' creativity.

Researching further, I soon learned that there were at least a handful of investigators and theorists who were actively pursuing work on the link between motivation and creativity of performance. Today with my own investigations, I am striving to build upon that earlier work. When I started my own creativity research program, I had a decision to make. As many researchers have done, I could have focused my attention on creative persons and researched the components that make up the so-called creative personality. I also could have chosen to study the creative process. While each of these dimensions interest me, I have preferred to take a social psychological approach that focuses on the impact of various environmental constraints and motivators placed on students. The same question I asked as an elementary school teacher now guides my empirical research program. What kind of classroom setting is most conducive to student motivation and creative performance?

More formally, this research program into the social psychology of creativity is built on a three-part conceptualization of creative performance. In order for a creative solution to be found or a creative idea or product to be generated, an individual must approach a problem with, first, the appropriate domain skills (background knowledge), second, creativity skills (willingness to take risks, experiment, etc.),

and third, task motivation. Under ideal circumstances, a confluence of these three factors forms what Amabile (1988, 1996) has termed the "creative intersection." While an individual's creativity skills (e.g., familiarity with brainstorming and related techniques or the ability to temporarily suspend judgment) or domain skills (e.g., knowledge of chemistry, physics or engineering, or facility with a paint brush) may be fairly stable, their motivational state is likely to be highly variable, and largely situation-dependent. It is on this question of how the environment helps to shape motivational orientation that my colleagues and I have focused our attention. The model upon which our work is based tells us that, in the West, there is a direct relation between the motivational orientation brought to a task and creativity of performance on that task, and it is the environment that in large part determines that motivational orientation.

Operationalizing Intrinsic and Extrinsic Motivation

In 1973, Lepper, Greene, and Nisbett published an investigation of the effect of expected reward on young children's motivation. Initially, this study was intended to look at the impact of the promise of reward on pre-schoolers' task motivation. Children who were passionate about using magic markers, boys, and girls who when given a choice of tasks almost always chose to draw with them, were randomly assigned to either an Expected Reward, an Unexpected Reward or a Control, No Reward condition. All children met individually with the same experimenter. Pre-schoolers in the control condition were simply asked to make a picture. Children in the Expected Reward condition were promised a "Good Player" certificate if they would draw a picture. Children in the Unexpected Reward condition also received a certificate, but no mention was made of this reward until after they had drawn their picture. For children in the Expected Reward condition, working for a "Good Player" award significantly decreased their interest in and enjoyment of the drawing task. When compared with the unexpected reward and the control (no reward) groups, the children who had contracted with the experimenter to draw a picture in order to receive a Good Player certificate spent significantly less time

using the markers during subsequent free-play periods. Moreover, this undermining of interest persisted for at least a week beyond the initial testing session.

In this experimental paradigm, the drawing task was intended simply as a "vehicle" for examining the impact of reward on task motivation. But as Lepper, Greene, and Nisbett (1973) were packing up their materials, they began to notice what looked like important performance differences between groups. Might the promise of reward also have undermined the *quality* of the children's drawings? In an effort to test this proposition, judges were recruited to rate the children's pictures, and it was found that the globally assessed "quality" of the drawings produced under expected reward conditions was found to be significantly lower than that of the unexpected reward or control groups. It was these data that would lay the groundwork for the many studies of the impact of the classroom environment on student motivation and creativity that were to follow. How could this simple, one-time offer of a Good Player certificate serve to undermine the motivation and the performance of pre-schoolers who were passionate about using magic markers? This is one of the major questions that has motivated my own work and that of many of my colleagues for over 30 years.

In our conceptualization of the creative process, we distinguish between two types of motivation. Intrinsic motivation is defined as the motivation to do something for its own sake, for the sheer pleasure and enjoyment of the task itself. Extrinsic motivation, on the other hand, is the motivation to do something for some external goal. Our earliest investigations relied on a basic hydraulic model, which proposed that as extrinsic motivation increased, intrinsic motivation was bound to decrease. We now understand, however, that things are not this simple. Whether prompted by genuine excitement about a task, the need to demonstrate one's competence, or the promise of reward, each person's motivational orientation results from an internal, individualized process—the complexities of which we are only beginning to appreciate.

All the studies that my colleagues and I have conducted are built upon the premise that certain social and environmental characteristics (factors such as how a teacher introduces a project to students or how

various classroom routines are constructed and presented) can have profound effects upon motivation. We have found that intrinsic motivation is a delicate entity: it can be easily destroyed. That in itself is bad news. I am sure that every teacher and student would rather approach each day's work with excitement and an eagerness to learn. But what is even more disturbing is that without intrinsic motivation students won't perform to their potential. All aspects of their work will suffer, including their creativity.

The Basic Research Paradigm

About 30 years of empirical investigations conducted in the US and a few other highly industrialized Western nations have led us to the Intrinsic Motivation Principle of Creativity: intrinsic motivation is conducive to creativity, and extrinsic motivation is almost always detrimental (Amabile, 1983, 1996). A paper that we published in 1986 outlines a prototypical investigation from this research tradition (Amabile, Hennessey, and Grossman, 1986). In this study, the reward offered to elementary school children was not a tangible gift to be delivered afterward. Instead, it was an exciting and interesting activity—playing with an "instant" Polaroid camera—which the children were allowed to engage in before completing the target experimental task. In other words, children assigned to the reward condition signed a contract and promised to tell a story later to first have a chance to use the camera. Children in the no-reward condition were simply allowed to use the camera and then were presented with the story-telling instructions; there was no contingency established between the two tasks.

The children in this study were asked to tell a story into a tape recorder to accompany a set of illustrations in a book with no words to examine the impact of reward expectation on children's verbal creativity, (Hennessey and Amabile, 1988). Elementary school teachers, familiar with the kinds of stories children in this age group typically like to write and tell, later rated these products relative to one another on creativity and a variety of other dimensions. A high level of inter-rater reliability was reached; and results indicated that, overall,

stories produced by children in the no-reward condition were judged to be significantly more creative than were stories produced by children in the reward condition. Importantly, all children taking part in this investigation took pictures with the camera. The only difference in the experience of the rewarded and non-rewarded children was their *perception* of the picture-taking as contingent or not contingent on the target story-telling activity.

"Killers" of Creativity—A Review of the Literature

Like the investigation just described, most of the early research exploring the effects of environmental constraints on motivation and performance were focused on the impact of *expected reward* (Deci, 1971, 1972; Kruglanski, Friedman and Zeevi, 1971; Lepper, Greene and Nisbett, 1973; Greene and Lepper, 1974; Garbarino, 1975; Shapira, 1976; Kernoodle-Loveland and Olley, 1979; McGraw and McCullers, 1979; Pittman, Emery and Boggiano, 1982). Study participants produced some sort of real-world product, which was then rated according to a set of specified procedures. Since the early 1980s, many investigations of this type have relied on the Consensual Assessment Technique (CAT), which asks raters to assess products relative to one another on creativity and a variety of other dimensions. Judges are not trained in any way, nor do they have the opportunity to confer with one another. Instead, they are instructed to use their own, subjective definitions of creativity, liking, technical goodness, and so on (Amabile, 1982b; Hennessey and Amabile, 1999). It is assumed that if knowledgeable judges can agree in their independent ratings of creativity, as well as other dimensions, then those ratings must have a high degree of validity.

This body of research spans three decades. Over time, experimental approaches have become more sophisticated, but the basic findings have remained the same. Hundreds of published investigations reveal that the promise of a reward made contingent on engagement in an open-ended task frequently serves to undermine intrinsic task

motivation and qualitative aspects of performance, including creativity (for a more complete review of the literature, see Hennessey and Amabile, 1988; Amabile, 1996; Hennessey, 2000). This robust effect has been observed across the entire life span, with everyone from preschoolers to experienced professionals experiencing the same negative consequences.

Another potential "killer" of creativity and motivation is the *expectation of evaluation*. Two decades ago, it was thought that evaluation contingencies would invariably undermine intrinsic motivation and creativity. But, as is the case with the literature on expected reward, studies designed to investigate the impact of expected evaluation have also become increasingly complex. Researchers now have a much more in-depth understanding of evaluation effects and are quick to point out that not all evaluative situations can be expected to have the same damaging impact. For example, we now understand that the type of task presented to study participants can, in large part, drive experimental results. When a task is especially difficult, the delivery of a competence-affirming evaluation or the expectation of an impending evaluation can sometimes increase levels of extrinsic motivation without having any negative impact on intrinsic motivation or performance. In fact, under certain, specific circumstances, evaluation expectation can actually enhance the creativity of performance. These complex effects of expected evaluation are demonstrated in several recent publications (Harackiewicz, Abrahams and Wageman, 1991; Jussim *et al.*, 1992).

The important element here seems to be the preservation of a sense of self-determination. As Deci and Ryan (1985) explain, any extrinsic factors that support a sense of competence without undermining self-determination should positively contribute to intrinsic motivation (and creativity of performance). Thus, rewards or evaluations that are perceived as informational, useful and informative as to the quality of one's performance rather than as controlling instruments of coercion can serve to increase involvement in the task at hand and should not be expected to have detrimental effects. In other words, the effects of evaluative contingencies are not universal. The expectation that one's

performance will be evaluated will only be detrimental if the inter-personal atmosphere of the evaluative setting causes the individual to feel intimidated or self-conscious. In situations in which the individual feels in control of her own destiny, motivation, and creativity need not suffer.

In more recent years, researchers have gone on to uncover the damaging influence of a variety of other environmental constraints, such as *deadlines*, *surveillance*, and *competition*, on task motivation and creativity of performance (Amabile, 1982a; Amabile, Goldfarb, and Brackfield, 1990). Perhaps because situations of evaluation often combine aspects of reward, competition, surveillance, and time limits, investigations that have focused on the impact of evaluation, despite the complexities of evaluation constraints noted above, reveal that the expectation that one's work will be judged can be the most damaging extrinsic constraint of all.

One representative study of the effects of evaluation was reported by Amabile (1982a). The primary goal of this investigation was to exam-ine the impact of a competitive evaluation situation on the creativity of girls, ages 7–11 years. Study participants were randomly assigned to either a Saturday or a Sunday "Art Party." Girls attending the Saturday (non-competition-control) session were told that a variety of desirable toys and gifts would be raffled off at the end of the party. They then spent the afternoon participating in various fun activities, including a collage-making task that they completed without any expectation of evaluation. Girls attending the Sunday (competition) session had an identical experience, with one important exception. They played the same games and were given the same materials with which to make their art works, but when they arrived at the party they were told that prizes would be awarded to those children who made the "best" collages. Following the procedures outlined in the CAT (Ama-bile, 1982b; Hennessey and Amabile, 1999), artist-judges assessed the collage designs for creativity and a variety of other product dimen-sions. Analyses revealed that those collages made by girls in the non-competition condition were rated as significantly more creative than those made by girls in the competition condition.

A Proposed Mechanism for These Undermining Effects

Western researchers have found it all too easy to undermine task motivation and creativity of performance. What has not been as easy is to discover the internal mechanisms that bring about the undermining effects of competition, expected reward and impending evaluation.

What we have come to understand is that both children and adults are usually not aware of their motivations and their reasons for behaving the way they do. Almost as if they were outside observers of their own behavior, our study participants seem to use essentially the same rubrics for explaining their own actions as they do for explaining why others behave in the ways that they do. In situations where both a plausible internal and external (intrinsic and extrinsic) cause of behavior is present, subjects tend to *discount* the internal cause in favor of the external cause. For example, a pre-schooler in the seminal "Magic Marker" study (Lepper, Greene, and Misbett, 1973) might have thought to herself: "I must be making this picture not because it is fun and I love using markers but because this man has told me that I will get a Good Player Award". And my own young students may have reasoned: "I must be writing this story or building this model of the solar system not because I am excited about and interested in these activities, but because I know that I am going to be graded on my performance, and I really want my teacher to choose my work to display in the hallway".

Some social psychologists have come to refer to this thought process as the "discounting principle" (Kelley, 1973). Other theorists propose a related explanation termed the "over-justification" hypothesis, a formulation derived from the attribution theories of Bem (1972), Kelley (1967, 1973), and deCharms (1968). Whatever the terminology employed, when multiple explanations for their behavior are available, young and old alike have been found to discount their own intrinsic interest in favor of a purely external explanation for task engagement. It is as if a person cannot handle too much motivation—a task cannot be "overjustified".

But how might this tendency to adopt an extrinsic motivational orientation lead to decrements in creativity of performance? Amabile

(1996) proposes that an open-ended "creativity-type" task is very much like a maze. There is only one starting point, one entrance, but there are a variety of exit points and many different pathways to those exits. For the problem solver faced with an expected reward or evaluation, the goal is to get in and out of the maze, to complete the task, as quickly as possible. The "safest," most straightforward route will be chosen, and all behavior, all effort, will be narrowly directed toward assuring that an acceptable product or solution will be produced. In order for a creative idea to be generated, however, it is often necessary to temporarily "step away" from environmental constraints (Newell, Shaw, and Simon, 1962) and to become immersed in the problem, the maze, itself. The creative problem solver must be willing to explore the maze and experiment with alternative pathways, even if this takes more time and is less efficient. Attention must be directed toward more seemingly incidental aspects of the task; yet the more focused an individual is on a promised reward or evaluation, the less likely it is that risky detours will be taken and that these alternative paths to solution will be explored. After all, why delay the receipt of an expected reward or risk not receiving the reward at all?

A Blueprint for the Typical American Classroom?

Did the elementary school classroom environment that I had so carefully constructed allow my students to be excited about projects, become immersed in their learning and experiment with alternative solutions to problems? Or had the children in my classroom been socialized to avoid risks and opt for the safest, most uncreative path (i.e., the direct route out of the "maze")? Incredibly, the list of killers of intrinsic motivation and creativity outlined earlier (Expected Reward, Expected Evaluation, Surveillance, Time Limits, and Competition (Amabile, 1996; Hennessey, 1996)) looks a lot like a blueprint for not just my school in Colorado but for almost every school in the US, if not the entire Western world. The problem is that teachers and administrators (as well as parents) have wrongly come to assume that extrinsic incentives are always necessary to motivate children.

In truth, many classroom tasks do not require creativity and are fairly uninteresting. Teachers hoping to motivate students to learn their times tables, perfect their handwriting, or master a long list of spelling words may well be justified in setting up situations of competition or offering rewards for a job well done. These so-called "algorithmic" tasks have only one "right answer" and one straight-forward path to completion and often fail to excite students. They must be distinguished from more intrinsically interesting, open-ended, creativity-type tasks, like story-telling or drawing or even computer programming, in which there are many possible solutions, some far more creative than others. The important point to be made here is that most educators are not aware of the far-reaching negative consequences of extrinsic motivators promised for tasks that require creativity and that are in and of themselves interesting to students.

A Multi-Cultural Perspective

To reiterate, over 30 years of research evidence tells us that there is a direct link between an intrinsic motivational orientation and creativity of performance; and it is the social environment that, in large part, determines this motivational orientation. If student intrinsic interest and creativity are to flourish, current Western educational practices must be thoroughly re-examined. As a researcher and former primary school teacher, I am excited about the possibility of making substantial changes in classrooms; yet, for me, there remains one fundamental concern. Each of the theoretical models presented here, like each of the individual investigations upon which they have been based, is entirely grounded in Western (primarily American) cultural tradition (Lonner, 1989). If I had been a young teacher in Singapore or China or the Middle East, would my charts with the blue and gold stars or my promises to hang the "best" student work in the hall have had the same deleterious effects?

While Asian investigators and theorists have made many significant contributions to the creativity literature (perhaps more than any other non-Western group), the focus of their attention has generally not been

on the social psychology of creativity. Instead, much of the work coming out of Asia has attempted to illuminate the broad issues of how creativity is viewed or the role that creativity plays in Asian culture (Rudowicz and Hui, 1997, 1998; Rudowicz, Hui, and Ku-Yu, 1994; Rudowicz and Yue, 2000; Yue and Rudowicz, 2002). Other important Asian work has focused on the interface between personality and creativity (Rudowicz and Yue, 2003) or on populations of students who have been identified as gifted and talented (Shi and Zha, 2000).

With the exception of only a very few studies, Asian researchers have chosen not to focus on the impact of the environment on motivational orientation or creativity. And the same can be said of other non-Western research traditions as well. Simply stated, there are little empirical data on whether the negative impact of expected reward, expected evaluation, and competition is a global phenomenon or whether it is culturally specific. Can the Intrinsic Motivation Principle of Creativity be applied to populations of students in Saudi Arabia or Japan? Is there a link between motivational orientation and creativity of performance for persons of all cultures? Do the extrinsic constraints that have been shown to be so detrimental to the motivation of westerners have the same deleterious effects in China? And might not the concept of creativity and the positive value associated with it be a by-product of a Western, secular, democratic, and maybe even capitalistic world view?

If we are to make any real progress in our attempt to understand creativity, we must start with the basics. Not only must we ask how the culture into which we have been born impacts our creative development, but also we must explore how our cultural background serves to frame the very way we ask our investigative questions and construct and conduct our experiments.

In his book *Creativity and Beyond*, Weiner (2000) contends that the focus on creativity of products, the view that objects are individually valuable artifacts, prevents Westerners from considering the larger cultural fabric of which each individual is a part. (Lau, Hui, and Ng, 2004) also made this criticism and argue further that many Asian researchers also tend to fall into this trap. Even in the face of weak or opposing evidence, they too blindly adopt the Western viewpoint that says that creativity must be defined and recognized as a linear progression toward

an observable outcome. Theorists and investigators working from an Eastern tradition would focus far less attention on products or other tangible evidence of "work" produced. Instead, their operationalization of creativity would involve personal fulfillment or the expression of an inner essence or ultimate reality (Lubart, 1999). In other words, there is growing evidence to indicate that non-Western cultures may be operating with a different sense of what it means to be creative. Rather than highlighting the accomplishments of any one individual, in some nations, the social construction of creativity appears to center on a heightened sense of community and strong awareness of and respect for ancestors and traditions.

In fact, the conflict between an individual's pursuit of novel art forms or ideas and the maintenance of group cohesiveness and tradition is at the core of recent research and theorizing about the creativity across cultures. When the preservation of cultural identity and social stability is the primary goal, emphasis is placed on maintaining continuity and that which is familiar. Cultures that demand this strong commitment to the group and to inherited customs and beliefs are referred to as "collectivist" and "traditional" and are often compared to so-called "individualistic" or "modern" societies. These terms have slowly made their way into the mainstream creativity literature, to the extent that contemporary treatments of creativity often make reference to the collectivist/individualistic distinction. A variety of other polarities are discussed as well: self/society, creativity/conformity, and disorder/order. According to Ogilvy (1989), it has become difficult if not impossible to overcome these and other dualisms that are fundamental to "modern" ways of knowing. But if we are to carry out a valid cross-cultural examination of the Intrinsic Motivation Principle of Creativity, it is essential that we move beyond these rather simplistic dichotomies to the recognition that creative behavior is always embedded in highly complex and multi-faceted cultural contexts (Montuori and Purser, 1995).

The provocatively titled book, *Why Asians are Less Creative than Westerners*, authored by Ng (2001), offers an especially detailed and precise look at the interaction between the individual and his/her society or culture. Ng (2001) focuses on the conflict between creative and

conforming behavior and bases many of his arguments on his first-hand knowledge of both the Asian and the Western experience. It is his view that the challenge of being creative is entirely connected to the type of society in which we live. In fact, Ng (2002) maintains that because cultures vary so widely, they should not and cannot be directly compared. Such comparisons, he believes, are innately inappropriate and unfair.

Seminal experimental work carried out by Markus and Kitayama (1991), the psychologists many credit with creating the field of cultural psychology, also points to the conclusion that the workings of the mind are inextricably linked to sociocultural environment. As a discipline, psychology has long assumed psychological universals across nations. But Markus' research reveals that across cultures, people differ in some basic ways: they are motivated by different factors and show great emotional variety. There are also important culturally based differences in the nature of self-concept and the functioning of self-esteem. While her work does not focus on creative behavior *per se*, Markus's investigations of motivation offer findings that are directly relevant to the social psychology of creativity.

Markus and Kitayama (1991) point out that in the West, motivational theories and models usually center on some type of internal, individually-based need that is thought to be at the core of what is termed a person's self-system. The need to enhance one's self-esteem, to achieve or to self-actualize is but three motives that have been frequently linked to creative behavior in the US, Canada, and Europe. Markus and Kitayama (1991) question, however, whether the self-systems of persons living in more interdependent societies might be different in some fundamental ways. She hypothesizes, for example, that the ever-present need to attend to others or to gain acceptance may influence the form and function of an individual's internal motives. In other words, the motivational roots and explanations for behavior identified in Western psychology may not be universal after all. Taking this premise one step further, if persons in primarily interdependent societies are motivated differently than their Western peers, if their self-systems are distinctly different, does not it make sense that their motivational orientation and creative behavior might be impacted differently by extrinsic environmental constraints?

The boundaries begin to blur. In some cultural contexts, intrinsic, and extrinsic motivation may not be best conceptualized as bipolar constructs after all. For example, Markus and Kitayama (1991) report that while American college students tend to perform better after receiving praise, Japanese students do better after receiving critical feedback. Similarly, 9-year-old children living in the US find situations of free choice especially motivating, but Japanese and Chinese 9-year-old children are especially motivated after learning that their mother or a friend has chosen a task for them. At issue here is the role played by psychological dependence Like creativity, personal autonomy, and obedience are culturally defined psychological constructs. Children growing up in the West are typically conditioned to view dependence on others in a negative light. At home and in school they are constantly being encouraged to differentiate themselves from their peers. But in the East, children quickly learn that psychological dependence on the group leads to social approval (Ng, 2001).

Concluding remarks

Were this a chapter dedicated to the question of how best to promote intrinsic motivation and creativity in US schools, I would end with the following pair of recommendations:

(1) Teachers must work diligently to create an interpersonal atmosphere that allows students to feel autonomous, self-determined and in control of their learning process;
(2) Teachers and administrators must step back and critically review incentive and feedback systems that are currently in place: are they necessary; have they (borrowing terminology from Deci and Ryan) been designed to be informational; or are they perceived by students as primarily controlling?

Can these same recommendations be applied to non-Western classroom situations? I am not sure. Just as my colleagues and I have worked to expose the many ways in which US schools serve to kill the intrinsic motivation and creativity of students, it is my hope that researchers from around the world, investigators who are intimately familiar with

a variety of cultural traditions and self-systems, will be motivated to explore the impact of their own society's world view, social structure, and schooling practices on the motivation and creativity not only of children but of all citizens. To accomplish this goal, researchers and theorists must be willing to "start from scratch". They must not be swayed by existing Western models and must instead develop new, and perhaps different, approaches to the study of motivational orientation, the self-system, the social psychology of creativity and the workings of the "creativity intersection" (Amabile, 1988, 1996). Should creativity be operationalized differently in non-Western empirical investigations? Is the relation between intrinsic and extrinsic motivation best viewed as a universal construct, or might this dynamic be culture-specific? Are creativity of performance and intrinsic motivation inextricably linked in Asia and the Middle East like they are in the West? Do the environmental constraints that have proven to be so detrimental to intrinsic motivation in Western classrooms have the same sort of deleterious effects on children living and learning in more collectivist societies? The research possibilities are abundant, and it is time that we explore these issues.

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High Ability and Creativity: Conceptual and Developmental Perspectives

Kurt A. Heller

Introduction

In general, *high ability* (a preferred term by Europeans) and *giftedness* or *talent* (a preferred term in the North-American area) is understood as individual potential for excellent performances. Primarily, in socio-psychological theories, the conditions in the social and cultural learning environments are recognized as playing important roles in the development of high ability and in the transformation of the potential into manifest achievements. In contrast, learning psychologists focus on the individual utilization of learning opportunities. They see the pivotal point for individual success in learning and achievement motivation, as well as in personal inclinations and interests in a special domain (e.g., mathematics, sciences, music, or chess). Hence, *expertise* (i.e., exceptional performance in a specific area) is the result of a long-term ("ten-year rule" of the expertise research) "deliberate practice" (Ericsson, Krampe and Heizmann, 1993; Ericsson, Krampe and Tesch-Römer, 1993).

From the point of view of developmental psychology, cognitive abilities are initially manifested, e.g., in the sense of intellectual and creative abilities, as relatively unspecific individual achievement potentials that interact with the social learning environment. This interactive process is to be understood as reciprocal influence of child-like behavior and parental goals and practices. Inherited genetic conditions become primarily effective through the individual selection and the utilization of learning opportunities made available through

the social environment (Scarr and McCartney, 1983; Thompson and Plomin, 1993; Sternberg and Grigorenko, 1997). The early indicators of *high ability* (or giftedness and talent) such as cognitive curiosity or an intensive urge to explore indicate that, before their first birthday, these children actively attempt to institute a supportive learning environment by attempting to satisfy basic cognitive and socio-emotional needs (for greater detail, see Perleth, Schatz and Mönks, 2000).

The nature vs. nurture debate wins a new dimension through the assumption of a differential developmental dynamic, according to which an individual develops by participating in the active formulation of his/her social environment which results in the construction of a dynamic system. The direction in which this development moves is, naturally, dependent on the socio-cultural conditions placed on the learning environment, in other words on the academic opportunities offered by—or neglected by—the school in terms of the promotion of giftedness.

Creativity and Intelligence as Constituents of Giftedness/Talent

What roles do creativity and intelligence play here as constituents of giftedness or talent? The term giftedness refers primarily to cognitive abilities that offer a substantial contribution to problem solving both in general and in specific domains (e.g., mathematics, the natural sciences, languages, chess or music, art, social abilities). Although *intellectual* talents are understood as those abilities that are commonly associated with convergent thinking, the term *creativity* is mainly associated with the so-called divergent (multi-track) thinking. This differentiation reaches back to a suggestion made by Guilford (1950). With the meantime established differentiation in terminology, however, it is not unusual to encounter contradictory postulations, although Guilford's intention was to establish complementary—not exclusionary, but rather supplementary—mental competencies. Characteristics for *convergent* thought production are classic intelligence tasks that require

single-track (inductive, conclusive) thinking, while relatively unstructured, open problems—such as those found in creativity tests—provoke *divergent* thought production. The problem is structured in a more or less restrictive manner, in other words it is characterized by "closed" (e.g., intelligence test items) vs. "open" (e.g., creativity test items) problems.

In order to model complex, demanding problem solutions, *multi-dimensional* intelligence and creativity concepts are needed. *One-dimensional* cognitive ability constructs are not capable of dealing with all of the facets of difficult, complex problems and do not play a major role in modern theories of giftedness and talent as well as of creativity theories—contrary to those still often encountered in diagnostic practice. Prime examples are models such as Gardner's theory of multiple intelligences (1983, 1999), Sternberg's (1985, 1991, 2000, 2003a/b) three-component theory of information processing or his recent Wisdom, Intelligence, Creativity Synthesized (WICS) model, Renzulli's (1986) three-ring model (i.e., creativity, intelligence, and task motivation), or the enlarged six-factor giftedness model by Mönks *et al.* (1986) as well as the Munich Model of Giftedness (Heller and Hany, 1986; Heller, 1992/2001, 2005; Perleth and Heller, 1994; Heller, Perleth and Lim, 2005). For meta-theoretical perspectives, see Ziegler and Heller(2000).

The Munich Model of Giftedness (MMG) as an Example of Multi-Dimensional Conceptions for Explaining Excellence in School and Higher Education

In the Munich Model of Giftedness (MMG), *giftedness* and *talent*—both terms are used synonymously—are conceptualized as multifactorized ability constructs within a network of noncognitive (motivation, self concept, etc.) and social moderator variables as well as performance-related (criterion) variables (Figure 3.1). The transformation of potential into a genuine manifestation of achievement depends
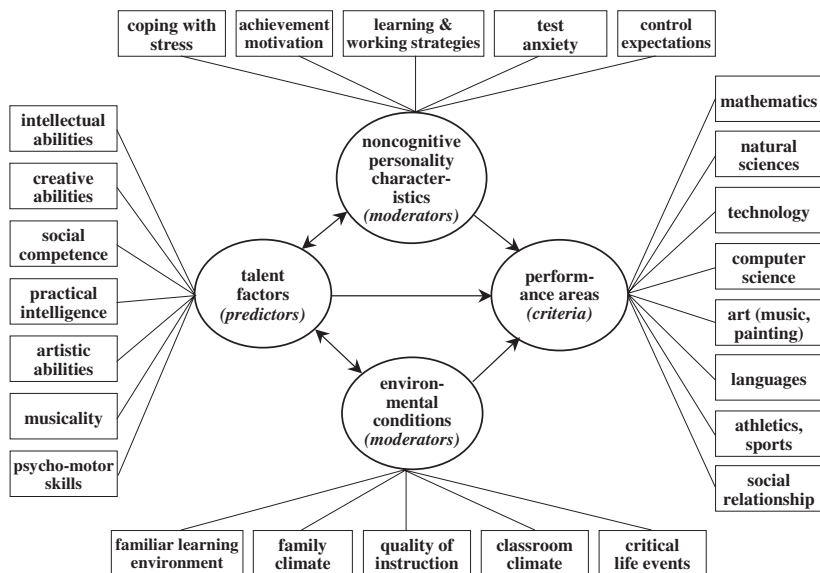
Fig. 3.1. The Munich Model of Giftedness (MMG) as an example of a multi-dimensional concept of talent (according to Heller, 1992, 2001, p. 24).

Legend

Talent factors (predictors)

– intelligence (language, mathematical, technical abilities, etc.)
– creativity (language, mathematical, technical, artistic, etc.)
– social competence
– musicality
– artistic abilities
– psycho-motor skills
– practical intelligence

(Noncognitive) Personality characteristics (moderators)

– achievement motivation
– hope for success vs. fear of failure
– control expectations
– thirst for knowledge
– ability to deal well with stress (coping with stress)
– self-concept (general, scholastic, of talent, etc.)

Environmental conditions (moderators)

– home environmental stimulation ("creative" environment)
– educational style
– parental educational level
– demands on performance made at home
– social reactions to success and failure
– number of siblings and sibling position
– family climate
– quality of instruction
– school climate
– critical life events
– differentiated learning and instruction

Performance areas (criterion variables)

– mathematics, computer science, etc.
– natural sciences
– technology, handicraft, trade, etc.
– languages
– music (musical-artistic area)
– social activities, leadership, etc.
– athletics/sports

on a number of non-cognitive personal characteristics that may be utilized as *moderator* variables in the prediction of extraordinary achievement. Gagné (2000) who differentiates between giftedness or (natural) abilities as potentials and talents as systematically developed skills describes these in his Differentiated Model of Giftedness and Talent (DMGT) as "catalysts", permitting the inclusion of not only individual moderators, but also social influences as well. The validity of the MMG has been proved in various large-scale studies (Heller, 1992/2001, 2004, 2005; Perleth, 2001; Perleth, Sierwald and Heller, 1993; Perleth and Heller, 1994; Heller, Perleth and Lim, 2005), and it has also been useful applied in intercultural research as well (Heller, Perleth and Sierwald, 1990; Scheblanova *et al.*, 1996; Heller and Perleth, 2004).

The MMG is based on a psychometric classification approach incorporating several types of giftedness or talent factors. Contrary to Gagné's differentiation between gifts and talents, both terms are used here synonymously. The MMG consists of seven relatively independent ability factor groups (the so-called *predictors*) like Gagné's giftedness factors. The main components of the MMG include various performance domains (the so-called *criteria*) as well as personality (motivational, self-concept, control expectations, etc.) and social environmental factors as the so-called *moderators*. The moderators (similar to Gagné's catalysts) influence the transition of individual potentials (predictors) into excellent performances (criteria) in various domains; Figure 3.1. The criteria are similar to Gagné's talents or skills.

Whereas the psychometric paradigm of giftedness research focuses *prospectively* on expected performance excellence at school, university, and work, the expertise research tries another approach, based on the expert-novice paradigm; e.g., Ericsson (1996, 1998), Schneider (2000) or Ziegler and Raul (2000). Here, the comparison of experts (e.g., professors of physics courses) and beginners or lay persons is, *respectively*, recorded in the search for central conditions surrounding knowledge and expertise acquisition. This is an important supplemental contribution to the prospective approach of the psychometric research mentioned above.

In the last years, *synthetic approaches* have been favored, such as Sternberg's conceptions of *giftedness as developing expertise* or his recent WICS model (Sternberg, 2000, 2003a/b). WICS is an acronym that stands for *W*isdom, *I*ntelligence, *C*reativity, *S*ynthesized. In the attempt to forge a bridge between the psychometrically based research into giftedness and the more process-oriented field of expertise research, Perleth and Ziegler (1997) extended the original MMG in Figure 3.1 to both the *Munich Process Model of Giftedness* and the *Munich Dynamic Ability Achievement Model* (Perleth and Wilde's contribution in Chapter 11).

Individual Needs and Instructional Conditions of the Development of Gifted (Intellectual and Creative Talented) Students

Individual differences of the potentials and learning needs demand differentiated scholastic curricula and instructional strategies. This postulate is based on the theoretical assumption that between the cognitive learning prerequisites (aptitudes) of the student's personality and the social learning environment created by the school or instructional method chosen (treatment), specific interactions are generated (Aptitude-Treatment-Interaction or ATI model). According to this model by Cronbach and Snow (1977), not all instructional methods are equally suitable for all students. For example, a more rigidly structured instructional format is more effective among younger, anxiety-prone or less intelligent students, while an open instructional format that offers the opportunity for discovery learning has been proven to be, by and large, more advantageous for older and generally more intelligent students (Corno and Snow, 1986; Snow and Swanson, 1992; Snow, Corno and Jackson, 1996). Consequently, intellectually gifted students and their learning needs and interests should be accorded as much consideration as that offered to individual handicapped groups. Long periods of continual under-stimulation in heterogeneous talent groups can lead to adverse developmental effects or even behavioral problems as a reaction to an insufficient promotion of individual

achievement. This danger is particularly potent for the 10% most talented students. These students are often characterized through cognitive curiosity, originality, an unquenchable thirst for knowledge, and a broad (not necessarily scholastic/academic) interest profile. Their quick learning tempo and particularly effective information-processing capabilities and memory skills, in conjunction with highly pronounced task motivation in the face of difficult and challenging performance situations, require open and comprehensive learning environments. How are such so-called "creative" or "effective" scholastic learning environments identified?

In order to empirically answer this question, one would make a comparison of particularly successful teachers with less successful teachers. Here one sees signs of higher levels of flexibility and attitudes marked by greater degrees of acceptance among successful teachers towards their students. In comparison with less successful colleagues, the effective (successful) teachers demonstrate a positive approach to particularly talented students, which results in an altered role perception. "The positions of student–teacher are, in comparison to traditional instruction, often exchanged. The teachers find themselves in the role of fellow-student in a course, which is partially organized by the students themselves" (Grotz, 1990, p. 17; translation by the author).

The goal of promoting independent thinking, learning, and problem solving in the students can be optimally combined with the concept of discovery learning. According to Neber (2006), *discovery learning* in an instructional environment means that the student does not receive learning material as a finished product, but rather that suitable learning environments are maintained in order to enable the student to engage in knowledge acquisition processes. The goal of discovery learning is to promote the independence of the learner. The student should, in this manner, acquire flexible, practical knowledge. Neber (2006) also notes that discovery learning has so far been realized in three basic forms. These comprise

- discovery learning through example, e.g., the acquisition of terminology and rules;

- discovery learning through experimentation, such as the acquisition of the knowledge of rules in natural science instruction;
- discovery learning through the resolution of conflict; For greater detail, see Heller (1999), Neber and Schommer-Aikins (2002).

Characteristics of Scientific Ability and Creativity as Determinants of Outstanding Achievement in the Area of MINT

"Scientific ability", as a hypothetical construct, can generally be defined as the ability to scientifically solve problems. If we examine it more closely, this means special talents for excellent performances in mathematics, informatics or computer science, a (natural) science field or subject (such as physics, chemistry, etc.), and technology (MINT). In other words, competencies are subsumed under *convergent* thinking. In open-ended problems with relatively unstructured goals—as employed in creativity tests—*divergent* thinking tends to be provoked. Therefore, problem structure can be more or less restrictive, i.e., including "closed" or "open" types of problems. Facaoaru (1985) was able to demonstrate that these are not the only two prototypes available. In the field of science and technology, mixed types are typically associated with difficult and complex problems (Table 3.1).

Table 3.1.   Basic types of problem situations, arranged according to the degree of structure from the beginning and final condition of a solution (according to Facaoaru, 1985, p. 60).

Structuredness of problem situation	Structuredness of final condition	
	Open: several solutions	*Closed:* one solution
Open: few restrictions	Field A Divergent tasks (Tests for divergent thinking)	Field B Discovery tasks (Divergent–convergent tasks)
Closed: many restrictions	Field C Constructions tasks (Convergent–divergent items)	Field D Convergent tasks (usual intelligence tests)

The systematics of various types of problems shown here implies the assumption of qualitative differences in the corresponding thought processes. These qualitatively different facets of problem solving represent complementary thought and action strategies. Thus, at the beginning of a complex problem-solving process, primarily divergent (creative) abilities, e.g., generating hypotheses are necessary. Later in the process, increasingly divergent–convergent or convergent–divergent and convergent thought competencies are necessary for making hypothesis decisions. In order to build a model of more complex and challenging problem solutions, *multidimensional* ability and creativity concepts are necessary. One-dimensional ability concepts hardly play a role in newer intelligence and creativity theories, and they are not adequate to describe the rich facets of most problems in the field of science and technology; also see Baer and Kaufman (2005), Sternberg (2005), among others.

Numerous empirical studies in the psychometric paradigm are addressed to scientific ability and creativity. In recent years, also cognitive psychological (experimental and semi-experimental) studies have been carried out (see Heller, 2007 for a detailed report).

The frequently referred *aptitude-traits* are formal-logical (convergent) cognitive abilities, ability to think abstractly, systematic and theoretical thinking, etc., but also richness and fluency of ideas, ability to restructure the problem (flexibility), and originality of solution methods and products (in the sense of more divergent thought production). On top of these come the following *non-aptitude-traits*: intellectual curiosity or thirst for knowledge, exploratory drive, desire to raise intellectual questions, intrinsic achievement motivation, task commitment, goal orientation, persistence, as well as tolerance for ambiguity, uncertainty and complexity, non-conformity, etc.

In addition to the general, that is more or less domain-overlapping and situation-independent personality determinants of achievement eminence that are postulated in the field of science and technology, newer experimental studies in psychology supplement the general findings with important domain-specific process characteristics.

Van der Meer (1985) carried out process-oriented analyses of mathematical scientific achievements in the Klix paradigm "experimental

diagnosis of giftedness". These were supposed to provide information about individual differences in mathematical-scientific problem-solving. The main purpose was to isolate the psychological mechanisms in the cognitive process which were responsible for such achievements.

Substantial characteristics of giftedness according to Klix (1983) are, on the one hand, the individual ability to *reduce problem complexity*, and on the other hand, *cognitive expenditure of energy* in solving the problem. In this, the task-oriented motivation is felt to play a key role: "The role of this *task-oriented motivation* consists mainly of creating and maintaining an activity level necessary for an effective search, assimilation and processing of relevant information up to and including finding a solution" (Van der Meer, 1985, p. 231; author's translation). In a manner similar to Sternberg's component analysis, Van der Meer uses tasks where inductive or rather analogous thought is necessary. Analogous conclusion processes are to be found in the recognition and transfer of relations between topics from one area to another. The medium for the analogies are chessboard-like patterns of varying complexity.

The most important result was the proof that gifted secondary school students (those specially nurtured in mathematics classes at the Humboldt University of Berlin) were significantly better at solving such analogy test items than a control group of average students. Further characteristics for mathematically-scientifically gifted, according to Van der Meer's results, were a significantly higher information-processing speed in regard to basic cognitive processes, as well as a lower or more economical solution effort. This indicates the use of more effective solution strategies containing minimal interim memory of partial results (in the working memory), which make up the higher quality of thought processes in the gifted. Van der Meer considers the superior style of connecting basal operations, as well as the increased simplicity and effectivity of finding solutions to be significant characteristics of *scientific ability* (Heller, 1993).

In order to *generate hypotheses*—according to Einstein, the most important step in the problem-solving process—the hypothetical concept "*science discovery*" was postulated by Langley *et al.* (1987), who

presented many results in their treatise. Similar to the concept of "wisdom" from the life-span approach to exceptionality (Pasupathi and Staudinger, 2000; Sternberg, 2003a,b), the concept of "cleverness" suggested by Hassenstein (1988) is a synthetic approach for the giftedness phenomena being discussed here. It suggests a combination of knowledge, a perceptual exactness in observation, good memory and logical-abstract reasoning, richness of ideas, fluency in associations and fantasy, as well as flexibility and inner drive with regard to motivation, etc. Cropley (1967, 1992) calls this "true giftedness" in order to indicate that creativity is an essential part of giftedness.

Concerning *technical creativity*, Hany (1994) conceptualized the hypothetical model depicted in Figure 3.2. This model served as a basis of the German-Chinese Study on Technical Creativity (Hany and Heller, 1996; Heller and Hany, 1997). The main hypotheses derived from the causal model could be proven by the empirical data in the mentioned study (Shi *et al.*, 1998; Heller, 2007).

Whereas the previously cited studies focused on *individual* determinants of outstanding achievement in science and technology, more recent *synthetic* approaches consider *social-cultural* determinants (e.g., Gardner, 1988; Haensly and Reynolds, 1989; Sternberg and Lubart, 1991; Sternberg, 2003a,b; Sternberg, Grigorenko and Singer, 2004).

In addition to the importance of *situational* variables or even *coincidental* factors (cf. Simonton, 1998, 2004), the role of *creative learning environments* and *social influences* on the development of ability and creativity are emphasized in the recent studies from the field of social psychology. Favorable and unfavorable developmental socialization influences on giftedness have primarily been studied in the social settings of the family, school, leisure time resources, and the professional areas (Amabile, 1983, 1996; Ambrose, Cohen and Tannenbaum, 2003; Csikszentmihalyi, 1988; Csikszentmihalyi and Csikszentmihalyi, 1993; Csikszentmihalyi and Wolfe, 2000; Gruber and Davis, 1988; Tannenbaum, 1983). In this respect, the importance of stimulating social learning environments, experimental possibilities, available information, and community resources is outweighed by the importance of
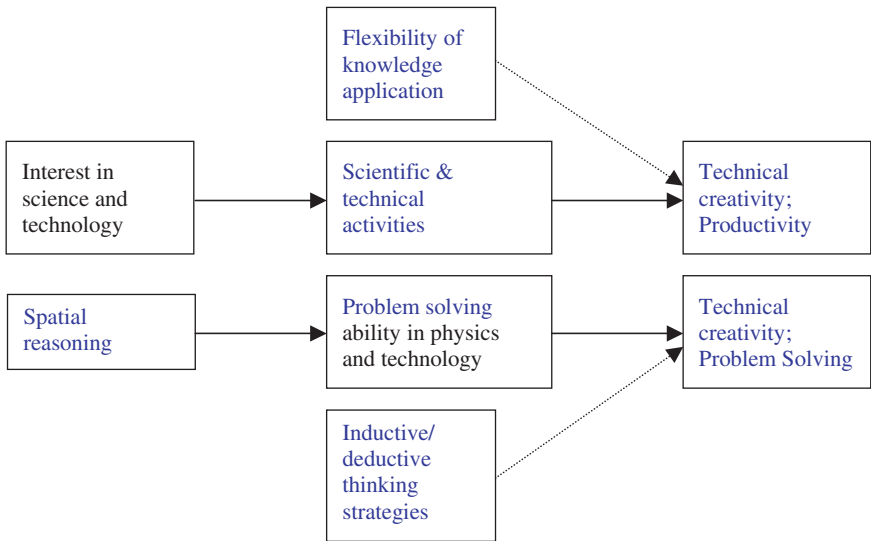
Fig. 3.2.   Hypothetical model of causal factors of technical creativity (Hany, 1994, p. 143).

using experts as creative models for the development of ability and creativity.

Regarding science and technology as fields of leisure-time activities in adolescence, we found significant differences in the Munich longitudinal study of giftedness (Heller, 1992/2001; Perleth and Heller, 1994) between highly intelligent and highly creative students in the domain of technology, but not in science. This corresponds to another result from the same study where the intellectually gifted students received the best grades in mathematics and physics, while the intellectually *and* creative gifted were the best students in the other subjects, especially German (mother tongue; see Heller 2007 for more information).

Conclusion

With only one exception in recent publications (Gagné's DMGT), the terms giftedness and talent are used synonymously in everyday language as well as in the scientific area; see Heller (2001) or Heller *et al.*

(2000/2002). Because gifted or talented individuals are a very heterogeneous set of persons, a comprehensive theory is hardly possible. Eysenck and Barrett (1993) view giftedness as a "fuzzy concept" that can be defined as synonymous with general intelligence, creativity, and special (e.g., artistic or scientific) ability. Sternberg and Davidson (1986) analyzed not less than 17 more or less different conceptions, which they divided into explicit and implicit terms. Such implicit conceptions were delivered by Renzulli (1978, 1986) or Tannenbaum (1983) concerning giftedness and by Tan (1992, 1995) with respect to (technical) creativity.

In our investigations addressing high ability and creativity, we made a real distinction between ability and creativity in which different factors are emphasized (e.g., Heller, 1993; Hany, 1994; Heller and Hany, 1997; Heller, 1992/2001; for a metatheoretical perspective see Ziegler and Heller, 2000).

Furthermore, the terms ability, creativity, giftedness, and talent can be divided into descriptive and explanatory conceptions. Both are necessary for theoretically *and* practically efficient definitions. This further necessitates different research strategies. As an example of the psychometric paradigm, the Munich Model of Giftedness (MMG) has been described in greater detail. The validity and usefulness of the MMG have been proved not only in the national (German) context but also in several international settings (e.g., Russia, Korea, Thailand; for greater detail, see Heller and Perleth, 2004). The MMG-based Munich High Ability Test Battery (MHBT) by Heller and Perleth (2007a/b) is the newest outcome of the Munich longitudinal study of giftedness and talent which started over 20 years ago.

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Creativity and its Cultivation*

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Introduction

According to Chinese philosophy, creativity emerges from what is already existed. Creativity does not come out from vacuum. This philosophy is well-reflected by thoughts of Daoism. The basic characteristic of Laozi's ideology opened the thinking of creativity, and it activated human being's natrure of *Tao* and help them to reach the super level of perfection (天人合一). His *Tao Te Ching* told us that feeling and thinking could help us to know the nature of the world, and everyone has the ability of feeling and thinking. He (Chuen-Qiou Period) said that 'Having is a kind of benefit, and not having is a kind of use' ("有之以为利, 无之以为用"), and this state opened the thinking of creativity and explained how important it was to create new things.

People may argue that sometimes an insight idea does appear in a sudden. In this case, it seems that at the very moment when the insightful idea emerges, we think that it appears suddenly. In fact, it turns out that insight which arrives suddenly is a result of a long, hardworking or hard-thinking period of the relevant topics or problems. In other words, without the knowledge and experience of previous work on or thinking of the problem, the insightful idea would not be surfaced.

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The Bio-psycho-social Model

From the Chinese perspective, the inter-relatedness of things and phenomena exists. Everything is related to other things. In this manner, creativity is not an isolated, a single factor but is conceptualized in a relatively comprehensive system within and without an individual. In general, we refer creativity to creativity of human beings. Creativity can be considered a distinctive behavior for human beings to survive in the physical world. To adapt well, human beings have to recognize and modify the features of the physical and the social world. The authors propose a bio-socio-psycho-model of human (Shi, 1999; Shi and Xu, 1999, 2004; Shi, 2002, 2003) followed by a systemic model of creativity (Shi, 1995, 2004) and a creativity training model (modified from Mayer, 1999; cited in Sternberg, 1999).

We propose a model of human beings comprising the biological, social, and spiritual dimensions (Figure 4.1). To illustrate Figure 4.1, we refer to some of our understanding of human heritability, psychological or spiritual processes and social behavior, and their interactions. As a matter of fact, heritability of human height is 0.81 and of weight is 0.78 (Yu, 1987). If we can accept the thesis that for optimal functioning
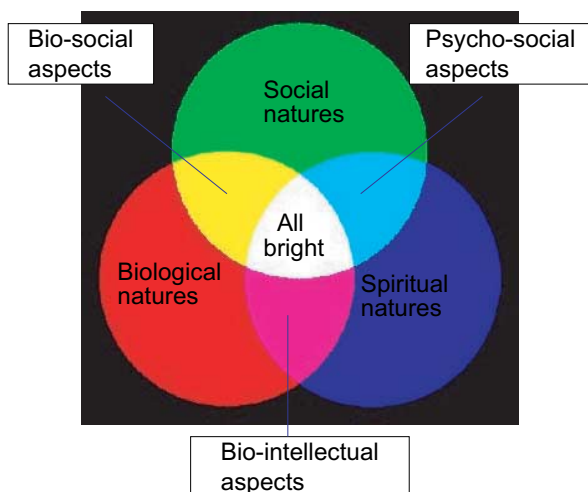

Fig. 4.1.   The structure of human nature.

mental or psychological abilities interplay with biological abilities, we cannot refuse the assumption that the biology or specifically genetics can directly or indirectly influence our mental abilities. In addition, we believe that human beings possess consciousness, spirit, and intelligence. This includes all psychological processes, such as perception, memory, thinking, reasoning, emotion, motivation, and willingness. As a social individual, a person has to be accepted by other people in his(her) society. S/he has to be aware of him(her)self, of the situation of a society, of the relations between him(her) and the others. To function well in a society, the following behaviors are essential: self-consciousness, self-regulation, self-confidence, collaboration, obligation of social duties, legalization, obedience, morality, communication with others, and self expression.

The complexity of how our biological, social, and spiritual aspects interact has attracted our attention (Shi and Xu, 1998, 1999). Integration of the various dimensions (aspect) mentioned above as a whole is essential for a person to function healthily and perform well.

The structure of human nature can be illustrated by imaging the nature of human color perception. According to the tricolor theory of Young-Helmholtz (cf. He, Zhang and Chen, 1983), the colorful world we see is the result of perception of different combinations of three essential colors—red, green, and blue. For example, 50% red plus 50% green makes yellow. And one third red plus one third green plus one third blue makes white. Every color can be described with the following formula:

$$(C) = r(R) + g(G) + b(B)$$

Here C is for "Color"; R, G, B for three basic colors, 'Red', 'Green', and 'Blue'; and r, g, b for the coefficient of 'Red', 'Green', and 'Blue', respectively.

Every visible matter is featured by 'brightness' and 'hue'. Brightness stands for the strength of the light. Hue stands for the strength of a color people can see. Just like the combination of colors, suppose, a mental characteristic is 'blue', a social characteristic is 'red', and a biological characteristic is green, the feature of an individual is combined with three basic characteristics. For example, if an individual has

balanced strengths in the biological, mental, and social dimensions. None of the dimension has a strong or weak color. If the individual has a balanced strength of three basic characteristics, and all of them are very strong, then s/he is likely to be a genius or a person with many talents. In the practical world, there are few geniuses. Most people have imbalanced strengths. For those who possess biological strengths, they are likely to be good at sports. For those who have social strengths, they are likely to be good at interpersonal communications. For those who have mental strength, they are likely to be excellent in intellectual works. If an individual have biological, social and mental strengths, they are likely to do well in multiple disciplines. A gifted person in this case, referring to our model, is an individual whose strengths are integrated and balanced.

A Creativity System

A systemic model of creativity is proposed (Shi, 1995) which includes nine interrelated components. These components are further divided into two main categories: the inner world and the outer world category. The inner world category includes intelligence or the intellectual potential, knowledge, and experience (including general and specific knowledge and practical skills, which are mastered in previous experience), non-intellectual personality characteristics, attitude, or tendency to work creatively, and creative behavior. The outer world category includes social environment or macro-environment, working environment (including family, economic, and physical conditions), education or educational opportunities, and the creative product.

All these components or variables can not be directly observed or measured, but they play their own roles in the system of creativity (Figure 4.2) (Shi, 2004). According to this model, a creative outcome is regarded as a function of one's active intelligence, personality, tasks, factors from social environment and the time when one is engaged in creative activity (Shi and Xu, 1997). The active intelligence refers to that part of one's intelligence that is involved in or directed toward creative activities. We would like to refer this active intelligence as Intelligence Current (IC). Also, IC can be looked upon as a function of one's intelligence level (or intellectual potential), personality, social
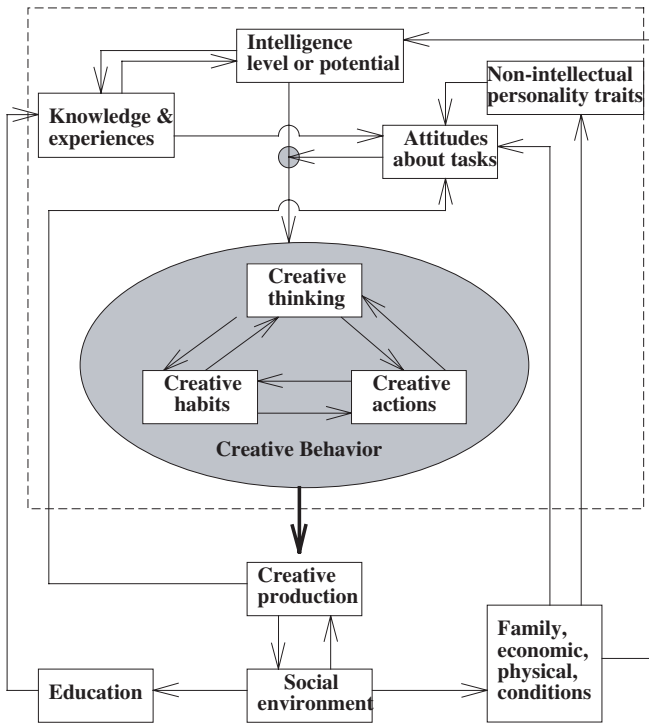
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Fig. 4.2.　The system of creativity.

factors and the time one spends on a specific task. One's creativity is also a function of one's intelligence current and the task on which one is working. So, the functions can be expressed mathematically as $f (Ic) = f (I, P, S, Tm)$, and $f (C) = f (Ic, Ts)$. Here C stands for one's creative performance, Ic for one's intelligence current in a specific creative task, P for one's personality traits, S for the factors from the society or environment one lives in, Tm for the time one is absorbed in a specific creative task, I for one's actual intelligence level or intellectual potential, and Ts for the specific creative task.

A Model of Creativity Training

The holistic or systematic perspective of creativity aimed at facilitating two features of creativity—originality and appropriateness. Based on
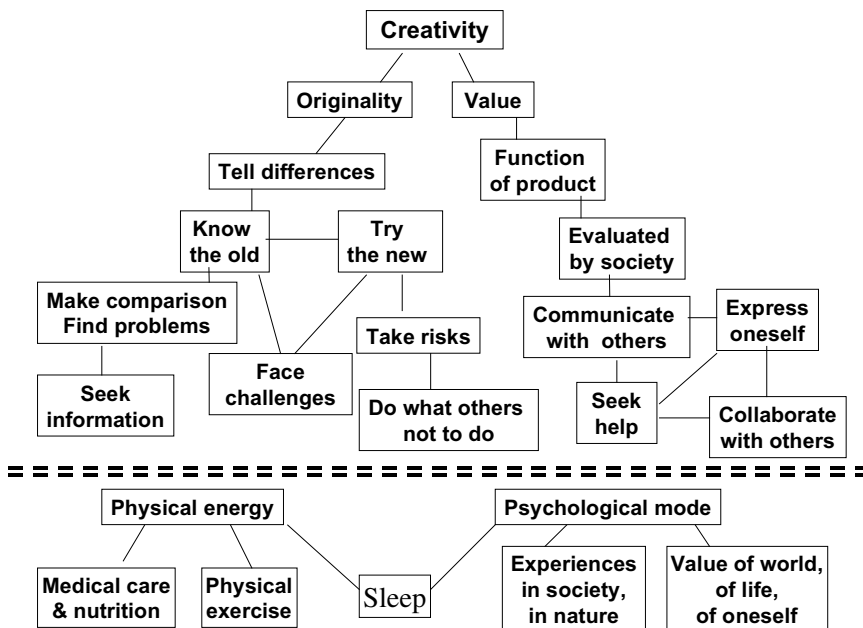
Fig. 4.3.   Iceberg-like structure of creativity cultivation.

this notion, we construct an "Iceberg Model" of creativity cultivation. The Iceberg Model (illustrated in Figure 4.3) is used to guide the practice of creativity training in our experimental classes.

The left branch of Figure 4.3 demonstrates how originality is concerned and activities pertaining to this feature of creativity considered. Originality means "different from others". In order to tell the uniqueness of different things, students must know what the old thing is, and what the new is. They need to learn old things. It is obvious that for students, knowledge is regarded as the old thing, so are experiences from textbooks, everyday life, and many other resources. People compare and identify differences. In this manner, students need to learn how to make comparison and find problems in the old. Meanwhile, they need to learn how to find helpful information. For this reason, the information seeking ability is considered. For comparison, knowing the old seems to be not enough. Students have thus to find the new one. What is new? Students are encouraged to explore and try

new things. They are encouraged to explore, to test what they think is possible. During that time, they have to face all kinds of challenges. They have to try their own way, and sometimes, take risks. That means they have to do something others do not dare to do. It is obviously that learning existing knowledge, making comparisons, finding problems, and seeking information involves cognition. Facing challenges, trying new things, and taking risks non-cognition is engaged. And when an individual tries to take a risk helps from others or helps each other is important and useful.

The right branch of Figure 4.3 demonstrates how appropriateness is concerned and activities relevant to this feature are considered. We refer appropriateness of a product to possibly the act of evaluating the value of the product. If people think it is useful they accept its appropriateness. Otherwise, it is inappropriate. The function of a product recognized by others determines its appropriateness in the society. It means that, on the one hand, the product must have some unique functions, and on the other hand, these unique functions must be recognized. First of all, the creator of a new product needs to let others know what the product is. The creator needs to know how to communicate with other people, to know how to express him(her)self. These procedures are involved in the category of socialization. And sometimes, an individual needs helps, comments, and suggestions from others. In the system of creativity, this is the procedure of interaction between the inner world and the outer world. In other words, the feedback from outside world to the creative products is important. In this case, collaboration is needed. Individuals must learn how to collaborate with each other.

There are two factors under a double dashed line in Figure 4.3. One is called physical energy (PE) which reflects the biological function of human nature. The other is psychological mode (PM) which reflects the social function of environmental influences. One can image that the double dashed line is like water surface and the structure in Figure 4.1 is just like an iceberg. And these two factors may be considered as a foundation of the iceberg. They are hidden under water. People cannot see them directly. They are but very eital and play very vital roles in the creativity system. The factor of PE (physical energy) is

important to supply an individual enough energy to survive, to work actively. It means that an individual has to be a 'healthy person'. We suppose here that in some cases people with some bodily disadvantages are mentally healthy. That means, at least their neuro-system for creative thinking is healthy. In order to keep an individual healthy, appropriate physical exercises, nutrition, relatively enough sleep (individual difference should be considered), and medical care is necessary.

The factors of PM (psychological mode) are important to support an individual to think deeply and freely. It is supposed that the real world is noisy all the time. There are many disturbing or distractive things. An individual with an optimistic attitude about the real world and him(her)self may have better psychological mode to deal with the disturbing matters than an individual with a pessimistic attitude. In order to have a good psychological mode it is necessary for an individual to have an optimistic attitude about him(her)self, about the society, the world, and the future. And the experiences in the society, world, and nature are very essential for an individual to build up a good psychological mode. Some people emphasize the importance of emotional intelligence (Goleman, 1996), but here, we would prefer psychological mode because it is an inner world situation rather than an emotion experienced or expressed. In many cases, the psychological mode is intrinsic or tacit. In Chinese philosophy, it is the factor from oneself rather than the factor from outside world which has great impact on him(her).

Concluding Remarks

To test the systematic theory and iceberg model of creativity, a preliminary educational experiment was conducted in a high school in Beijing (Qu and Shi, 2003). About 75 first grade (equivalent to 10th grade in US) students from a senior high school participated in the present study. About 20 of them are academically gifted students from experimental class (GS), 35 are randomly selected from other classes of the same grade in same school as an experimental sample (ES), and the rest 20 are randomly selected from the same grade in same school as a control sample (CS).

Before the training program, all students were tested with Group Intelligence Test of Children (GITC) (Jin, 1996), Chinese version of Williams Creative Thinking Test (WCTS-C) (Lin, 1997). GITS is for measuring students' IQ and the WCTS-C is for creative thinking. Then the gifted sample (GS) and experimental sample (ES) were involved in a four months training program while the control sample (CS) in regular program of school. The training program offered various activities for the GS and ES once a week. All activities were designed and coordinated by a teacher (one of the authors). To avoid the labeling effect, the program was titled as 'developing potential program' rather than 'creativity training program.' Training activities were arranged once a week. The training program lasted four months. At the end of the program GS and ES students were ask to finish two kinds of homework. One was a collaborative work and the other was an individual one. Meanwhile, all GS, ES, and CS students were tested again with both GITC and WCTS-C tests again as the post-test of their IQ and creative thinking.

The training activities can be divided into three major categories as cognitive abilities, non-intellectual personality aspects, and collaborative skills. Cognitive abilities include thinking skills, such as critical thinking, divergent thinking and regular psychological tendency breaking; meta-knowledge and meta-strategy such as time organization, plan making, and executing and learning strategies; opening experiences such as drawing a picture after listening a piece of music, writing, and playing a mummery based on Chinese idioms. Non-intellectual personality aspects include self-challenging and risk taking, such as watching films of scientific explorers, giving a speech to the public, and debating competition; task commitment and motivation stimulating such as encouraging students' interest, curiosity and desire of exploring. Collaborative skills include team construction, such as designing an icon, composing a song for the team, and preparing and playing a collective performance.

From the creativity training a series of products of students such as painting or drawing, poems, performances, designs, and handcrafts, etc., was obtained. These products were very creative in general evaluated by either teachers or students. However, the significant increments

in conventional creative thinking abilities such as openness and elaboration were obtained. But the significant increments of creative thinking test scores were found only in the experimental group with average intelligence not in intellectual gifted group. The authors argued that the conventional creative thinking tests are not able to detect the diversity of creativity in the real world, so maybe we need some training on developing the school children's solutions for the realistic and social problems (Tan, 2000).

Creativity as the nature of human development is even more attractive subject in the research and application fields. According to the consideration of the human being's nature, we are cognizant of the importance of creativity in the whole course of human development. On the deep base of Chinese culture and the actuality of China's development these years, we make our own practical creativity model in which we take many important factors into account, such as environmental, physiological and psychological factors. We also design some training projects according to our creativity model. They work well. We still wish to design more multiple trainings for the school children in this new century.

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Part One
Exploring the Nature of Creativity

Section II
Research in Creativity

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The Biological Basis of Creativity

Martin Reuter

Introduction

Creativity research as compared to investigations on intelligence is a field that is widely neglected. In the literature, there exist countless studies investigating the genetic, neuronal, and biochemical underpinning of intelligence. Research on creativity in this area is nonetheless scarce. The electronic literature data bank SCOPUS have 76,686 entries (as of April 2006) that match the keyword "intelligence" but only 9,117 that match "creativity". This preponderance of intelligence research as compared to research on creativity was mentioned by Guilford (1950) in his presidential address to the American Psychological Association. Simply, creativity is defined as a mental process involving the generation of new ideas or concepts, or new associations among existing ideas or concepts. According to Guilford (1956), the components of divergent thinking, namely originality, flexibility, and elaboration comprise the core of creativity. Therefore, new inventions rely on a maximum of cognitive flexibility not covered by convergent thinking alone—the core feature of intelligence.

Creativity research has been neglected due to methodological problems with respect to objectivity, reliability, and validity in measuring creativity and to lack of consensus in the definitions of creativity. Most, if not all intelligence tests are constituted of items that allow only one correct answer. Creativity tests often demand different responses. The problem in evaluating creativity tests is to decide how many responses are virtually distinct and in how far they can be labeled as inventive. The reasons for the neglect in creativity research can not undermine the significance of creativity for the human beings. As a matter of fact,

the great advancements in technology, science and arts are inseparable from creativity.

Some creativity tests are designed based on the so called *process* or *trait approach* (Brown, 1989). The trait approach tries to discover the processes underlying creativity by developing appropriate instruments to measure it. The assumption is that creativity is a trait normally distributed in the population. This assumption implies that every person is creative. The question remains how creative a person is. In this manner, the trait approach of creativity is in agreement with the conceptualization of intelligence defined as a normally distributed trait. The view of creativity as a quantitative trait is supported by the view that intelligence and creativity share a proportion of common variance.

The Product Approach

The *product* approach in contrast to the trait approach defines creativity in terms of exceptional real world creative production, which very few individuals are able to achieve (Stravidou and Furnham, 1996). Those who adhere to the product approach define authors, artists, and scientists as creative persons. The product approach to creativity is confronted with the critique that it is difficult to decide if members of different domains (or professions) are indeed produce exceptional ideas. It seems that the trait or the product approach faces a similar problem in creativity, i.e., objectivity, reliability, and validity.

The factors determining intelligence have been extensively investigated. The so-called nature vs. nurture debate has caused vivid controversies. However, today it is widely accepted in the scientific society that genes and environmental factors influence intelligence. Studies from behavioral genetics (twin and adoption studies) quantified the proportions of variance in intelligence for which accounted by genes and environment. Up to 70% of the variance in general intelligence or g is caused by genes (e.g., Bouchard *et al.*, 1990). There are two reasons to support the thesis that creativity is highly heritable. First, creativity and intelligence are substantially correlated (0.50). Second, in several models of intelligence creativity or divergent thinking are facets of intelligence (Jäger, 1982; Guilford, 1967, 1979).

Intelligence is a trait normally distributed in the population. Thus, intelligence is not a single gene locus but many genes, or quantitative trait loci (QTL), code for intelligence (Plomin *et al.*, 1994). Genes constitute the biological make up of the organism. The development of new technologies in molecular genetics and the successful decoding of the human genome have enabled the search for genes which form the molecular basis of intelligence (Plomin *et al.*, 2001). Representing genes are among others the structural information for neurotransmitters, enzymes, hormones, and the morphology of the brain. Therefore, the identification of candidate genes yields information on biochemical and electrophysiological processes of cognitive abilities. It has to be pointed out that by stimulating gene expression environmental factors can interact with genetic factors.

This chapter provides an overview on the research on the biological basis of creativity. It reviews and analyzes reasons for the neglect of creativity research from the biological perspectives. It presents various approaches to creativity research including electrophysiology, endocrinology, and molecular genetics. It outlines future research on creativity. The aim of biologically oriented creativity research is to find robust associations between biological variables of creativity and a phenotype, characterized by a lack of consensus in creativity definition and questionable test statistics.

Electrophysiological Correlates of Creativity

The EEG studies

For intelligence, it could be demonstrated by measures in the electroencephalogram (EEG) or positron emission tomography (PET) studies that differences in general cognitive ability are associated with differences in brain activity. Some studies showed that for the time aspects of brain activity latencies in event-related potentials (ERP) are negatively correlated with intelligence (e.g., Chalke and Ertl, 1965; Ertl and Schafer, 1969; Callaway, 1973). They also showed that the string length of ERPs (representing a more complex EEG wave and a reduced vulnerability for axonal and dendritic signal

transduction) is positively associated with intelligence (e.g. Hendrickson and Hendrickson, 1980). In addition, the nerve conduction velocity (NCV) was reported to be positively associated with intelligence and negatively with reaction times (Reed and Jensen, 1992; Vernon and Mori, 1992). Some studies found that for spatial aspects of brain activity during the performance of cognitive tasks a stronger EEG coherence in high intelligent persons than in persons with lower intelligence (e.g., Anokhin, Lutzenberger and Birbaumer, 1999). EEG coherence is a measure that reflects the similarity of brain processes between different areas of the same and the opposite hemisphere. Moreover, positive associations between the EEG alpha-power and intelligence during task performance could be detected (Jausovec, 2000). Alpha waves are regular electrical oscillations visible in the EEG when a person is awake and relaxed. They have a frequency of 8–13 hz. If a person is involved in a cognitive task the alpha waves are blocked and beta waves (14–30 hz) reflecting cognitive effort become more dominant. Therefore, a positive relationship between the alpha-power and intelligence during a cognitive task performance indicates that more intelligent persons need less brain activity for this task.

The PET Studies

PET studies, in contrast to EEG studies, yield information of the brain metabolism. It turned out that more intelligent persons need less glucose for cognitive processes than persons with lower intelligence scores (e.g., Haier, 1993). This finding supports the neural efficiency hypothesis of intelligence.

The presented electrophysiological correlates have provided the basis for the investigation of the biological basis of creativity. The distinction between divergent thinking and convergent thinking in characterizing the differences between intelligence and creativity implies that the brain physiology of creativity must be distinctly different from that of intelligence. There is substantial evidence to support the view that creativity is essentially independent of intelligence quotient, IQ above about 115 (Sternberg and O'Hara, 1999).

A Physiological Theory of Creativity

Martindale (1989, 1999) proposed a prominent physiological theory on creativity. Creative thinking according to Martindale's theory has the following characteristics: More unconscious than conscious cognitive processes, the ability to enter states of defocused attention and more flat association hierarchies, i.e., less associations to the focus of an acute problem than to more decentered topics (defocused attention). On a physiological level creative persons should be characterized by the simultaneous activation of as many neuronal connectivities as possible. According to Martindale's low arousal hypothesis such a state can be obtained under circumstances of low cortical activation, as strong cortical activation in a network leads to an inhibition of less activated systems.

Jausovec and Jausovec's (2000) study yielded supportive findings for Martindale's hypothesis. They reported higher inter- and intra-hemispheric EEG coherence in tasks demanding creativity than in those where creativity was negligible. Their findings were in congruence with those reported in Petsche's (1996) study. According to Petsche's (1996) findings acts of creative thinking characterized by more coherence increases between occipital and frontopolar electrode sides than any other mental tasks. He referred the findings to a strong involvement of long cortico-cortical fibre systems in creative tasks. The results from Petsch's study demonstrated the importance of an increase in frontooccipital EEG relations for creative performance. This result is confirmed by two independent studies (Jausovec and Jausovec, 2000; Razoumnikova, 2000).

Two questions were often asked: Which electrophysiological brain parameters are involved in creative tasks? How these parameters are distinguishable from electrophysiological correlates of intelligence? Jausovec (2000) in a study nonetheless investigated another question: Are there individual differences between high and low creative subjects?

In performing convergent and divergent tasks Jausovec (2000) compared the EEG brain activity among high creative/high intelligent, high creative/average intelligent, average creative/high intelligent and average creative/average intelligent subjects. High creative subjects compared to average creative subjects showed more coherence

between different brain areas and lower cortical activity in the lower alpha spectrum in the divergent tasks. The same result was witnessed when high creative subjects were compared to high intelligent/average creative subjects. In the upper alpha spectrum the results were reversed. In contrast high intelligent but average creative persons showed a higher brain desynchronization between different brain areas in the lower alpha spectrum and a higher synchronization in the upper alpha spectrum. These findings support Martindale's hypothesis. Jausovec assumes that the lower alpha spectrum represents processes involved in attention and episodic memory whereas the upper alpha spectrum should be relevant for semantic processing. Based on his findings, Jausovec assumes that high intelligent but average creative subjects choose a more semantic approach to solve the creativity tasks whereas high creative subjects solve these tasks in a more intuitive and less consciousness controlled way.

To relate creativity to the brain topography, Martindale *et al.* (1984) investigated the EEG alpha asymmetry during creative tasks (Alternate Uses and Remote Association Tests). In highly creative subjects, he found greater EEG activity in the right than in the left hemisphere. This lateralization phenomenon was specific to creative performance and was not observable in less creative subjects. The findings were in congruence with the hemispheric lateralization theory originating in the 1970s. Studies on patients who received commissuroectomies (the corpus callosum, connecting the two hemispheres, was surgically bisected to inhibit seizures) have suggested that especially the right hemisphere is involved in creative thinking (Bogen and Bogen, 1988; Hoppe, 1988). However, new studies on split-brain patients relativise theories of right-brain creativity. These studies demonstrated that creativity depends on the co-ordination of processes subserved by both hemispheres (Katz, 1997; Runco, 2004). For example, Hoppe and Kyle (1991) observed that split-brain patients lacked all kinds of integrated thought, like intuition and mental flexibility that are necessary for creativity. In a polymethodological approach using both EEG and PET measures, Bekhtereva, *et al.* (2001) study yielded further evidence for the thesis that an interhemisheric interaction is necessary for creative

thinking. The reorganization in both frontal lobes (Brodmann' s areas [BA] 8–11, 44–47) especially seems to be of major significance for the organization of creative processes in the brain. This pattern of brain activity was specific for creative thinking (composition of stories out of a set of certain words) and could not be detected in control tasks (the reconstruction of correct grammatical forms and a memory task) where no divergent thinking is involved.

The Endocrinological and Biochemical Basis of Creativity

It is known that hormones and neurotransmitters influence brain activity and contribute to individual differences in cognitive functions. Neurotransmitters are directly involved in the signal transduction between nerves. Action potentials are transmitted by neurotransmitters across synaptic clefts. Steroid hormones that are able to cross the blood brain barrier influence brain activity due to binding sites on central nervous neurons or by stimulating gene expression in the brain.

Using the *product* approach Hassler (1992) reported an association between creative musical performance and saliva testosterone. According to her results the impact of the sex steroid testosterone on creativity shows a sexual dimorphism. The optimal testosterone level for the expression of creative musical behavior was at the bottom of normal male testosterone range and at the top of the normal female testosterone. This implies that the testosterone levels are positively correlated with creativity in females and negatively in males. Furthermore, in an eight-year period of adolescent development and in adulthood musicians achieved significantly higher test scores in spatial ability than non-musicians. This finding is in congruence with the lateralization hypothesis of creativity (dominance of the right hemisphere in creative thinking) as spatial performance is predominantly processed in the right hemisphere.

The study by Hassler closes the gap among personality, creativity and testosterone. Eysenck (1993, 1995) postulated an association between the personality trait of psychoticism (P) and creativity as the P dimension is not only characterized by creativity but even more

by aggressiveness which in turn is related to high testosterone levels (e.g., Banks and Dabbs, 1996; Higley *et al.*, 1996; Kouri *et al.*, 1998; Mazur and Booth, 1998). As demonstrated by Hassler, it can be assumed that testosterone is related to creativity. In line with Eysenck's opinion on the relationship between Psychoticism and creativity there exists evidence in the literature that creativity is associated with an inclination to psychopathology most often hypomanic or mildly psychotic traits without full-blown illness (Andreasen, 1987; Jamison, 1989; Flaherty, 2005).

The Trait Approach

Reuter *et al.* (2005a) based on these assumptions tested the hypothesis if testosterone is related to creativity and to Psychoticism as measured by the Eysenck Personality Questionnaire (EPQ-R). Furthermore, included into the study was another personality trait, the SEEK dimension of the Affective Neuroscience Personality Scales (ANPS) (Davis, Panksepp and Normansell, 2003). The rationale to include the SEEK dimension was the following. The SEEK dimension consists of items that measure creativity related behaviours based on self-report data such as the desire to explore and to engage in new experiences. In addition, Panksepp (1998) postulates that the biological basis of SEEK is composed of dopaminergic structures. In the biological-oriented cognitive neurosciences one of the best established findings is the crucial role of the dopaminergic system for cognitive processes (e.g., Previc, 1999; Remy and Samson, 2003; Flaherty, 2005; Reuter *et al.*, 2005b).

Reuter *et al.* (2005a) tested the associations between two personality dimensions related to cognitive functioning, testosterone and dopamine (indirectly via the SEEK dimension) on creativity. The study was based on the *trait* approach, i.e. creativity, personality measures, and saliva testosterone were investigated in a sample of $N = 48$ students. Creativity was assessed by the test battery 'inventiveness' of the Berlin Intelligence Structure test (BIS), (Jäger, 1982). The BIS defines creativity as a subcomponent of intelligence. The inventiveness tests challenge the flexible production of ideas, the power of imagination, and the skill to consider many possible ways and solutions to solve

a problem. They measure figural, verbal, and numeric creativity. To control the influence of intelligence on the association between personality and testosterone on creativity, fluid, and crystallized intelligence were also tested and served as covariates. Results showed that testosterone was neither related to personality nor to creativity. There was no association between Psychoticism and creativity as suggested by Eysenck (1993, 1995). However, subjects with high testosterone levels had significantly higher SEEK scores than subjects with low testosterone levels. Testosterone explained more than 15% of the variance in SEEK. This finding could be confirmed in the male and in the female sub-samples. Moreover, the uncorrelated predictors testosterone and creativity explained 39% of the variance in SEEK with an identical predictive power of testosterone and creativity. Intelligence, that was controlled for in the analyses was unrelated to the personality measure and to testosterone.

Panksepp (1998) in his Affective Neuroscience Theory comes to the conclusion that the mesolimbic dopaminergic system is the biological basis of the SEEK system. However, cognitive functions are associated with mesocortical dopaminergic projections. Therefore, the question arises how the SEEK system can be related to creativity.

Flaherty (2005) solves this problem by distinguishing between creative skill and creative drive. The former is related to neocortical association areas and the latter to the limbic system. According to Flaherty, drive correlates better with successful creative output than skill does. Creative subjects have higher baseline levels of arousal and greater response to sensory stimulation (Martindale, 1999). Mesolimbic dopaminergic activity raises baseline arousal and triggers the focused aspect of creative arousal, its high goal directedness. This explains why dopamine is related to reward-seeking, gambling and substance abuse. Often psychoactive drugs like cocaine leading to an increase of extracellular dopamine are used by artists, musicians, and writers to enhance their creativity. To demonstrate that the dopaminergic system is indeed the biological basis of the SEEK system as postulated by Panksepp we analyzed $N = 258$ subjects of the gene data bank of the Giessen Gene Brain Behavior Project (GGBBP). From our study, we found a significant association with a polymorphism of the

dopamine transporter (see the section chapter below on the genetic basis of creativity).

The Genetic Basis of Creativity

This section on the genetic basis of creativity is inseparably entwined with the two previous sections. As mentioned, genes code for enzymes, neurotransmitters hormones, and proteins build the prerequisites for brain activity and signal transduction. In this way, the section chapter on the biological basis of creativity is conceptualized in a top down strategy. The physiology of the brain is influenced by neurotransmitters and hormones. The brain chemistry in turn is dependent on the genetic make up. There exists much resentment against genetic research stirred up by the anxiety that our genes determine our fate, our will can not influence our behavior, and genetic data can be abused leading to a stigmatization of certain people. This leads to the neglect of basic research in genetics which may help us understand among others how our brain functions, which systems are involved in cognitive, emotional and motivational processes. The new understanding of our brain is helpful for people whose brain functions are impaired.

Intelligence is the most heritable psychological phenotype known. Its importance in academic achievement and job performance (Jensen, 1998) has become a motivating factor for the search for its biological basis, one of the greatest scientific challenges. As mentioned, widely acknowledged is the influence of creativity on scientific and industrial progress and on the creation of outstanding arts and music. This acknowledgment however has yet given any salient impact on creativity research. The reasons for this have already been mentioned.

Evidence from Twin Studies

The importance of genes on intelligence has been shown. Twin and adoption studies have demonstrated that about 70% of the variance in intelligence is determined by genes (Bouchard *et al.*, 1990). However, the search for specific candidate genes of intelligence has so far been rather unsuccessful (Reuter *et al.*, 2006a). One of the reasons for this is the complexity of the phenotype. Therefore, newer strategies

prefer to analyze the so-called endophenotypes of intelligence, which are distinct sub-components of general cognitive ability, such as memory, attention, vigilance, or executive control. These endophenotypes are less complex than general cognitive ability and therefore presumably determined by a smaller amount of genes (Reuter *et al.*, 2005b). However, little is known about the genetic basis of creativity and the heritability of it. A review of 10 twin studies on creativity originating from the 1970s yielded an average correlation of 0.61 for identical twins and 0.50 for fraternal twins (Canter, 1973). According to some work, this genetic influence of about 20% is primarily due to the correlation between creativity and IQ. When IQ is controlled, identical and fraternal twin correlations for creativity tests were scarcely different (Nichols, 1978). It has to be pointed out that the problem of some of these studies was the precise measurement of creativity and the comparability across studies.

Until now, there is also little known about the molecular genetic underpinnings of creativity. Molecular genetic research is a rather young discipline. Since the recent decoding of the human genome and the development of new techniques in molecular genetics is now possible to conduct genetic association studies relating polymorphisms on candidate genes to psychological phenotypes. It is absolutely impressive that a single nucleotide polymorphism (SNP), this means the change of one out of three billion bases of our human genome, can have a tremendous effect on the brain metabolism. Especially those mutations, referred to as polymorphisms because a certain gene locus can have alternate alleles, who are located on a coding region (located on an exon) or a promoter region of a gene (with has an effect on the gene transcription) are of interest.

Candidate Genes

To our knowledge there is only one molecular genetic association study on creativity available until now. Reuter and colleagues (2006a) investigated three polymorphisms on candidate genes for cognitive functioning, the catechol-O-methyltransferase (COMT) VAL158MET, the dopamine receptor 2 (DRD2) TAQ IA, and the tryptophan

hydroxylase 1 (TPH1) A779C SNPs with respect to creativity. Especially the COMT gene has been successfully related to cognitive functioning before. There is a bulk of literature that unequivocally relates the methionine (MET) allele or the homozygous MET/MET genotype of the COMT gene to higher performance in prefrontal executive functions like working memory and executive control as measured by the Wisconsin Card Sorting Test (Egan *et al.*, 2001; Joober *et al.*, 2002; Malhorta *et al.*, 2002; Goldberg *et al.*, 2003). Functional studies have demonstrated that the MET allele of the COMT gene is characterized by a 3- to 4-fold reduction in COMT enzyme activity (Lachman *et al.*, 1996). The authors conclude that the findings support the assumption that high dopamine levels in the prefrontal cortex are associated with higher cognitive abilities. However, it has to be mentioned that the total dopamine activity is not only influenced by the dopamine catabolism but also by the synthesis rate, the activity of the dopamine transporter, the receptor density and the receptor affinity (Reuter *et al.*, 2006b). The DRD2 TAQ IA has been investigated with respect to intelligence but the results were heterogenous. One study reported a higher IQ in carriers of the A1A1 genotype in a female Taiwanese sample (Tsai *et al.*, 2002). Berman and Noble (1995) found a significant reduction in visuospatial performance in a sample of Caucasian children. Petrill *et al.* (1997) found no association between IQ and the DRD2 gene in an adult Caucasian sample.

The rationale for investigating the TPH A779C polymorphism, a serotonergic SNP, with respect to creativity is based on evidences that the serotonergic (5-HT) system is also involved in cognitive functioning. The mechanisms how the 5-HT system influences cognitive functions is less understood. Support from the literature is scarcer than for dopamine. Cuccaro *et al.* (1993), for example found a significantly negative correlation between whole blood 5-HT and cognitive-intellectual abilities in a sample of autistic patients and their first-degree relatives. By means of tryptophan depletion, an elegant method to investigate the involvement of 5-HT in brain functions, impairment in cognitive functioning could be demonstrated in both animal studies and studies on healthy human subjects (Mazer *et al.*, 1997; Evers *et al.*, 2005). Further evidence stems from clinical studies showing the beneficial effects of

substances increasing central 5-HT activity (Harvey, 2003; Poyurovsky *et al.*, 2003). All these findings underline the role of the 5-HT system in cognitive functioning, although the role of the dopaminergic system seems to be more salient. It can not also be excluded that some of the 5-HT effects on cognitive functioning are mediated via an indirect pathway by influencing the activity of the dopaminergic system. It is known that the 5-HT system exerts an inhibitory effect on DA release (e.g., Porras *et al.*, 2002). In its function as the rate-limiting enzyme of 5-HT synthesis, the tryptophan hydroxylase 1 gene (TPH1) is a promising candidate gene for cognitive functioning. However, previous positive association studies investigating the TPH1 gene have been criticized because the TPH1 gene is primarily expressed in the periphery and not in the brain (Shaltiel *et al.*, 2005). A recent finding by Nakamura *et al.* (2006) reporting a specific role of the TPH1 gene for the central 5-HT synthesis in a late developmental stage underlines that the TPH1 gene could indeed have an impact on cognitive functions.

In the study by Reuter *et al.* (2006a), creativity and intelligence as a control variable were measured in analogy with the study on creativity conducted Reuter and colleagues (2005a). The results obtained in a sample of $N = 92$ Caucasian subjects showed that the DRD2-gene and the TPH1-gene were both associated with total creativity explaining together 9% of the variance while COMT was not related to creativity at all. With respect to the subcomponents of creativity, the A1+ allele of DRD2 was related to higher verbal creativity as compared to the A1- allele and carriers of the A allele of TPH1 showed significantly higher scores in figural and in numeric creativity. The findings for the total creativity scores were presented in Figures 5.1 and 5.2.

Verbal tasks are assumed to be processed in the left hemisphere and numeric and figural tasks in the right hemisphere. The findings indicate that the two gene loci discriminate between higher cortical functions according to the organisation of cognitive functions in the respective hemispheres. Moreover, the results indirectly support Eysenck's hypothesis on creativity (Eysenck, 1993, 1995) suggesting higher creativity in subjects scoring high on the psychoticism dimension. Psychoticism is related to aggressiveness. There is evidence in the literature that the A-allele of the TPH1 A779C allele associated
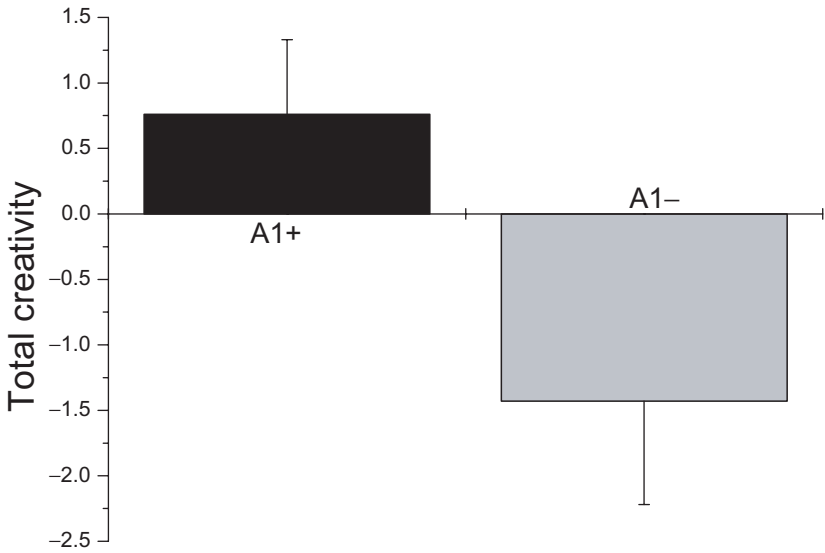
Fig. 5.1. Association between the A1+ allele of the DRD2 TAQ IA polymorphism and total creativity (z-scores). $F_{(1,88)} = 5.03$, $p = 0.027$.
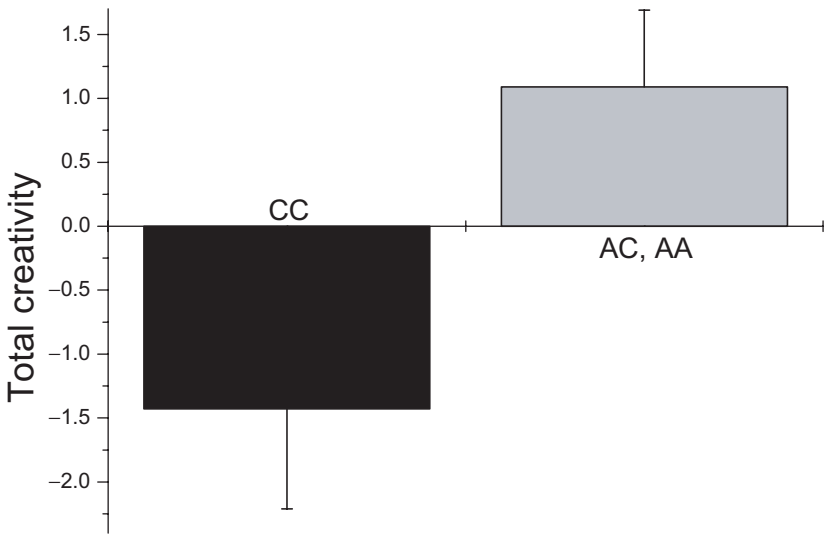

Fig. 5.2. Association between the A-allele of the TPH1 A779C polymorphism and total creativity (z-scores). $F_{(1,82)} = 6.57$, $p = 0.012$.

with higher creativity scores (Reuter, *et al.*, 2006a) is related to high aggression (e.g., Hennig *et al.*, 2005).

The study by Reuter *et al.* (2006a) is at present the only molecular genetic approach directly addressing creativity. Some preliminary results from the *Giessen Gene Brain Behavior* gene data bank support the positive association between the personality dimension of SEEK and creativity (Reuter *et al.*, 2005a). It was postulated that the dopaminergic system is the biological basis of the SEEK system (Panksepp, 1998). Exactly the mesolimbic dopaminergic system that is involved in the processing of emotions constitutes also the biological basis for creative drive (Flaherty, 2005). In a sample of $N = 258$ healthy Caucasian subjects the dopamine transporter (DAT) polymorphism was associated with the SEEK system (genotype level: $F_{(2,255)} = 5.02$, $p = 0.007$; allele level: $F_{(1,256)} = 9.92$, $p = 0.002$). Carriers of the homozygous 9/9 polymorphism had significantly higher SEEK score than carriers of at least one 10-repeat allele (Figure 5.3).
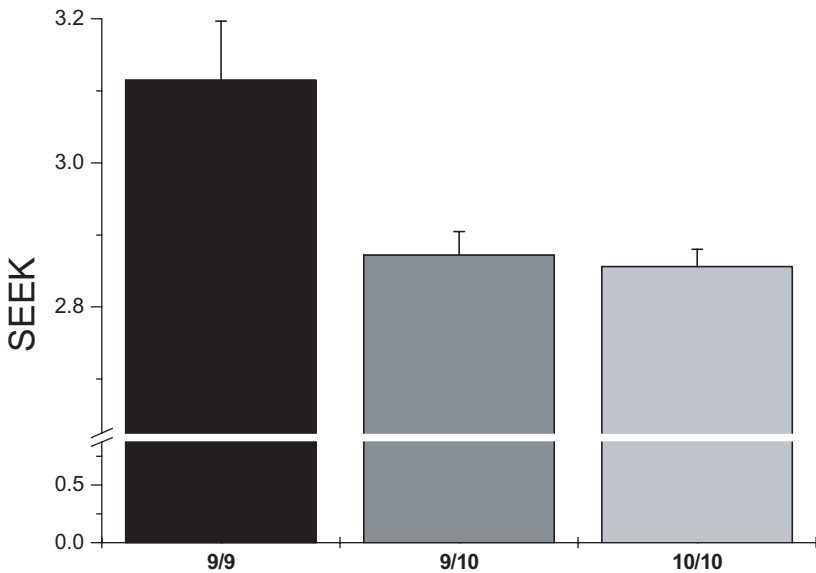
Fig. 5.3.   Association between the dopamine transporter (DAT) polymorphism and SEEK: $F_{(2,255)} = 5.02$, $p = 0.007$. The 9/9 genotype tested against the 9/10 and the 10/10 genotype: $F_{(1,256)} = 9.92$, $p = 0.002$.

The DAT polymorphism is a variable number of tandem repeats (VNTR) polymorphism where a sequence of 40 bases is repeated different numbers of times. The 10-repeat allele is the most common and is related to lower DAT levels in the brain as compared to the 9-repeat allele (van Dyck *et al.*, 2005). Thereby the cycle is closed: a genetic variant of the dopaminergic system is related to a personality dimension (SEEK) that is associated to creativity.

Future Perspectives in Biological Oriented Creativity Research

This chapter has outlined the reasons why creativity research in general and specifically biological creativity research has been widely neglected. By developing new reliable and valid instruments for the measurement of creativity 'the role of creativity research as a prodigal stepbrother to research on intelligence' (Sternberg, 1988) will overcome. Such behavioral tests of creativity with both interrater reliability and predictability for future performance (Jäger, 1982; Cropley, 2000; Carson, Peterson, and Higgins, 2005; Flaherty, 2005) are now available. This development opens the stage for a new era in creativity research. New developments and the invention of new techniques in the neurosciences like PET, fMRI (functional magnetic resonance imaging), or techniques in molecular genetics make it possible to investigate the biological underpinning of creativity on a very proximal level. This means that brain activity can be monitored while cognitive tasks are performed or the genetic determinants for differences in brain activity can be detected. The most promising approach will be to combine techniques from functional imaging with those of molecular genetics. The gap between gene and behavior will be narrowed if subjects are *a priori* screened with respect to candidate genes for creativity and then differences in cerebral blood flow are measured when they are solving cognitive tasks.

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Creativity Research and The Classroom: From Pitfalls to Potential

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Introduction

Consider, Mr. Arrow, an elementary school teacher who values creativity, but views creativity as being synonymous with unconstrained originality. Consequently, he is unable to justify spending class time on what he feels will lead students "off-topic" and away from what he has been hired to teach. As such, he often will dismiss students' unexpected ideas, explaining that such ideas are "creative" but "not appropriate" given the goals of the lesson. Or consider, Ms. Pascal, a high school science teacher who teaches an entire instructional unit on scientific creativity in which she highlights key breakthroughs of eminent scientists. Unfortunately, she believes that the only creativity that counts is on the level of major creative contributions (e.g., Newton's Third Law of Motion; Einstein's Theory of Relativity). Although she acknowledges that her students may have creative potential, she also believes that only time will tell if any one of her students will be destined to be creative in science. She therefore fails to recognize the unique and meaningful insights frequently demonstrated by her students.

Although, the above vignettes are hypothetical, the marginalization of creativity represented in them is a reality in many schools and classrooms (Beghetto and Plucker, 2006; Sternberg, 2003). This marginalization results from a variety of factors—ranging from a lack of resources to competing curricular demands. However, a primary source of this marginalization has been attributed to problematic beliefs and misconceptions about creativity (Plucker, Beghetto and Dow, 2004;

Aljughaiman and Mowrer-Reynolds, 2005). Too often, misconceptions about the nature of creativity result in teachers thinking that creativity has no place in their classrooms.

There are a variety of conceptual pitfalls that stem from problematic beliefs about creativity (Plucker, Beghetto and Dow, 2004) which, in turn, can lead to the marginalization of student creativity. Common conceptual pitfalls include: (a) viewing creativity as synonymous with originality; (b) believing that only the highest level of creative contribution counts as creative; and (c) focusing too little attention on the role of classroom environment plays in supporting creativity.

Purpose

In the present chapter, I draw on contemporary creativity scholarship to examine common conceptual pitfalls and offer considerations for how these pitfalls might be addressed. The chapter is organized into five sections. In the first three sections, I discuss how educators might recognize and avoid: (a) *the originality pitfall* (i.e., viewing creativity and originality as synonymous), (b) *the creativity as major breakthrough pitfall* (i.e., believing that the only creativity that counts are contributions on the level of major breakthroughs), and (c) *the creative person/technique pitfall* (i.e., believing that only certain students have creative potential or that the only way to promote creativity is by using some specific step-by-step technique). I then highlight practical considerations for helping teachers to maximize students' creative potential. The chapter closes with a brief summary and concluding remarks.

Avoiding the Originality Pitfall

A common pitfall for educators is equating creativity with originality. This is not surprising given that originality is the most widely recognized attribute of creativity (Runco, 2004a). Indeed, originality is necessary for an idea or product to be considered creative. However, originality is not sufficient for creativity. Rather, creativity researchers generally agree that creativity also requires that a novel product, idea, or behavior be viewed as appropriate, meaningful, or of value (Plucker, Beghetto and Dow, 2004; Runco, 2004a).

Conceptions of creativity that do not recognize the criterion of appropriateness can result in the development of a creativity-as-negative-deviance stereotype (Plucker, Beghetto and Dow, 2004). For instance, if teachers (like the elementary teacher in the opening vignette) come to view creativity as unconstrained originality it is easy to imagine how they might feel that creative expression is inappropriate for their classroom. Indeed, a common belief of teachers is that creative students are disruptive students (Westby and Dawson, 1995; Scott, 1999; Runco, 2003). Given such beliefs, it is not surprising that teachers would be leery of promoting student creativity (as doing so might lead students "off-topic" or result in disruptive behavior). Such problematic beliefs about creativity undermine students' creative expression in school and classroom settings.

This is why creativity researchers have emphasized that creativity involves a combination of originality *and* appropriateness (Plucker, Beghetto and Dow, 2004). By recognizing that creativity requires the combination of novelty and appropriateness, teachers put themselves in a better position to maximize rather than marginalize creative potential. Teachers can then incorporate this requisite combination of novelty and appropriateness in assigning projects, activities and assignments. For instance, a teacher might encourage her students to express their creativity by writing a Shakespearean sonnet. To consider the poem to be creative, students would be required to construct a novel *and* appropriate representation of a Shakespearean sonnet, staying within the established conventions of the form, but doing so with their own unique contribution of content.

In addition to emphasizing the requisite attributes of novelty and appropriateness, creativity researchers have also stressed the importance of considering the social context and the interaction among individual, process and environment in conceptions of creativity (Plucker, Beghetto and Dow, 2004). As will be discussed in the sections that follow, recognizing that creativity is defined within a social context helps educators avoid the common pitfall of thinking that just because a child's contribution (e.g., poem) is not considered to be creative in a broader social context (e.g., international poetry contest) that it therefore lacks creativity in any context (e.g., 3rd grade classroom).

Also, recognizing that creativity involves an interaction among person, process, and environment helps educators avoid the pitfall of thinking that only certain students can be creative or that creativity can be promoted by following some step-by-step algorithm.

In summary, educators who develop a more complete conception of creativity avoid the common pitfall of viewing creativity as simply a form of unconstrained originality. By doing so, they can then consider how they might better support students' novel conceptions within the constraints of a particular assignment, activity, or tasks (blending the novel with the appropriate). Moreover, by recognizing that originality and appropriateness are defined in a social context and that creative expression results from a dynamic interaction among individual, aptitude, and environment teachers position themselves to address related conceptual pitfalls pertaining to what counts as creativity and the role of the classroom environment in supporting creativity.

Avoiding the Creativity as a Major Breakthrough Pitfall

Most anyone would quickly judge Einstein to be a creative genius, even though they know virtually nothing about the field of physics or the details of his various contributions. The highest levels of creativity (e.g., the creativity of Einstein) are referred to as Big C creativity. Such examples of eminent creativity are quite compelling and serve as the focus of much attention in the research literature (e.g., Simonton, 1984; Gardner, 1993). However, too great a focus on the highest forms of creativity may reinforce educators' (and students') misconceptions about creativity. For instance, if educators (like the science teacher in the opening vignette) come to see creativity as only that which is of the Big-C level, then there is little room for recognizing the creative potential and production of young students.

Fortunately, creativity scholars have argued that Big C creativity represents only the far end of the creativity continuum. For instance, Cohen (1989) has developed a compelling model that provides a way of thinking about creativity as progressing along a developmental trajectory from early childhood through adulthood. Cohen's (1989) model

stresses that that all students can be creative. And recent creativity research and scholarship has been aimed at demonstrating the every-day, ubiquitous nature of creativity and creative potential (Runco and Richards, 1997; Runco, 2004b; Beghetto and Plucker, in press).

The notion that all students can be considered creative is based on the recognition that creativity is determined by the social context. This means that what is creative in one setting (for instance, a 4th graders classroom drawing) does not necessarily have to be considered creative in another setting (e.g., an exhibit at the Guggenheim). Therefore, just because a students' creative contribution is not revolutionary does not mean it is not creative in the context of the classroom. Indeed, a student's contribution can be considered creative as long as it is judged to be novel and appropriate for the particular assignment, situation, or context. This level of creativity is referred to as *little-c creativity.*

In addition to little-c creativity, some creativity researchers (Beghetto and Plucker, in press; Cohen, 1989) have argued (following Jean Piaget and J. P. Guilford) that learning itself is a creative process. Beghetto and Kaufman (2006) have referred to this level of creativity as "mini-c creativity." Mini-c creativity is based on the assertion that the transformation and interpretation of experiences into new under-standing is ultimately a personal creative process (Runco, 2004b).

By recognizing, there are different levels of creativity (mini-c, little-c and Big-C), educators can move away from the common pitfall of believing that Big-C creativity is the only level of creativity that mat-ters. Awareness of the different levels of creativity also highlights the importance of not taking an extreme position regarding the domain specific nature of creativity. For instance, a great deal of debate has sur-faced in the creativity research literature regarding the domain general versus domain specific nature of creativity (Baer, 1998; Plucker, 1998; Kaufman and Baer, 2005). The domain debate refers to the question of whether creativity is best thought of as domain general or domain specific. For instance, if Olivia is creative in science will she also be creative in art?

A general consensus amongst researchers is that the highest levels of creativity are best thought of as domain specific. This is because the highest levels of creative contribution generally require upwards of

10 years of investment and commitment in a particular domain (Simonton, 1984). And each domain has its own set of criteria (and gatekeepers) used to judge whether a particular contribution is creative (Csikszentmihalyi, 1999). Moreover, as Runco (2004a) has reported, important differences also seem to exist within sub-domains (e.g., poetic creativity seems to differ from the creativity of novelists or playwrights). The recognition of variations in creative criteria across domains and within sub-domains has led creativity researchers, such as, Simonton (2004), to conclude: "Creators are not interchangeable no matter what their domain of creativity" (p. 94). However, there are important considerations for interpreting this research when it comes to school-age students.

Perhaps most important is the recognition that just because a student does not demonstrate creative aptitude in one particular domain does not mean that he or she does not have creative potential that can be cultivated in other domains. Educators should, therefore, avoid extreme positions when it comes to thinking about the domain specificity of children's creativity. Fortunately, creativity researchers have started developing hybrid models of creativity that offer a more balanced perspective on the domain issue as it pertains to school age students. For instance, the Amusement Park Theoretical (APT) Model (Kaufman and Baer, 2004) represents an integrative framework of domain specificity and generality. The APT model posits a variety of domain general initial requirements (e.g., environment, ability, and motivation) that are required for any creative act. These initial requirements then serve as the basis for entry into and selection of increasingly more specific thematic areas (e.g., the arts), domains within those areas (e.g., writing) and micro-domains (e.g., poetry) in which individuals ultimately make their creative contributions.

Similarly, Plucker and Beghetto (2004) developed a hybrid model that illustrates how a flexible middle position (in-between domain generality and domain specificity) may be most optimal for creative production. The hybrid model is useful in recognizing that too much domain generality leads to superficiality, whereas too much domain specificity leads to fixedness. In light of this, educators are advised to consider

the potential problems inherent in approaching school and classroom-based creativity enhancement efforts with a set of de-contextualized activities. An example of this de-contextualized approach is when educators rely too much on attempting to enhance creativity with generic divergent thinking tasks (e.g., "Try to come up with as many novel uses as you can for a pencil…").

The hybrid model also highlights the problem with limiting creativity enhancement efforts to particular content areas. For instance, segregating creativity enhancement efforts to the arts (e.g., visual, performing, and written). Or encouraging students to focus of their attention in a particular domain (e.g., science) that they fail to develop their ability to think flexibly across domains (e.g., art, math, history). Such practices only serve to reinforce misconceptions about creativity. And given that school-ages students' interests are still developing, focusing too narrowly on a given academic context may result in premature foreclosure and unrealized creative potential in other academic areas. Rather, the hybrid model encourages enhancement efforts that stress the importance of interest and task commitment within domains while also recognizing the value of diverse experiences, flexible thinking, and cross-fertilization of ideas across various domains.

In summary, the recognition of multiple levels of creative magnitude helps educators recognize that all students have creative potential. This in turn allows educators to acknowledge the importance of Big-C contributions (like the science teacher in the opening vignette) while at the same time focus on the development of their students' ability to generate new and meaningful personal insights (mini-c creativity) as well as novel and appropriate contributions that are recognize as creative given the constraints of a particular activity, task, or project (little-c creativity).

Avoiding the Creative Individual/Technique Pitfall

Another potential pitfall for educators interested in supporting student creativity is to believe that only certain students are disposed

to be creative or that the only way to promote creativity is by using some step-by-step creativity enhancement technique. Although certain dispositions (e.g., openness to new experiences; being less conventional; and having high self-confidence, drive, and ambition) are more likely to be found in highly creative individuals (Feist, 1998), such dispositions are not necessarily static traits or dichotomously distributed in a population (i.e., either you have it or you don't). Moreover, placing too great a focus on traits and dispositions may result in the common pitfall of believing that only certain people can be creative (Plucker *et al.*, 2004). Rather, it is important for educators to recognize that most anyone can be creative (Nickerson, 1999) and that the classroom environment plays an important role in influencing whether students will feel supported and encouraged in their creative expression.

Similarly, rather than spend time seeking out some sure-fire technique for promoting student creativity, teachers might better spend their time focusing their attention on how their everyday classroom policies, practices, and procedures support or thwart creative expression. Indeed, creativity researchers have argued that best way to promote student creativity is for teachers to encourage and model the creative thinking and behaviors in the classroom (Sternberg and Grigorenko, 2004). For instance, teachers might encourage and model the expression of original ideas (divergent thinking) by encouraging students to imagine various perspectives a key historical event. And, at the same time, help students use their evaluative skills (convergent thinking) by ensuring that imagined perspectives offered by students have some basis in historical documents, records, and other appropriate source materials.

Although there are various strategies that may be helpful in supporting the development of students divergent and convergent thinking skills (Nickerson, 1999; Piirto, 2004; Scott, Leritz and Mumford, 2005), the importance of classroom practices, policies, and procedures that encourage students' willingness to take the intellectual risks necessary for creative expression should not be overlooked. Indeed, as Nickerson (1999) has argued, the desire, motivation, and commitment

to take such risks are as important (or perhaps more important) than raw ability or the use of some technique:

> Desire, internal motivation, and commitment are more important, in my view, than either domain specific knowledge or knowledge of specific creativity-enhancing techniques or heuristics. With sufficient motivation, one is likely to obtain the necessary knowledge and to discover useful heuristics; without it, knowledge of any kind is unlikely to do much good (p. 420).

Simply stated, when it comes to whether students will take the intellectual risks necessary for creative expression: students' motivational beliefs matter. And motivational researchers (Kaplan *et al.*, 2002) have demonstrated that the policies, practices, and procedures of the classroom have an important influence on students' motivational beliefs. Moreover, with respect to the idea generation (divergent thinking) phase of the creative process, Collins and Amabile (1999) have explained that the ability to identify problems and generate multiple ideas is often linked to high levels of interest, enjoyment, and task commitment. Motivational researchers have reported that interest, enjoyment, and task commitment are more likely to be found in *mastery-oriented* environments rather than *performance-oriented* environments (Ames, 1992; Pintrich and Schunk, 2002).

Mastery oriented environments stress the importance of learning, understanding, and self-improvement. Conversely, performance-oriented environments emphasize the importance of avoiding mistakes, demonstrating one's competence, and outperforming others. Not surprisingly, some features of performance-oriented environments seem to derail creative thinking. For instance, Collins and Amabile have found that student creativity is, in most cases, undermined if students are distracted by extrinsic concerns (e.g., comparisons to others or concerns about how they might be evaluated by the teacher).

This is not to say that competitive environments are necessarily detrimental to the creative expression of all students. For instance, Amabile (1996) has reported that competition can have a positive effect for some individuals and work teams. At this point, however, additional research is needed to determine for whom and under what conditions

social comparisons and competitive environments are supportive of creativity. Indeed, it is easy to imagine how too great a focus on social comparison and avoiding mistakes can undermine creative expression.

For instance, consider the potential influence that the classroom environment might have on students' intellectual risk taking in the form of sharing creative ideas. In order for students to be willing to take the risk of sharing a creative idea, they need to feel supported in doing so. Unfortunately, a common practice of teachers, as reported by Kennedy (2005), is to dismiss students' unexpected ideas (regardless of their potential merit). If students' creative ideas are dismissed by teachers or met with giggles and eye roles from their peers, it would not be surprising if they soon come to believe that creative expression is not worth the effort and risk. Although it may be the case that being creative involves "defying the crowd" (Sternberg and Lubart, 1995), the classroom need not be experienced as a dismissive, unwelcoming, or demoralizing environment for students. To avoid this pitfall, educators need to continually monitor the motivational messages being sent to students by the classroom environment.

From Pitfalls to Potential

A reoccurring theme throughout the chapter has been the importance of developing a more complete understanding of creativity. In doing so, teachers put themselves in a better position to avoid common pitfalls and, instead, maximize students' potential. The following practical considerations summarize and extend key insights discussed in the chapter and are aimed at helping educators move away from pitfalls and toward maximizing student potential:

- *Become familiar with your own beliefs about creativity.* Teachers' beliefs influence the expectations they hold for students as well as the way in which they design educational experiences. These beliefs and expectations have important implications for student creativity. For instance, the expectation placed on young students to conform (be it tacit or explicit) has been suggested as a possible reason why researchers have consistently found a slump in student creativity by the 4th grade (Runco, 2004a). Also, somewhat surprisingly,

Beghetto (in press) found that prospective teachers who generally had more favorable past schooling experience (i.e., liked school, felt like they belonged, viewed themselves as competent students) were less likely to see the importance in promoting student creativity as compared to prospective teachers who had more negative past schooling experiences. Given that teachers own past experiences as students influence their current beliefs about the importance of promoting creativity, educators interested in promoting creativity are advised to reflect on their past schooling experiences and identify potentially problematic beliefs about creativity. In this way, educators can ensure that their efforts are not being undermined by their own assumptions, beliefs, and conceptions of creativity.

- *Help address misconceptions held by students, colleagues, and parents.* As has been discussed earlier, myths and stereotypes about creativity abound. And becoming aware of how creativity researchers have addressed these myths and stereotypes is only the first step. Ultimately, educational practitioners must take the responsibility upon themselves to help educate students, colleagues, parents, and related stakeholders about problematic beliefs and conceptions about creativity. A good place to start is with exploring definitions and beliefs of creativity already held by students, colleagues, and parents. Indeed, most everyone has developed robust conceptions about the nature of creativity. These "implicit theories" (Sternberg, 1985) are important because they influence the everyday judgments and decisions people make about the nature and value of creativity. By helping colleagues, students, parents, and related stakeholders consider how creativity has come to be defined in the research literature (including, issues surrounding magnitude, enhancement, and domain generality and specificity), educators can make great strides in setting the necessary conceptual groundwork for supporting student creativity in the classroom.

- *Consider whether educational environments are supportive of creative expression.* School and classroom environments play an important role in whether students' creativity will be supported. As such, educators have a responsibility to actively consider how the motivational messages sent by school and classroom policies, practices, and procedures

are influencing student creativity. Beghetto (2005) has provided several general recommendations for ensuring that student creativity is supported in educational settings. Those recommendations include: (a) Setting challenging but realistic goals for students and focusing on the features of a task that are interesting and personally meaningful (rather than attempting to motivate students to complete tasks simply because they are assigned and will be graded); (b) Supporting creative expression by encouraging the generation of novel ideas and helping students then select the most promising and appropriate ideas for a given task; (c) Minimizing the pressures of assessment; (d) Helping students recognize that the primary reason for engaging in a task is self-improvement rather than just showing others that they can successfully complete a task, (e) Helping students learn from mistakes and recognize that making mistakes is a natural part of learning; and (f) Rather than focusing solely on letter grades and test scores, helping students consider what those grades mean, i.e., what they did well and how they might improve in the future.

Conclusion

The present chapter had the purpose of highlighting common conceptual pitfalls regarding creativity and providing considerations for avoiding such pitfalls. A key insight that can be drawn from the creativity scholarship reviewed in this chapter is that educators interested in support student creativity should take an ambitious, yet feasible approach. Ambitious in that creative potential is widely distributed and is likely to be fulfilled under the right environmental conditions. Feasible in that supporting student creativity need not be seen as an extra-curricular or Herculean activity. The goal for educators should not be to try to create a classroom full of Einstein (as this likely would be impossible), but rather focus on integrating creativity into the everyday curriculum by encouraging students' original ideas while at the same time ensuring that their ideas are appropriate for the curricular goals and standards of a particular activity, lesson, or assignment.

With this ambitious yet feasible approach, educators can make great strides in helping to fulfill students' creative potential. Although there

are a variety of techniques that may help facilitate this process, teachers cannot rely on techniques alone. Indeed, there are no recipes for creativity. Rather, by being sensitive to the motivational climate created by classroom policies, practices, and procedures; teachers can increase the likelihood that their efforts will pay off in the form of building the creative capacity of all students.

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Part One
Exploring the Nature of Creativity

Section III
Identification and Assessment

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The Two Torrance Creativity Tests: The Torrance Tests of Creative Thinking and Thinking Creatively in Action and Movement

Kyung-Hee Kim

Introduction

E. Paul Torrance is identified with his tests of creativity, but assessment of creativity was not one of Torrance's goals for the tests. The tests were intended tools for research and for tailoring an individual student's curriculum to enhance his(her) long-term potential. Torrance's tests provided a physical measure and groundwork for the idea that creative levels can be scaled and then increased through practice. The thought that creativity can be taught was previously only conceptual (Childs, 2003). Ultimately, Torrance's research into creativity shattered the theory that IQ tests alone can measure real intelligence (Powell, 2003; Shearer, 2003).

Torrance (1966) realized that creative thinking requires risk taking and ways of thinking that diverge from the norm. Torrance found that individuals who are troublesome as children, because they are unusually full of ideas, tend to become successful later in life in creative fields. Further, he found that individuals are required to think creatively when facing unexpected or unusual situations. Thus, he developed the Torrance Test of Creative Thinking (TTCT) to measure how individuals' thoughts can diverge from the norm in an effort to study creativity. Torrance also developed the Thinking Creatively in Action and Movement (TCAM) because he realized that verbal and written responses

were not adequate for very young children, e.g., pre-schoolers and kindergarteners.

The Torrance Test of Creative Thinking (TTCT)

The Torrance Test of Creative Thinking was developed and used much earlier. In 1966, Torrance published the TTCT in the form of substantial use today as a part of his long-term research program emphasizing classroom experiences that stimulate creativity (Swartz, 1988). Originally, the TTCT was planned as a basis for individualizing instruction for different students based on the test scores (Torrance, 1966, 1974). Torrance discouraged interpretation of scores as a static measure of a person's ability and, instead, argued for using the profile of strengths as a means to understand and nurture a person's creativity (Hébert *et al.*, 2002; Torrance, 1966, 1974, 1979a). Therefore, the original purpose of the Torrance tests were research and experimentation, general use for instructional planning, and determining possible strengths of students. Notwithstanding the tests' intended purposes, the TTCT have been widely used for assessment for the identification of gifted children. The TTCT are the most widely used and studied creativity tests (Treffinger, 1985; Swartz, 1988; Johnson and Fishkin, 1999).

The TTCT consist of two different tests, the TTCT-Verbal and the TTCT-Figural, and each test has two alternate or parallel forms. The TTCT are standardized measures of creative strengths, are culturally fair, provide a comprehensive score, grade and age norms, and national percentiles, and both have 40+ years of trial and research. Since their development in 1966 the scoring has been renormed[1] several times: in 1974, 1984, 1990 and in 1998. Results of the TTCT were originally expressed by four factors: Fluency (the number of relevant ideas), Originality (the number of statistically infrequent ideas), Flexibility (the

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[1]Creativity tests do not have lists of right or wrong answers and are not uniform in their scoring. It takes considerable skills to score a creativity test. Re-norming the tests updated the scoring guide to account for variances in education, culture, and societal changes. It is proposed that different cultures should develop different norms (Kim, 2006a).

number of shifts or categories in responses), and Elaboration (the number of details used in a response).

The TTCT can be administered as an individual or group test from the kindergarten level (age 6) through the graduate level and beyond. They require from 30 to 45 minutes working time. So speed is important and the Figural versions of the test require some drawing ability, however, artistic quality is not required to receive credit (Chase, 1985). Scholastic Testing Service, Inc. holds the copyright for the TTCT and provides a 1998 Norms- Technical Manual for the tests.

The atmosphere in which the TTCT are administered is important. Torrance (1966) recommended the creation of a game-like, thinking, or problem-solving atmosphere to avoid the threatening situation associated with testing. His intent was to set the tone so that examinees would enjoy the activities. Examinees should be encouraged to "have fun," and should experience a psychological climate that is as comfortable and stimulating as possible (Ball and Torrance, 1984).

The Torrance Tests of Creative Thinking-Verbal (TTCT-Verbal)

The TTCT-Verbal is formally titled "Thinking Creatively with Words." The TTCT-Verbal has two alternate forms A and B. They can be administered from Kindergarten to adults. They consist of six timed activities with each activity taking either five or ten minutes.

Activities 1 to 3 start with a single ambiguous picture. Activity 1, Ask Questions, consists of asking questions about the picture. Activity 2, Guess Causes, consists of guessing causes of the action in the picture. Activity 3, Guess Consequences, consists of guessing consequences, immediate or long-term, about the picture. Subjects are allowed five minutes to complete each of these activities.

Activity 4, Product Improvement, consists of showing an item, such as a stuffed animal, and asking for suggestions to improve it. Examples of verbal responses for Activity 4 by a 7th grader with a reading and writing learning disability after being shown a stuffed elephant are: "Alter it to make it a warrior elephant with lots of accessories to defend Earth from the orangutan pack"; "Give it bigger ears, call it Dumbo,

and write a sequel"; and "Make it come with an elephant circus—tight-rope walker elephants, lion tamer elephants".

Activity 5, Unusual Uses, consists of thinking of alternative uses for a common object, such as cardboard boxes or tin cans. Uses for parts of the object are acceptable. Fantastic or impossible uses beyond all possible reality are not counted.

Activity 6, Just Suppose Hypotheses, consist of thinking about an improbable situation. For instance, suppose we could transport ourselves anywhere we want with just a twitch of the nose or blink or the eye. What would be some problems, benefits, etc., of this situation?

The TTCT -Verbal results in measures of Fluency—the number of relevant ideas, Originality–the unusualness of the ideas, and Flexibility (Shifts)—the variety of ideas.

The Torrance Tests of Creative Thinking-Figural (TTCT-Figural)

The TTCT-Figural is formally titled "Thinking Creatively with Pictures". The TTCT-Figural has two parallel forms, A and B. It consists of three activities: Picture Construction, Picture Completion, and Repeated Figures of Lines or Circles. Ten minutes are required to complete each activity.

Activity 1 requires the subject to construct pictures using a pear or jellybean shape provided on the page as a stimulus. The provided shape must be an integral part of the resulting pictures. Activity 2 requires the subject to use ten incomplete figures to make objects or pictures. Activity 3 requires the subject to complete pages of lines or circles to create pictures (Torrance, 1966, 1974, 1990, 1998). The TTCT-Figural measures Fluency, Originality, Elaboration, Abstractness of Titles, Resistance to Premature Closure, and Creative Strengths.

Content Areas of the TTCT-Figural

The TTCT measures of Fluency, Flexibility, Originality, and Elaboration are based upon the divergent-thinking factors found in Guilford's (1956) Structure of the Intellect Model (Baer, 1997; Torrance, 1966, 1974).

Although there have been several revisions of the TTCT scoring, the tests have remained unchanged. The stimuli of the TTCT of 1984 are identical to those of 1966 and 1974, but the scoring procedures were streamlined in the third (1984) edition (Ball and Torrance, 1984). Chase (1985) criticized earlier editions of the TTCT because of a lack of empirical basis for the scoring decisions due to the subjectivity of scoring. The 1984 revisions were designed to overcome this objection.

The 1984 TTCT-Figural manual simplified the scoring procedures and provided a detailed Scoring Workbook (Ball and Torrance, 1984) in addition to the Norms-Technical Manual. Two norm-referenced measures of creative potential, Abstractness of Titles and Resistance to Premature Closure, were added to Fluency, Originality, and Elaboration; and Flexibility was eliminated because it correlated very highly with Fluency (Hébert et al., 2002). Thus, the following five norm-referenced subscales (Torrance, Ball and Safter, 1992) are measured:

1. Fluency: a count of the number of relevant ideas using the stimulus—Shows an ability to produce a number of figural images.
2. Originality: a count of the number of statistically infrequent ideas—Shows an ability to produce uncommon or unique responses. The scoring procedure counts the most common responses as "zero" and all other legitimate responses as "one". The Originality lists have been prepared for each item on the basis of normative data which are readily memorized by scorers.
3. Elaboration: a count of the number of ideas added beyond the minimum details that would be necessary for the basic response. One point for each additional idea added to the basic response. Additional ideas include: decoration, details, shading, body position, etc. These demonstrate the subject's ability to develop and elaborate upon ideas.
4. Abstractness of Titles: The degree beyond labeling—Based on the idea that creativity requires an abstraction of thought. It measures the degree a title is expressed beyond obvious labeling of the pictures drawn.
5. Resistance to Premature Closure: The degree of psychological openness—Based upon the belief that creative behavior requires a

person to consider a variety of information when processing information and to keep an "open mind."

Torrance's 1984 revision also added 13 criterion-referenced measures, which Torrance called Creative Strengths, to the scoring (Ball and Torrance, 1984; Torrance, 1990b). The Creative Strengths are Emotional Expressiveness, Storytelling Articulateness, Movement or Action, Expressiveness of Titles, Synthesis of Incomplete Figures, Synthesis of Lines or Circles, Unusual Visualization, Internal Visualization, Extending or Breaking Boundaries, Humor, Richness of Imagery, Colorfulness of Imagery, and Fantasy.

Finally, in 1984 Torrance also added the "Creativity Index". The Creativity Index incorporates the standard scores of each of the five subscales and Torrance's Creative Strengths according to the TTCT Norms-Technical Manual (Torrance, 1998). The calculation of the Creative Index starts with the raw scores on each of the five subscales converted into standard scores with means of 100 and standard deviations of 20. The standard scores for each of the five norm-referenced measures are averaged to produce an overall indicator of creative potential. For the frequency of creative strength, a "+"or "+ +" is awarded on the basis of the scoring guide. The number of "+"s is added (range for Creative Strengths: 0–26) to the averaged standard scores to yield a Creative Index (Torrance, Ball and Safter, 1992).

Torrance added the new subscales based on information that was unavailable when he originally published the TTCT in 1966 because of his concern that the norm-referenced score was not measuring the breadth of creativity manifestations that he had observed (Torrance, 1979b; Hébert *et al.*, 2002). He used continued research to expand his test, including studies of the creative giants, personality studies of creative people, creativity training guides, his own studies, and other literature in the field. Torrance (1979b, 1988, 1994; Ball and Torrance, 1984) also provided evidence to show that the new subscales are valid predictors of creative achievement and that they improved the test's content validity and construct validity of the scoring variables have been studied in a factor-analytic study (Mourad, 1976), a comparative study (Rungsinan, 1977), a developmental study (Alieldin, 1979;

1982), and Torrance's (1979b) *The search for Satori and creativity.* According to Johnson and Fishkin (1999), revised scoring system for the TTCT addresses essential constructs of creative behaviors reflective of Torrance's (1988) definition of creativity. Therefore, Torrance showed that the TTCT is not only a divergent thinking test, but also a creativity test as of the 1984 revisions (Ball and Torrance, 1984).

Reliability of the TTCT-Verbal and Figural

Scoring Reliability

Standardized scoring of the TTCT takes time, training, and effort to master. Rosenthal, DeMers, Stillwell, Graybeal, and Zins (1983) reported inter-rater reliability of 0.90 or higher scoring TTCT-Verbal tests of 125 gifted and 428 nongifted elementary school children. Torrance (2000b) reported inter-rater reliability of 0.95 for flexibility to 0.99 for Fluency between scorers of TTCT-Verbal.

In his1984 revisions, Torrance published a streamlined scoring system for the TTCT-Figural to allow for faster and easier standardized scoring of the TTCT (Torrance *et al.*, 1992). The TTCT-Figural manual of 1990 reports that the inter-rater reliability among the scorers for Scholastic Testing Service, Inc. was above 0.90. Samples included 88,355 kindergarten through 12th grade students in the U.S. from the South (41.4%), Northeast (28.5%), North Central (5.1%), and West (5.1%), as well as some students from Canada (Torrance, 1990b).

Ongoing TTCT Scoring Training is offered by the Torrance Center for Creativity and Talent Development at The University of Georgia. The Center's 3-day workshop takes an in-depth look at the TTCT in terms of how to administer, score and interpret the figural test through hands-on practice. Participants who complete the training and get their scores for the sample tests within 90% agreement with standard scoring samples will receive a certificate (Torrance, 2000b).

Test-retest Reliability

The test-retest reliability coefficients of the TTCT-Verbal and Figural ranged from 0.59 to 0.97 (Torrance, 2000b). Torrance believed that

the creative thinking abilities including those measured by the TTCT are susceptible to development through educational experiences. In addition, emotional, physical, motivational, and mental health factors also affect creative functioning and development and may contribute to a lowering of test-retest reliability. Treffinger (1985) concluded that, given the complexity of creative thinking, the TTCT can be seen as having reasonable reliability for group and research applications.

Validity of the TTCT-Verbal and Figural

Predictive Validity

Any creativity measurement is useless unless it has a proven ability to predict performance. Preliminary studies established the validity of the TTCT and, thereafter its ease of use fostered research on the TTCT (Swartz, 1988). Thus, the TTCT are more researched and analyzed than any other creativity instruments (Treffinger, 1985; Swartz, 1988; Johnson and Fishkin, 1999). The TTCT has over 25 years of extensive development and evaluation (Millar, 2002) and one of the largest norming samples with valuable longitudinal validations (Davis, 1997).

While some controversies remain about the interpretation of its results, the conclusion of most of the research about the TTCT is that the tests have a predictive validity over a very wide age range (Cropley, 2000) and for long periods of time.

Longitudinal Research

The major body of longitudinal research was initiated by Torrance himself when he was the Director of the Bureau of Educational Research for the University of Minnesota. Beginning in 1958 and continuing through 1964, all students enrolled in grades 1 to 6 in two Minnesota elementary schools took the TTCT each year and in 1959, all students enrolled in grades 7–12 of the University of Minnesota High School took the TTCT. Groups of these students were tracked thorough four time periods (7-year, 12-year, 22-year, and 40-year) and their creative achievements measured.

A follow-up of 46 high school students at a 7-year interval indicated that three of the TTCT subscales (Fluency, Flexibility, & Originality) correlated significantly ($r = 0.39$ to 0.48, $p = 0.01$ level) with two indices of creative achievements, e.g., quantity and quality (Torrance, 1969, 1972). Two TTCT subscales (Flexibility & Originality) also correlated significantly ($r = 0.46$ and 0.42, $p \leq 0.01$) with the third measure of creative achievement, motivation. The correlation between Fluency and creative motivation was slightly lower but still significant ($r = 0.34$, $p \leq 0.01$). IQ, as measured by the Iowa Test of Basic Skills, Lorge-Thorndike, or the Stanford-Binet Intelligence Scale, correlated ($r = 0.37$, $p \leq 0.01$) with quality of creative achievements and with creative motivation ($r = 0.32$, $p \leq 0.01$). The three TTCT subscales (Fluency, Flexibility, and Originality) were significantly better predictors of these indices of creative achievement ($r = 0.39$ to 0.48, $p \leq 0.01$) than IQ ($r = 0.22$ to 0.37, $p \leq 0.01$), high school achievement ($r = 0.09$ to 0.20, $p \leq 0.01$), or peer nominations ($r = 0.13$, $p \leq 0.01$).

A follow-up of 236 high school students at the 12-year interval indicated that all of the creativity predictors (Fluency, Flexibility, inventive level, Elaboration, Originality, & IQ [only for quality]) were found to be significant ($r = 0.29$ to 0.45, $p \leq 0.01$). However, the correlation with IQ for quantity of creative achievements ($r = 0.06$, $p > 0.05$) or creativeness of aspiration ($r = 0.18$, $p \leq 0.05$) for females was not significant (Torrance, 1972).

A follow-up of 211 elementary school students at the 22-year interval (Torrance, 1980b, 1981a, b) found a significant correlations ($r = 0.38$ to 0.57, $p \leq 0.01$) between creativity index and the five indices of creative achievement (Torrance, 1981a). The indices of creative achievement were the number of high school creative achievements, number of post high school creative achievements, number of creative style of life achievements, quality of highest creative achievements, and creativeness of future career image. In this 22-year follow-up, Torrance also found that there are factors other than creativity ability manifested in childhood that also correlate to creative achievements. In particular, Torrance found that a future career image developed in childhood,

and mentors, such as a "special" teacher, have significant correlations ($r = 0.44$ to 0.20 and $r = 0.23$ to 0.33).

A follow-up of 99 elementary school students at the 40-year interval (Torrance, 2002) indicated correlations with TTCT and IQ with creative achievements. The predictors included IQ, Fluency, Flexibility, Originality, Elaboration, Creative Strengths, whether respondents had a mentor in 1980, and whether respondents had a mentor in 1998. The criteria used were number of publicly recognized creative achievements and quality of public achievements. IQ was a significant predictor of quantity ($r = 0.44$, $p \leq 0.01$) and quality ($r = 0.46$, $p \leq 0.01$) of creative achievements for females, but not for males. Originality was a significant predictor of quality of creative achievements for both males ($r = 0.32$, $p \leq 0.05$) and females ($r = 0.40$, $p \leq 0.01$). Creative Strengths was a significant predictor of quality for males ($r = 0.45$, $p \leq 0.01$) and both quality ($r = 0.41$, $p \leq 0.01$) and quantity ($r = 0.29$, $p \leq 0.05$) for females. Having had a mentor in 1980 was a significant predictor of quantity ($r = 0.41$, $p \leq 0.01$) and quality ($r = 0.50$, $p \leq 0.01$) of creative achievements for females, but not for males. Having had a mentor in 1998 was a significant predictor for both males ($r = 0.36$, $p \leq 0.05$) and females ($r = 0.40$, $p \leq 0.01$) for quality of creative achievements, but not for quantity.

Torrance's 40-year follow-up also revealed a high correlation between quantity and quality of creative achievements for both males ($r = 0.90$, $p \leq 0.01$) and females ($r = 0.81$, $p \leq 0.01$). This showed a link between quantity of ideas and the production of quality of ideas (Hébert *et al.*, 2002).

Torrance's longitudinal studies have shown that TTCT results from both high school and elementary school correlate to adult creative achievement. Other studies involving Torrance's data, such as Torrance and Wu's (1981) study, and Yamada and Tam's (1996) reanalysis and Plucker's (1999) reanalysis, have concluded that TTCT Creative Index was the best predictor for adult Creative Achievement. Plucker found that the standardized path coefficient from the TTCT to adult Creative Achievement was 0.60, while the standardized path coefficient from IQ scores (the Stanford-Binet Intelligence Scale, Wechsler Intelligence Scale for Children, or California Test of Mental Maturity) was only 0.19.

Construct Validity and Dimensionality

Guilford (1959, 1962) conceptualized divergent thinking as multi-dimensional, and many researchers have hypothesized that creativity consists of several independent psychological factors. Torrance (1966, 1974) encouraged the use of individual subscale scores and warned that using a single total score maybe misleading, and he suggested each of the different subscale or factor is distinct and important. Kirton (1976, 1978, 1989) hypothesized the Adaptor-Innovator Theory of creativity. According to Kirton (1978), innovators prefer to create change by threatening the paradigm, while adaptors prefer to create change by working within the existing paradigm. Thus, two types of creativity, and maybe more, are apparent.

However, studies on the TTCT have shown conflicting results regarding its dimensionality (Dixon, 1979; Hocevar, 1979a, b; Hocevar and Michael, 1979; Chase, 1985; Treffinger, 1985; Heausler and Thompson, 1988; Runco and Mraz, 1992; Clapham, 1998) Many researchers (Dixon, 1979; Hocevar, 1979a, b; Hocevar and Michael, 1979; Chase, 1985; Treffinger, 1985; Heausler and Thompson, 1988; Runco and Mraz, 1992; Abernathy Tannehill 1998; Clapham, 1998) found high correlations between fluency and originality ($r = 0.79$ to 0.86) and warned that the TTCT measures only one factor, or that the subscales are not independent because of the high correlations among the subscales. Hassan (1986) also concluded that there was no justification for considering creativity as composed of the distinct traits recommended by Torrance (1966, 1974). However, Torrance and Safter (1999) reasoned that the person who produces a large number of alternatives is more likely to produce original ones. Simonton (1990) also found that a person's originality is a function of the number of ideas formulated. In addition, the high correlations between all the variables might partly result from the fact that the five different subscales are based on the same stimuli. The longitudinal studies of the TTCT discussed above have also shown a link between the quantity of ideas and the quality of ideas that are produced (Hébert *et al.*, 2002).

There are not many studies that have analyzed factor structures of the TTCT. One study modeled two components through a principal

component analysis and concluded that the scores of the TTCT primarily reflect one general factor (Heausler and Thompson, 1988). Clapham (1998) also concluded that there is only one general factor for the TTCT. However, the results of Kim's (2006b) confirmatory analyses indicated that a two-factor model fit significantly better than a single factor model. Kim analyzed the results of 500 6th graders to examine the possibility of a two- factor model based on Kirton's (1976, 1978, 1989) Adaptor-Innovator Theory. Factor Innovative is loaded by Fluency, Originality, and Resistance to Premature Closure, while Factor Adaptive is loaded by Elaboration, Abstractness of Titles, and Creative Strengths. The relationships between the factors and the five subscales were on the basis of Kirton's descriptions of Innovative and Adaptive, scoring experiences of the TTCT of the author's of this chapter, and Torrance and other researchers' findings (e.g, Isaksen and Puccio, 1988; Puccio, Treffinger and Talbot, 1995; Torrance and Horng, 1980). The logic for the double loading by Resistance to Premature Closure originated from Torrance's (1990b, 1998) theoretical assumption of creative individuals. Based on the results of the study, the proposed two-factor structure of the TTCT fit well. Another study (Kim, Cramond and Bandalos, 2006) based on 3,000 kindergarteners, third, and sixth graders also support a two-factor structure. With the findings from these studies, the TTCT can give more information not only about individuals' strengths and weaknesses from the scores of each of the five subscales, but also about the type of creativity, Innovative or Adaptive.

Uses of the TTCT-Verbal and Figural

Differing Genders, Races, Status, Languages and Cultures

One, often overlooked, strength of the TTCT is that they are fair in terms of gender, race, community status, and for persons with a different language background, socioeconomic status, and culture (Cramond, 1993; Torrance, 1977). Albeit, it has been proposed that different cultures should develop different originality lists and norms (Kim, 2006a). It should be less biased for speakers of English as a second language (Torrance, 1977) because the test is not based upon a student's ability to use the English language. In addition, the results of

multiple group analyses indicated that the latent structure of the TTCT showed more differences across grade level groups than across gender groups. (Kim, Cramond and Bandolos, 2006). The findings were consistent with Torrance's (1977) conclusion (Cramond, 1993) that the TTCT-Figural was fair in terms of gender. The study indicated that different grade level groups not only have different mean scores, but also somewhat different factor structures (Kim, Cramond and Bondalos, 2006). This indicates that when TTCT scores are compared among different grade levels, more caution may be needed for interpretation. As a result of its apparent neutrality in gender, race, community status, language, socio-economic status, and culture, the TTCT are in widespread use as a creativity measure outside of the U.S. As a result, the TTCT have been translated into over 35 languages (Millar, 2002).

Use for Identification of the Gifted

The most extensive use of the TTCT is for identification of children for gifted programs. The TTCT is valuable in that it allows another perspective on the student's ability that is vastly different from other aptitude and achievement tests. Identification based on IQ scores is the most use way to identify gifted students in educational systems, but such a limited selection criteria risks overlooking creatively gifted children (Torrance, 1960, 1962). A common alternate means of identifying the gifted students (other than IQ) is teacher recommendations. However, teachers focus more on the student's classroom performance than other kinds of potential and often miss disruptive but creative behavior (Anderson, 1961; Davis and Rimm, 1994; Oliphant, 1986; Rimm and Davis, 1976; Ritchie, 1980; Robinson, 1980). As a result creatively gifted students may be overlooked by mere IQ assessments, or excluded from consideration by teachers who view them as "troublemakers" rather than successful young scholars.

While its use is growing, the TTCT is not usually used by itself to make high stakes decisions on admission to gifted programs. As an example, the Georgia Department of Education (1998; Krisel and Cowan, 1997), sets the eligibility for gifted programs as: a student must either (A) score at the 99th percentile (for kindergarteners-2nd

graders) or the 96th percentile (for 3rd–12th graders) on the composite or full scale score of a standardized intelligence test and meet the achievement criteria, or (B) qualify through a multiple-criteria assessment process by meeting the criteria in three of the following four areas: intelligence, achievement, creativity, and motivation. Thus Georgia uses creativity as one—but not the only—criterion to identify a gifted student. Additionally, since Georgia adopted this multiple criteria selection process in part based upon the TTCT, more minority, disadvantaged, and other at-risk students were placed in gifted programs than when Georgia merely used IQ scores (Williams, 2000).

Thinking Creatively in Action and Movement (TCAM)

While in development and in use earlier, Torrance published the TCAM in 1981 for widespread use. The TCAM is designed to measure Fluency, Originality, and Imagination in preschool and primary aged children ranging from ages three to eight (Torrance, 2000a). Torrance (1980a) stated that the TCAM was developed based upon four guidelines: i) Kinesthetic, rather than verbal, modality is the most appropriate for eliciting the creativity of preschool children; ii) preschool children require procedures for warm-up and motivation; iii) the tasks for assessing creativity should be things preschool children are familiar with; and iv) the test should be easy to administer and score.

The test consists of four activities: Activity 1, How Many Ways?, assesses Fluency and Originality in moving alternate ways across the floor; Activity 2, Can You Move Like?, assesses Imagination in moving like animals or a tree; Activity 3, What Other Ways?, assess Fluency and Originality in placing a paper cup in a waste basket; and Activity 4, What Might It Be?, which assesses Fluency and Originality in generating alternate uses for a paper cup. The equipment the test requires is paper cups, a wastebasket, pencils, and red and yellow tapes.

Administration of the TCAM

According to Torrance (1979a, 1980a, 1981c), the TCAM is administered individually, and it takes between ten to 30 minutes. No time limit should be imposed, but the examiner should keep a record of the

time used. The examiner should try to record all responses made by the child as completely and accurately as possible. Only one child should be in the activity room and enough apace for movement is necessary. It is suggested to avoid time periods that may lead to fatigue. The examiner records responses in movement, in words, or in a combination of both.

Before an examiner administers the TCAM, warm-up activities and some familiarity are necessary so that children can relax and take the activities as fun. The testing environment should help promote creative involvement by including warm-up and motivational procedures. Examiners are encouraged to get into action with the child when instructions are given and during the introductory phases of each activity so that the proper atmosphere can be created for children's maximum performance (Torrance, 1980a).

Scoring of the TCAM

A scoring guide is provided in the test manual (Torrance, 1981c). The directions for scoring are clear and the procedure is easy to follow. Activity 2 is scored for Imagination and the other three activities are scored for Fluency and Originality. Fluency scores are the number of relevant responses; Originality scores ranging zero to three points for each response are based on comparing responses to the statistical frequencies of responses in the originality lists in the scoring guide; and Imagination scores are based on a 5-point Likert-type scale ranging from "no movement" to "excellent; like the thing."

Norms of the TCAM

According to Torrance (1979a), preliminary norms for the TCAM are based on 1,227 children ranging in age from 3 to 8 years from nine states and Guam with equally represented Whites and Blacks. According to Torrance (1980a), norms for the TCAM are based on 1,896 children ranging in age from 3 to 8 years from 11 states and Guam with also equally represented Whites and Blacks. Tables for converting raw scores to standard scores (M = 100, SD = 20) are reported for 3- to 6-year olds only.

Reliability of the TCAM

Inter-rater reliability coefficients were reported as 0.90 to 0.99 by Torrance (1979a, 1980a) and other researchers (e.g., Bolen, 1976). Test-retest reliability coefficients were 0.84 for a sample of 20 three to five year olds for a two-week interval and 0.71 to 0.89 for a sample of 30, seven to eight year-old learning disabled boys for 1–14 days interval in which the alpha coefficient for total test internal consistency was 0.79. (Holguin and Sherrill, 1989).

Validity of the TCAM

Significant positive correlations between TCAM and other creativity characteristics are reported: Between TCAM and the production of various types of humor (Erickson, 1977); between Fluency scores for the TCAM and the Multidimensional Stimulus Fluency Measure (Tegano, Moran and Godwin, 1986); between TCAM and a modified Piaget measures of divergent thinking and a mathematics test that allows various approaches for solving problems (Reisman, Floyd and Torrance, 1981); and between TCAM and children's private speech (Daugherty, White and Manning, 1994).

Significantly high correlation coefficients were reported between TCAM and mothers who rated the family as chaotic when compared to mothers who rated their family as rigid (Hudson and Stinnett, 1990). This is consistent with the results of other studies, such as Albert's (1994, 1996) findings that families that have more creativity are usually more complex, varied, and expressive than other families; Halpin, Payne, and Ellett's (1973) findings that positive influences on creativity that can be found within a family include parents who are less strict, critical, and punitive, but allow greater freedom; Dacey's (1989) findings that flexibility in guiding children's behavior instead of a reliance on rigid rules strengthen their children's creativity; and other researchers' findings that authoritarian child-rearing attitudes (Datta and Parloff, 1967; Dewing, 1970; Foster, 1968; Gardner and Moran, 1990), parental vigilance (Getzels and Jackson, 1961), and hostile, rigid, and controlling home environments (Halpin, 1973; Papalia and Olds, 1986) have negative relationships with children's creativity.

Significant increases in the TCAM scores were reported using the Bringing Out Head Start Talents project as an intervention (Karnes and Johnson, 1987); and a creative movement program for Taiwanese preschool children (Wang, 2003).

Scores on the TCAM are relatively unrelated to measure of intelligence such as Columbia Mental Maturity Test (Erickson, 1977), McCarthy Scales of Children's Abilities, the Wechsler Intelligence Scale for Children-Revised, or the Stanford-Binet; (Paget, 1979), which indicates that something other than intelligence is being assessed by the TCAM (Torrance, 1979a). In addition, Torrance (1980a) also stated that the low relationship between the TCAM and measures of intelligence is observed by most of the users of the TCAM.

Torrance (1981c) found no evidence for bias in sex, socioeconomic status, or race in TCAM scores. Scores on the TCAM are unrelated to sex (Bolen, 1976; Westra, 1978); race and previous nursery or preschool attendance (Bolen, 1976); socioeconomic status (Haley, 1978); and cooperation (Ross, 1977; Torrance, 1980a). There was no bias toward city children when comparisons were made between city and a remote mountain rural development centers (Smith and Downey, 1975). However, Westra (1978) found that children in a preschool with a farm setting scored significantly higher than children in a preschool with a city setting. Upon further inquiry this was thought to be because of the many creative learning activities in the particular preschool with the farm setting that was studied.

Uses of the TCAM

Special Children

The TCAM can be used with special children such as the emotionally disturbed and the deaf (Lubin, 1979; Lubin and Sherrill, 1979; Sherrill, 1985). No statistically significant differences were found between TCAM scores for handicapped and non-handicapped children for Fluency and Originality, but handicapped children scored below the age norms for Imagination (Cropley, 1987). Significant increases in the TCAM scores for handicapped children were reported using a dance

program for pre-school handicapped children (Jay, 1991); a creative drama as a therapeutic intervention for children with behavior disorders (Warger and Kleman, 1986); and a 20- day program of creative movement exploration for deaf children ((Lubin, 1979; Lubin and Sherrill, 1979).

A Teaching Tool

According to Cooper's (1991) evaluation, TCAM's usefulness as a teaching tool is probably its most distinguishing trait. Evidence is presented in the manual, which attests to teachers' heightened awareness about the benefits of using creative movement and creative brainstorming techniques in preschool and lower elementary grades after using the tests. This awareness may spawn curriculums that focus on developing creative expression and problem solving.

Summary on the TCAM

The TCAM has good reliability, proven validity, it is easy to use, and is neutral as to a wide variety of factors such as gender, race, community status, language and culture even though it is designed for very young children. The TCAM represents an important contribution to the field of measurement of creativity because it provides the means for examining abilities in very young children and in children who have been excluded from other testing instruments (Renzulli and Rust, 1985) such as the handicapped.

One limitation of the TCAM is that since 1981 the TCAM has not been renormed, nor have the Originality lists been updated. Thus, the credibility of the norms and originality scores can be questioned. It is probable that children's performance and the frequency of different responses have changed between 1981 and the present (Kim, 2006a).

Conclusion on the TTCT and TCAM

Among Torrance's creativity tests, the TTCT and the TCAM, are in widespread and worldwide use because they have good reliability,

proven validity, they are easy to use, and are neutral as to a wide variety of factors such as gender, race, community status, language and culture. Torrance's creativity tests are useful to assess creativity in a wide variety of situations and for a wide variety of age groups from as young as age 3 to adults. The TTCT and the TCAM are not only good measures for identifying and educating the gifted, but also for discovering and encouraging creativity in everyday life in the general population. When used appropriately, the TTCT and the TCAM are important parts of Torrance's legacy and dream: to nurture and enhance creativity.

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Identification of Talents

Christoph Perleth and Annett Wilde

Introduction

The objective of this chapter is to give an overview about methods and ways to identify gifted children and youth. There are various reasons why we want to know if a child has special talents and gifts. Generally, we want to promote every student adequately according to his/her abilities and interests. With respect to gifted students, the same principle holds through: we want to foster him/her according to his/her extraordinary abilities, performance, and/or special interests. However, it is necessary to identify specific talents or the giftedness profile of the individual to choose the best strategy for promotion. Another important and most frequent reason is, the need to identify gifted students for special promotion programs. Ways to promote gifted can be enrichment courses for gifted children, competitions, or acceleration programs, such as, special classes or schools (Campbell, Wagner and Walberg, 2000; Heller, 2002a,b; 2002a,b; Neber and Heller, 1996, 1997, 2002; Renzulli and Reis, 2000).

In educational and counselling psychology, it is also necessary to clarify adverse individual and social development conditions to offer special actions, for instance, to improve attribution styles or motivation (Heller and Ziegler, 1996, 1998, 2001; Ziegler and Heller, 2000a,b,c). This means that the assessment of motivational and personal characteristics as well as the aspects of the learning environment are important parts of the diagnosis of giftedness. Further on, we want to analyse causes for underachievement in gifted children and youth (Butler-Por, 1993; Langfeldt and Tent, 1999; Peters, Grager-Loidl and Supplee, 2000; Ziegler, Dresel and Schober, 2000; Ziegler and Stoeger, 2003).

It is also necessary to analyse social conflicts or behavioural and educational problems, which could possibly be caused by giftedness (Holling and Kanning, 1999; Kaufmann and Castellanos, 2000; Elbing, 2000; Freeman, 2000; Webb, Meckstroth and Tolan, 2002). Finally, special attention should be directed at risk groups, that is at children and youth whose giftedness is easily overlooked. Such groups are for instance gifted girls, handicapped gifted, children from ethnic minorities or children from underprivileged social groups (Yewchuck and Lupart, 1993; Borland and Wright, 2000; Kerr, 2000; Stapf, 2003).

However, before dealing with the identification of giftedness, we have to clarify what the concept means for us. Elsewhere in this book, you can find the giftedness models by Urban (Chapter 8) or Amabile (Chapter 2). A model that is supposed to provide a basis for diagnostic issues must be quite differentiated and include a large amount of relevant variables. Therefore, we will introduce another model, the Munich Dynamic Model of Giftedness (see also Heller, Chapter 3). It is characterized by the integration of various aspects of giftedness and a developmental focus.

The Munich Dynamic Model of Giftedness as an Integrative Framework of Giftedness Models

The model for giftedness we present here (Figure 8.1) was developed by Perleth (1997) and is based on the well-established model from the Munich High Ability Study (Heller and Perleth, 2004; Heller, Perleth and Lim, 2005; Perleth and Heller, 1994). Though the original Munich Model fulfils the demand for including different areas of achievement behaviour, it does not sufficiently account for "deliberate practice" (in the sense of Ericsson). Our model is elaborated in Perleth (1997, 2000, 2001a; Heller and Perleth, 2004; Heller, Perleth and Lim, 2005); the following outline is based on Perleth (2000; 2004).

In the left box, we see the basics of giftedness development (e.g., working memory, perception, attention characteristics), on which all promotion of giftedness must be based. Within the framework and limitations of these innate characteristics giftedness can develop. It would be an illusion to think that every child can develop a talent in any area
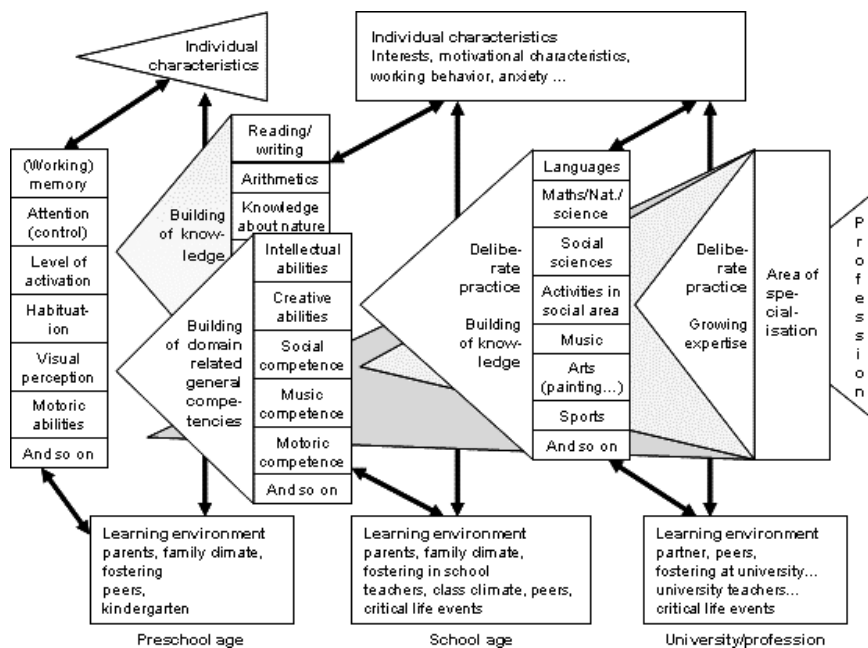
Fig. 8.1.   The munich dynamic model of giftedness (see also Heller and Perleth, 2004; Heller, Perleth and Lim, 2005; Perleth, 1997).

by simply providing the appropriate educational means. However, parents, educators, and teachers should support children to develop their talents in different areas according to their potentials. Because gifted children posses a number of these basic innate characteristics in a special way, these attributes are placed at the left side of the model where they mark the beginning of the individual development of giftedness.

Pre-School Age

Already during infancy and pre-school age important courses are set for the development of giftedness (see the triangles in Figure 8.1). In this stage of life the influence of parents is quite important for the development of giftedness in different areas. Talents develop based on innate characteristics and the activities of the child. Depending on the activities, the child engages in, whereby encouragement from parents plays an important role, intellectual competences develop as well as

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creative, social, music, , or motoric talents (light triangle bottom left in Figure 8.1). Even if these abilities are related to specific areas (music, art, intellectual), they can be fruitful in various other domains. For instance, artistic abilities can be an advantage in mathematics or social studies whereas intellectual giftedness can be beneficial in music or art.

In pre-school age the basis for personality development is provided (light triangle top left in Figure .1), which is pivotal for giftedness development, including self-confidence, courage to meet challenges, tenacity to achieve one's aims, or take pleasure in achievement. Children with such traits have advantages for the further development of their gifts and performances because they engage in problem-solving, more courageous, and acquire knowledge and skills more quickly. Various activities with the children lead to skills and knowledge acquisition about everyday life's subjects (animals, nature) to the point of basic knowledge in counting (and therefore basic arithmetic) as well as reading and writing (dark triangle on the left). Reading means not only to decipher letters, but the general understanding of symbols. Writing on the other hand means also that children can use symbols purposeful. Needles to say gifted children sometimes excel their peers by far in these abilities and skills.

The good match between dispositions and environment is characteristic for the pre-school age: the children grow up in families where similar dispositions and talents exist. At the same time, parents offer a beneficial family environment for the development of talents. So parents in a musical family might provide instruments and encourage musical activities. Sportive parents might not only exercise at home and play active games with their children, but also take them to workouts and attend play or sport groups for infants.

Primary School-age and Adolescence

In pre-school age and with the beginning of primary school the talents of a child in different areas unfold and the basis is provided for the future development of gifts and talents. Research shows that giftedness develops until old age, but the position of an individual in its age-group changes barely from third or fourth grade on. Someone who belongs

to the most gifted in an age-group will normally hold this position for several years.

From primary school age on, parents' influence on their children decreases. Instead, school environment and especially teachers become more important for the development of the child. It is beneficial if teachers notice the special abilities of a child, so that they can respond to their needs and help to nurture their talents. However, it is now less important to develop talents. What matters is the purposeful development of knowledge and skills in different areas (sports, languages, math, literature, music, and so on) as depicted in the light triangle in the middle of Figure 8.1. This knowledge is the basis for future achievement development in different areas. Therefore, the acquisition of this fundamental knowledge is the focal point for talent and achievement development in school age. On one hand, high ability is necessary to acquire knowledge: gifted children learn more quickly and effectively in their special domain. On the other hand, a broad and well-organized knowledge provides the basis for the development of talents. Therefore, achievement in adulthood is based both on talents and knowledge.

In adolescence, peers gain influence on the development of gifts and achievement: adolescents select friends who mach their abilities and who help to advance their talents. This is especially important for musical gifted youth: In the follow-up-study of the Munich High Ability Study, young excellent musicians reported that peers had more influence on their musical development by the way of encouragement and practice together than parents and teachers (Perleth, 1997, 2001a).

Adulthood

Crucial for development in adulthood is job specialization (light triangle on the right in Figure 8.1). This is managed all the better and faster the better the individual gifts and abilities are in line with the requirements of the chosen occupation, and the more the individual can rely on knowledge and abilities acquired in school. With some individuals, this specialization starts already in school or even pre-school-age, this is depicted by the medium and dark grey triangles that cover the

individual development from pre-school age until job specialization in adulthood. This applies for instance to chess players, musicians or athletes who have to start intense practising in young age in order to show outstanding performance as teenagers and young adults.

To summarize, we can say that our model is an attempt to integrate fundamental approaches and perspectives from high ability and expertise research and to present them together in a consistent framework.

General Methodological Considerations concerning the Identification of Gifted

The greatest concern when identifying gifted children and youth is to get as much "hits" as possible. "Hit" in this context means that somebody identified as gifted (blue subset in Figure 8.2) is gifted indeed. Reversed we want as little as possible to overlook gifted children (red subset in Figure 8.2) and to identify children falsely as gifted (Figure 8.2, Hany, 1987; Heller, 2000; Perleth and Sierwald, 2000).

When identifying giftedness, we get in total four diagnostic groups (Table 8.1). Group A and D represent individuals who are correctly identified—either as gifted or not gifted. Diagnostic errors are represented in Group B and C: students falsely identified as gifted and students whose giftedness is overlooked. It would be desirable if all individuals would be assigned to Group A or D and diagnostic errors could be minimized. Unfortunately this is difficult to realize, because
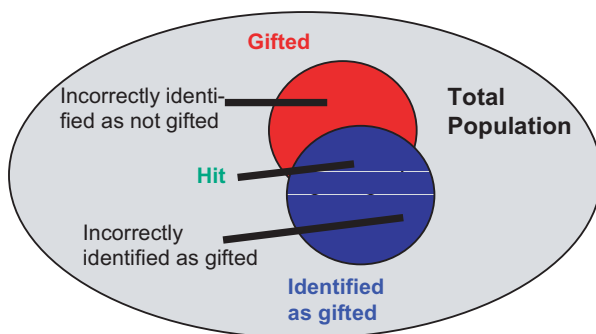
Fig. 8.2.   Problems with the identification of gifted children and youth.

Table 8.1. Diagnosis of giftedness.

| | Identified as | | Total |
	Gifted	Not gifted	
Gifted	A	B	A + B
Not gifted	C	D	C + D
Total	A + C	B + D	P = A + B + C + D

diagnostic methods are never absolutely reliable and valid (Table 8.1). Depending on the aims of the diagnostic process, we can only try to minimize errors in Group C or B, but have to accept that this leads to an increase of errors in Group A or D.

To exemplify this, assume that a school wants to select a team of gifted students in mathematics to promote these students over a period of time. Finally, they are going to take part in a math competition. In this case, it would be useful to minimize Group B to identify and promote every gifted student (unless the promotion would be very expensive). However, assume on the other hand a research project where we want to examine differences between highly gifted students and students with average abilities. Under these circumstances, the group of gifted students should ideally contain only students who are gifted indeed. Therefore, Group C, should be minimized, but inevitably there will be more cases in Group B. With the Table 8.1, we can assess the *effectivity* and *efficiency* of a measure to identify gifted children and youth. The effectivity can be described as "A/ (A + B) × 100" (see Table 8.1). This formula gives the percentage of gifted students who are identified correctly with the respective measure. On the contrary, the efficiency of a measure, calculated as A/(A + C) × 100 gives the percentage of gifted students in the as gifted identified group.

Prerequisites for Psychological Measurement and Identification Methods

When applying a psychological test, we intend to get some information on the intellectual, emotional or motivational characteristics of the testees. These characteristics are conceptualized as constants in each person. Unfortunately, we cannot directly measure the true values of these

characteristics. Instead, we have to estimate from test results the characteristics we are interested in. These tests are regarded as realization of random variables; therefore they can differ more or less from the true values. In other words, the measured scores differ by a certain (normally distributed) error from the true values (Perleth and Sierwald, 2000 for a more detailed overview on the mathematical and statistical considerations that underlie psychological tests). To minimize differences between test results and true values certain quality criteria for (psychological) research have to be met. These prerequisites for psychological measurement, including objectivity, reliability, validity, norms, and test fairness, are introduced in the following section.

Objectivity

Objectivity is supposed to guarantee that the result of a test or diagnostic measurement does not at all or as little as possible depend on the test situation and the person conducting and/ or analyzing the test. Test authors usually try to ensure objectivity by prescribing in detail how to conduct, analyze, and interpret the test. This aims at the highest possible comparability of test results between different students.

During the conduction of a test instructions are often prescribed literally by the test author to obtain high objectivity. If this would not be the case, different instructions could lead to different motivation and thus to different (i.e., wrong or misleading) results. In a drawing test on creativity, for example, an instruction can be focused rather on performance ("We want to know who can draw best.") or rather on pleasure ("You can now draw whatever you like."). Good tests also give detailed instructions about the best point in time for the conduction of the test (usually in the morning when students can reach their performance peak) and the arrangement of the test situation.

Another point concerns the analysis of the test results. Multiple choice tests usually ensure high objectivity. Tests with open answers need categorization systems with detailed instructions how to classify answers as right or wrong (for instance free answers to the question "What have cat and dog in common?"). Answers like "both are pets" or "mammals" are surely correct, whereas answers like "Both lie on the

sofa" or "Are called Garfield and Odie" are definitely wrong. But what about answers like "Have four legs and a fur" or "Both eat meat"?

The aim of an achievement test is to get to know if the result of a student is rather above or below average that is if s/he is gifted or has intellectual deficiencies. For the objective interpretation of test results, the handbooks of most tests contain norm (standard) tables with reference values. By means of these tables, raw values can be transformed in standardized values which make the direct comparison possible between the individual result and a reference group or population (for instance the population of all 12-year-old pupils). This ensures that test values are interpreted in the same way for all members of a reference group.

Reliability

The next quality criteria, reliability refers to the accuracy of a diagnostic measure. As stated above, each test result is infected by a certain error. Therefore, the measured value differs more or less from the true value of an individual. If the test user has information about the reliability of a test he can, for a given certain probability, estimate an interval around the measured value where the true value of the testee might be located. With other words, the reliability is necessary to compute the confidence interval, which contains the true value of a person considering a specific probability value.

Validity

The validity of a test indicates how accurately a test measures or predicts the personality characteristics or behaviors that it is supposed to measure or predict. Only tests with high validity can be meaningful interpreted. Therefore, the improvement of validity is one of the most important (and most difficult) aims when constructing a diagnostic measure. Apart from the fact that the test items must fit to the conception of the measured variable (a series of simple calculations would surely not measure intelligence) the following validity aspects can be differentiated.

Depending on the time between the collection of test and criterion scores *concurrent* and *predictive validity* can be distinguished. If test

scores and criterion values are measured simultaneously or consecutively, concurrent validity can be obtained. With this validity, coefficient conclusions can be drawn about simultaneous criteria. This is for instance important to analyze current achievement problems. If the criterion score is measured after the test score we refer to predictive validity. With this validity, we can prognose from the test score (about academic achievement or job performance). Although both, predictive and concurrent validity, are computed in the same way, their different diagnostic meaning is to bear in mind.

Norms

The interpretation of test results is not possible without a frame of reference. There are three reference norms in psychological diagnostics:

- *Social reference norm* means that the test score is related to the scores of a reference group, e.g., all 8-year-old children. Measured here is the distance between test score and the mean of the reference group.
- *Individual reference norm* means that the result is related to previous performance of the student, measured is the individual advancement or deterioration of performance.
- *Task-oriented reference norm* finally means that the result is related to a criterion defined before (e.g., learning goal), measured here is the distance between performance and learning goal.

Most intelligence and performance tests use social reference norms, even if for the assessment of school performance the task-oriented norm would be more appropriate.

Standardization of a test means the construction of a numerical reference system (usually tables), which allows to compare individual test scores (e.g., right answers) with the test scores of a reference population. This reference values are referred to as norms. Two points are crucial for the quality of standardization. First, the sample for the standardization of the test has to be chosen carefully. The sample must be representative of the test population. Second, during the standardization test objectivity must be ensured. Therefore, well-trained examiners are required.

To construct norm tables test authors choose one of the common norm scales (Table 8.2). The mean of the reference group is then assigned to the mean of the scale; the variance of the reference group is assigned to the variance of the scale, etc. Crucial for the interpretation of standard scores is not only the reference group but also how old the norms are. Norms conducted more then 10 years ago have to be considered as obsolete and must be verified by empirical studies.

Auxiliary Quality Criteria

Fairness of a diagnostic measure refers to the degree that test persons from different social, cultural, ethnic, or psychological groups are treated fairly during the diagnostic process, and that decisions based on this diagnostic process do not favor or discriminate a group. Since 1970, it is stipulated to include fairness as an additional quality criterion in psychological testing, especially for intelligence and achievement tests (Möbus, 1983). Some researchers consider test fairness to be a main quality criterion besides objectivity, reliability, and validity (e.g., Stumpf, 1996).

Just like test fairness other auxiliary quality criteria in psychological diagnostics address as well as the applicability of diagnostic measures in certain diagnostic contexts. First, a diagnostic measure or test should be *comparable* to other tests, which measure the same construct. A good diagnostic measure should also be *economical*, that is it should be fast and inexpensive to apply (in terms of test material, time, number of examiners needed, individual- or group-assessment) and analyze. It should also be *useful*: it should serve the target purpose and help to make decisions.

Methods for Identification of Gifted

Psychometric Tests

Psychometric measures (tests and questionnaires) for the assessment of high ability or rather intelligence are widely used in research and practice to identify and nurture gifted children and youth. A test is a

Table 8.2. Important standard scales the interpretation of standard scores.

Scale	M_X	s_X	<<Ø	<Ø	Ø	>Ø	>>Ø	Example
IQ-Scale	100	15	x < 70	70 <= x < 85	85 <= x <= 115	115 < x <= 130	130 < x	WISC, CFT, SB V
WP-Scale	10	3	x < 4	4 <= x < 7	7 <= x <= 13	13 < x <= 16	16 < x	WISC
T-Scale	50	10	x < 30	30 <= x < 40	40 <= x <= 60	60 < x <= 70	70 < x	CAT
PR	50%	—	PR < 2	2 > PR < 16	16 <= PR <= 84	84 < PR <= 98	98 < PR	

Legend:<<Ø, <Ø, Ø, >Ø, >>Ø: far under average, under average, average, over average, far over average. Bold: important scales.

Note: Of course there are more scales not mentioned in the table, e.g., SN-Skala ($M_x = 5$, $s_x = 2$) or the old scale of the Stanford-Binet IV ($M_x = 100$, $s_x = 16$).

psychological instrument to measure a clearly defined personality characteristic (e.g., intelligence, retentiveness, concentration, or anxiety) and is designed by scientists for practical application. Tests usually give numerical results, so that test results or parameter values of different persons can be compared directly (for an overview see Perleth, Schatz and Mönks, 2001). It is particularly interesting to examine to what extent the test score of an individual differs from the mean score of a reference group. To get meaningful values, it is necessary that all examinees are evaluated on equal terms. To ensure objectivity, test items and test situation have to be standardized. Most test authors assume that psychological characteristics underlie a Gaussian or normal distribution. Most statistical measures to analyze empirical data (especially in the context of test construction) require a normal distribution as well. Taken intelligence gifted children and children with intellectual deviancies represent the extreme points in this distribution. So the gifted deviate just as far as the mentally retarded from normality.

Tests and questionnaires are still the best methods to predict performance. Intelligence tests for instance are the strongest predictors for school achievement. It must be pointed out that tests have more prognostic strength in the beginning of the academic career (during the education increases the importance of previous knowledge) and the intelligence structure becomes more differentiated over the years. Therefore, tests of general intelligence are useful at the beginning of primary school, whereas during secondary school more differentiated tests should be applied which make profile analyzes possible (Wild, 1991; Rost, 1993; Heller, 2000; Perleth and Sierwald, 2000; Hany, 2001; Perleth, 2001b).

Psychometric tests should be applied retentively in very young children (pre-school age) because the prognostic validity is quite low and measured traits are rather unstable over time (Lubinski *et al.*, 2006; Lubinski *et al.*, 2001). In particular there is a lack of longitudinal studies which could give useful information about the development of giftedness from an early age on. First major longitudinal studies like the Study of Mathematically Precocious Youth show, however, that there is a positive relationship between exceptional test scores (here the SAT

was applied) before age 13 and occupational and life accomplishments in adulthood (Wai, Lubinski and Benbow, 2005). Similar results have been reported by Perleth and Sierwald (2001) and particularly Perleth (1997; 2001a; Heller and Perleth, 2004) for the Munich Giftedness Study. In the following paragraph, we give examples of the most important tests used for identifying gifted children and youth.

Stanford-Binet Intelligence Scale

The Stanford-Binet Intelligence Scales: Fifth Edition (SB5) by Roid (2003) is the current version of the Stanford-Binet intelligence test originally developed by Terman on the basis of Binet and Simon's scale (Binet, 1905). The norm sample of the SB5 consists of 4,800 individuals between the ages of 2.0 and 96 years and matches the U.S. census from 2000 (Becker, 2003). The SB5 provides the examiner with an overall score for general intelligence which is composed of five factors: knowledge, fluid reasoning, quantitative reasoning, visual-spatial processing and working memory (Roid, 2003). Each factor contains both verbal and nonverbal content. The test can be used with children from the age of 2 years.

Wechsler Intelligence Scale

The Wechsler Preschool and Primary Scale of Intelligence—III (WPPSI-III) (Wechsler, 2002) and the Wechsler Intelligence Scale for Children, now in its Fourth Edition (WISC-IV) (Wechsler, 2003) are the second most widely used intelligence tests in gifted children. They measure "the aggregate or global capacity of the individual to act purposefully, to think rationally and to deal effectively with his environment" (Wechsler, 1958). In consequence, the most frequently used indicators derived from the tests are the total score and until the third edition the global scores for the verbal and performance scale. Although there have been some studies of the factor structure of the WISC-III (Brown *et al.*, 1991; Wilkinson, 1993; Masten, Morse and Wenglar, 1995) alternative scores or the profile are seldom used for scientific or practical purposes. As in the Stanford-Binet, the Wechsler scales have been shown to be sufficiently reliable and valid for the

assessment of general intelligence in gifted children (Kaplan, 1992; Kaufman, 1992; Bracken and McCallum, 1993; Spangler and Sabatino, 1995; Sparrow and Gurland, 1998). The main change of the current edition of the WISC to the former edition was the omission of the familiar verbal and performance index scores. Instead there are now four composite scores: Verbal Comprehension, Perceptual Reasoning, Working Memory and Processing Speed. As before one total score can be computed. Since the comparison between the verbal and performance index scores were often used the new structure will require time for users to adjust to and will have to prove its usefulness and practicability (Burns and O'Leary, 2004). The test has been normed on normal children (2,200 children) as well as on special populations (550 children, e.g., children with Attention-Deficit/Hyperactivity Disorder, Learning Disabilities or intellectual gifted children). However, the sample sizes of the special groups are quite small, they range from 16 to 89 children per group (Burns and O'Leary, 2004).

Kaufman Assessment Battery for Children

The Kaufman Assessment Battery for Children, Second Edition (K-ABC II) (Kaufman and Kaufman, 2003) can be used with children from 3 to 18 years. It consists of all in all 20 subtests from which a certain subset is chosen for different age groups and which can be aggregated to five scales: Learning, Memory, Simultaneous Processing, Planning, and Knowledge. Before administration, the examiner must select the underlying theoretical model for interpretation, either the Luria-Model or the Cattel-Horn-Carroll-Model (CHC) (Kaufman and Kaufman, 2003). The main difference between the two models is that the Luria-Model focuses on mental processing and excludes acquired knowledge as far as possible, whereas the CHC-Model distinguishes between fluid and crystallized intelligence. Therefore the Luria-Model contains only four scales, the subtest Knowledge (in the sense of crystallized intelligence) is omitted. The test authors suggest the CHC-Model as the model of choice, because they consider knowledge to be an important aspect of cognitive functioning. The K-ABC II was normed with 125–250 children for each age group. From a

theoretical point of view, however, it seems to be a little queer that in the framework of the K-ABC different theoretical concepts as, e.g., Luria's Sequential Processing which stems from a neuropsychological perspective and Memory (a factor analytic perspective) should be identical. In any case they are operationalized identically.

Tests of Nonverbal Reasoning Abilities

A cultural fair instrument to measure cognitive abilities is the Progressive Matrices Test (Raven, Court and Raven, 1983, 1986). It measures nonverbal reasoning abilities (inductive reasoning) without relying on verbal, quantitative, or memory aspects. Because of the omission of verbal items the test is attractive for the assessment of children from minority groups or risk groups (e.g., foreign children, children from underprivileged families and so on). The test is sometimes classified as tests for general intelligence in the sense of Spearman (Heller and Perleth, 2000) since it measures solely nonverbal reasoning abilities. The covered age ranges from 5 to 11 (Colored Progressive Matrices) and 6 to 17 years (Standard Progressive Matrices). For older gifted students and adults the Advanced Progressive Matrices are available.

Peabody Picture Vocabulary Test

The Peabody Picture Vocabulary Test—Third Edition (PPVT-III, Dunn and Dunn, 1997), successor of the PPVT-Revised (PPVT-R, Dunn and Dunn, 1981) or the British Picture Vocabulary Test (Dunn *et al.*, 1997) is sometimes used as a screening measure to select gifted children–despite it is a pure verbal test (e.g., Hayes and Martin, 1986). Norms for different age groups are available from 2 1/2 years on to adulthood. The reliability and validity is judged as sufficient, but Sattler (1988) advices against the use of the PPVT-R as a "screening device for measuring intellectual level of functioning" (p. 350). The use of the test as a (screening) instrument for the identification of gifted children can be criticized from a methodological point of view (e.g., Hayes and Martin, 1986; Tarnowski and Kelly, 1987) as well as because of its exclusively verbal character.

Teacher-Checklists

For economic reasons in both diagnostic practice and scientific research a multi-level proceeding is preferred for the identification of gifted children and youth. On the first level a screening takes place with the help of so called check lists. Concerning the application of check lists in school it matters in the first place how appropriate they are, that is how good teachers can identify gifted children in their classroom on the basis of a check list. The recently finished Bavarian Primary School Study addressed among other questions the quality of identification by teacher check lists (Heller, Reimann and Senfter, 2005).

As expected, primary school teachers were better at assessing crystallized intelligence (Cattell, 1963) than fluid intelligence. Whereas, fluid intelligence is supposed to apply to genetic dispositions, crystallized intelligence depends rather on socialization. Teachers were also better at assessing crystallized intelligence in older students. Contrary to their expectations teachers did not very well at the assessment of creative and social skills; the hit rate was about 20% (creativity) or below (social skills).

We can conclude that teacher check lists provide valid assessments with a certainty of about 50% primarily for verbal and mathematical abilities. Difficulties arise concerning the assessment of gifted underachievers, that is students with notable worse performance than their intelligence would indicate. Teachers often fail to recognize these gifted underachievers (Wild, 1991; Rost and Hanses, 1997; Ziegler and Stoeger, 2003). One possible explanation might be that teachers (like anybody else in such a situation) orient in the first place by clearly visible performance behavior and much less by performance potential, which is only indirectly observable. It is also difficult for teachers to differentiate between specific areas of giftedness, instead teacher judgments are rather global (Wild, 1993). In favor of teacher nomination is to say that the diagnostics is based on extensive observations. However, normally performance rather than potential is assessed and high intelligence is detected poorly. Furthermore teachers underestimate giftedness in students with educational difficulties and overestimate the abilities of motivated students. Based on these problems standardized instruments should be deployed as well (see above).

Nomination by Parents

Research shows that nomination by parents is as difficult as nomination by teachers and assessment errors are even worse. Another point is that information about the development of the child (language, motor or social development) is usually collected retrospectively, but retrospective data are not very reliable.

Nomination by Peers

Peer nomination (diagnostics based on the assessment of classmates) also could not qualify for the identification of gifted. This procedure was suggested in the first place to identify creativity and social skills. With regard to intelligence could be shown that assessment is based on previous grades and that it is strongly consistent for different areas of intelligence. In addition younger children's assessments proved to be highly unreliable.

Conclusions

In the context of a re-analysis of the data of the Munich High Ability Study (Perleth, 1997; Perleth and Sierwald, 2000) ability ratings from different sources (test, questionnaires, and teacher nomination) were compared. Based on these comparisons we can conclude:

- Giftedness is not unidimensional. There is no such thing as "The gifted" but rather different areas of giftedness must be differentiated.
- Depending on the source of information and the diagnostic measure different groups of people will be identified as gifted within a certain talent area.
- It could be supported that teacher assessments are rather global and that teachers are more likely to identify students with high academic achievement as gifted.

Therefore, we can conclude that there is no perfect identification method. Depending on the aim of the identification process different diagnostic measures can be the best.

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Assessing Creativity: A Componential Model

Klaus K. Urban

Introduction

Creativity as an Evolutionary Power

Csikszentmihályi (1990) conceptualizes creativity as "a special case of cultural evolution" (p. 204). I wish to take his conception of creativity one step further. From an evolutionary viewpoint, especially that of human evolution, creativity is the specific human contribution to the development of the planet earth rich in material and organismic resources and possibilities. Creativity is the highest form of human evolution or *ideavolution*; and creativity leads to evolution. Human evolution, at the same time, challenges and needs creativity. I would like to use a metaphor to illustrate my view. Creativity resembles the engine and fuel of the specific part of human evolution, which has strong effects on all kinds of human and non-human environments.

From an evolutionary perspective, creativity is thus a most valuable human resource. But, it becomes increasingly obvious that in an evolutionary sense not all human creative ideas and products are positive. Modern technology, science, medicine, and biology have constructed means for development. Their implications and effects have to be examined thoroughly for the future of every person and the globe. We have learned that some human activities have created environments which less friendly to live in or inhibit creative thinking and doing. Human and humane *evolution*, which is not based upon high ethical standards and humanistic foundations, always has the tendency to lead to "*devolution*". It is imperative to cultivate a high level of responsibility for *evolution* constructive to mankind.

Coping with the Changes of Living Conditions

The speed of life has been increasing continuously. Changes in all aspects of everyday living conditions have become increasingly faster. The speed of life and changes in living conditions are man-made, but it seems that we have encountered growing difficulty to cope with such a shift. What appears like progress may cause disadvantages. The adaptive potential of human intelligence seems to come to its limits, at least, that mainly developed and made available through learning in school and in life. If we do not wish to become increasingly passive and helpless recipients, we then should develop our creative potential which may enable us to be active "constructors" of our lives, now and in the future.

Creative adaptation, according to Rogers (1959), is the possible way to keep up with the kaleidoscopic changes in the world. In Landau's (1990, p. 9) words: "A creative attitude towards life does help to master changing conditions instead of leaving them rule over us. Education for creativity procures those traits and abilities, which are necessary to expose oneself to uncertain situations and inconsistencies and to cope with them consciously." Landau, having extensive experiences of creativity in education and psychotherapy, is deeply convinced that creativity involves the most important and meaningful ways and means to prepare everyone for life. The so-called new or changed childhood allows children to be far less active in "shaping" their environment or to use all their senses to discover their world. Their experiences likely are mediated by other persons. This creates an increasing challenge to schools, though we admit that schools can not compensate or dissolve all "mis"-conditions of today's children's environment!

What is Creativity?

The so-called "nature" of creativity to which we refer, is not natural or an entity in itself. We shall not forget that creativity does not have a nature! Creativity that we conceptualize remains a hypothetical construct which describes or explains (to a certain extent) a special kind of human potential or aptitude. Creativity is not a power in itself; it is a

human-bound potential, dependent on, demonstrated and manifested by a person, his/her thinking, acting, and doing. This special human activity results in a new, innovative product.

My definition of creativity thus includes a process description from problem to product. It is presented as follows (Urban, 1990):

Creativity means

  (i) The creation of a new, unusual, and surprising product as a solution of a perceived problem with insight and sensitivity or of a given problem of which its implications have been sensitively perceived.
 (ii) The creation of this product is on the basis and by means of sensible, insightful, and broad perception of existing, available and open data as well as of information searched for and acquired openly and purposefully.
(iii) Its creation is dependent on analyzing, solution-oriented but highly flexible processing, utilizing unusual associations and new combinations of the information. It is with the help of data from one's broad and comprehensive knowledge bases (experiences) and/or with imagined elements.
(iv) The creation is also engaged in synthesizing, structuring and composing the data, elements, and structures into a new solution-gestalt (whereby the processes in #iii and #iv may partially run simultaneously on different processing and consciousness levels).
 (v) The new solution-gestalt, which is elaborated as a product representation, in a product in whatever shape or form.
(vi) The product finally through communication may be grasped directly via senses or via symbolic representations experienced by others as meaningful and significant.

A Componential Model

The definition of creativity above is cognitive-oriented; but (cognitive) creative functions are bound to a set of personality traits. As such, it is

important and necessary to ask what components of the personal structure may be responsible for creative behavior; and what aspects of the human personality may be identified as creativogenic components. As indicated above and according to Necka (1986) it seems evident that neither the creative act itself nor the psychological traits of creatively gifted people may be described and explained by one, single magic-like formula or by means of a simple model. Indeed, one may notice that during the recent decades a complex view on creativity has gained its preference. This preferred view of creativity includes the procedural structure of interacting cognitive and personal components of the creative individual and mutual dependencies of person and environment during the entire process of creative activity.

After thorough literature search, I propose a componential model of creativity. From the literature, one may identify two large classes of theoretical approaches to creativity differing briefly from one another: a more cognition oriented view or a more personality oriented view (Urban, 1995). It is evident that cognition is not something outside or different from personality. Cognition is part of personality. The terminological use of cognition, nonetheless, distinguishes it from personality, including traits, motives, emotion, and others, the psychic set of a person (this is wrong, in a narrow sense; since cognition is also psychic). Following that, I suggest two main groups of components of creativity, the cognitive, and the personality components. The first three representing the cognitive components are:

- divergent thinking and doing,
- general knowledge and thinking base, and
- specific knowledge base and specific skills.

The other three representing the personality components are:

- focusing and task commitment,
- motives and motivation, and
- openness and tolerance of ambiguity.

The six components with their subcomponents are explicated in the Figure 9.1. (See Urban, 2003, for a detailed description).

URBAN'S components model of creativity

A: individual dimension/environment
B: group- or local dimension/environment
C: societal, historical, global dimension/environment
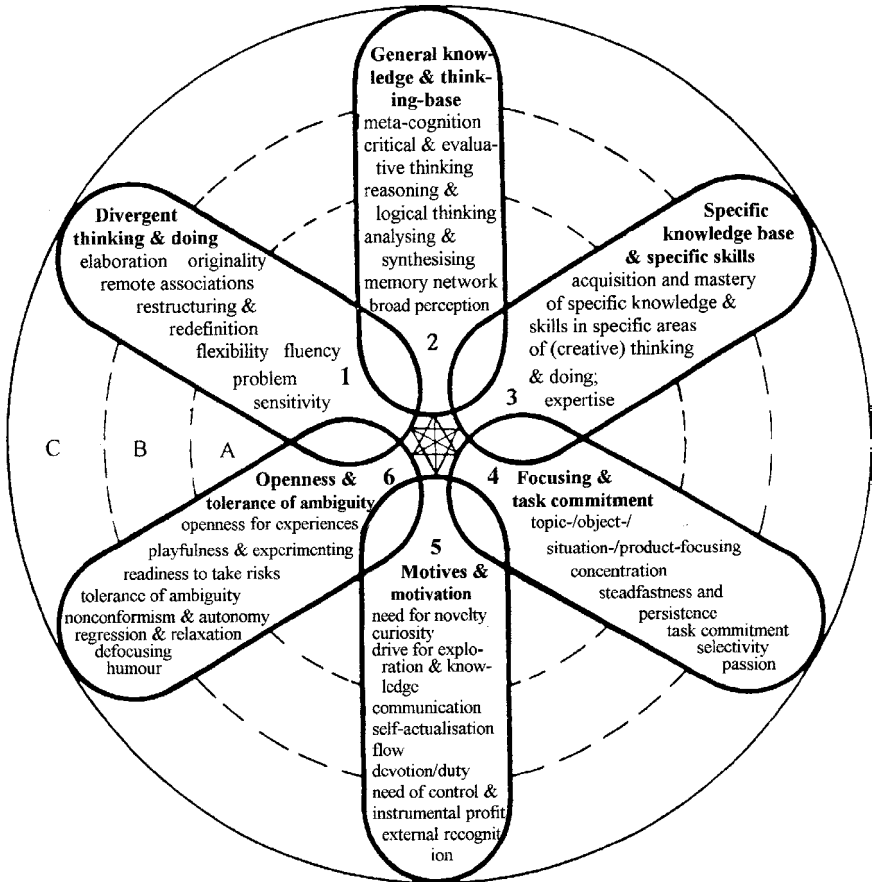
Fig. 9.1. A componential model.

Divergent Thinking and Doing

Since Guilford (1950) *divergent thinking* has been the component instantly linked to creativity. Guildford (1950) identified several factors of divergent thinking which have influenced enormously research and writing of creativity. Some authors especially designers of creativity

tests, have taken divergent thinking synonymous with creativity. Such a limited view applies restriction to a creativity concept.

Problem sensitivity, the ability to find problems, is a pre-supposition and critical starting point for creative processes. The same facts may evoke a question stimulus in one person but may not in another person. Asking question, one of the first verbal expressions, seems to be natural to all children. The ability of asking is closely linked to children's natural curiosity, the drive for exploration and for knowledge. The relation of thinking activities, in our case the divergent thinking, to other personal, non-cognitive traits becomes obvious. We will find repeatedly the interactive relationship between different main components and their subcomponents of creative thinking and doing.

General Knowledge and Thinking Base

Problem sensitivity and all divergent subcomponents are related to the second component, i.e., general knowledge and thinking base. Divergent thinking must be founded on the *broad perception* and general deep knowledge and thinking base. Pre-suppositions for fluent, flexible, and associational thinking include quick perception and processing of information and data, as well as storage in a flexible and accessible *memory network*. Reformulations, redefinitions, reconstructions of problems need to be *analyzed* and *evaluated* with reference to their usefulness. *Analyzing*, *reasoning*, and *logical thinking* are necessary for collecting and preparing the information required in the starting phase of the creative process. Together with *critical* and *evaluative thinking* in the final phase, the above-mentioned forms of thinking bring forth realization and elaboration of the creative idea or product.

The dynamic balance of the two components (divergent thinking and doing, general knowledge and thinking base) brings the creative process forward. This may explain why some researchers discuss about a certain level of intelligence (convergent thinking) necessary for high creativity. This kind of balanced interchange is essential to all components of creativity and their collective, functional, and dynamic system.

Specific Knowledge Base and Specific Skills

Divergent thinking alone will not lead to creative excellence in a special field without *special field mastery*. In recent years, some attention has been given to *content area specific knowledge* as a pre-supposition for generating creative ideas and products, especially for those of outstanding and original, of historic, and revolutionizing importance.

Focusing and Task Commitment

The acquisition of comprehensive and detailed content area specific knowledge and skills requires disciplined *topic commitment* and a high level of *persistence*. The problem in question and the connecting thematic field have to be kept in the *focus* of attention over a longer period of time and with varying intensity. *Concentration* and *selectivity* are necessary for collecting, analyzing, evaluating, and elaborating information and data.

Motives and Motivation

An appropriate motivation, preferably intrinsic in nature, is a presupposition. *The need for novelty, curiosity, drive for exploration and knowledge* is inborn to each child, but too often suppressed by parental or other educational environment.

Openness and Tolerance of Ambiguity

Finally, in a dialectic relationship with focusing and task commitment, the component of *openness* and *tolerance of ambiguity* is of substantial relevance. Using Einstein as an example, Lesgold (1989) demonstrates an essential difference between creatively productive and "normal" problem-solving processes. For Lesgold, Einstein's genius lies, on the one hand, in the adequate combination of mighty and focused thinking and his expertise in natural sciences and, on the other hand, in his ability to withdraw and muse from time to time, i.e., *defocused* phases.

We find again, the balance of two seemingly oppositions, the ability to focus and the ability to withdraw. An additional factor to this is the

possibility to *postpone quick solutions*, to inhibit or stop (an) execution of products but simply to allow that less directed thinking to dominate by spreading patterns of activity.

The interplay becomes obvious between processes in the musing phase with unconscious, divergent, associational thinking, connected with deep, domain-specific knowledge and broad, open perception and, "inter-connected" processing and storing of data, information, and others.

Other related subcomponents are resistance to group pressure, maintaining *non-conformist* behaviour and *autonomy of thinking* at certain times and intervals. The *readiness to take risks* allows for *remote associations*, *playfulness*, and *experimenting* with fluency and flexibility. *Tolerance of ambiguity* is supported by passion.

The dialectic combining of subcomponents above could be continued at length. Generally, *no single component* may be sufficient or responsible for the creative process to lead to a creative product. The componential model is regarded as a *functional system*. The (sub) components are used for, participate in or determine the creative process to differing degrees and with differing subcomponents and combinations of subcomponents. Each (sub)component plays its interdependent, functionally adequate role at a certain stage, a certain level, a certain situation. Each component is a pre-supposition and a result of the others.

Creativity, the creative process and the degree or level of creativity are not defined by process and componential variables alone but by the final creative product and the quality of its new gestalt. The success and acceptability of any creative process depend on its inherent communicative, innovative, "infectious" power on the one hand and on the receptivity and evaluation of significant others on the other hand.

The dynamics and mechanics of the componential functional system are dependent on discouraging/inhibiting or nurturing/stimulating/inspiring/cultivating influences of the various environmental (sub)systems in which the creative individual becomes active. Considering the criterion of newness and the aspect of creative development in childhood (Urban, 1991) it is necessary to work with the

components model in three different, but interacting "reference levels" (A, B, C):

A: the individual, subjective dimension with the direct, situational, material and social environment,

B: the group or local dimension with family, peer group, school, local educational system, the micro-environment, and

C: the societal, historical, global dimension with the cultural, political, scientific conditions, the macro- and meta-environment.

The assumption of the three reference levels is important. To differing degrees the environmental frames are influenced more or less directly by the following three aspects:

1. the development of and education for creativity in children,
2. the actual and concrete course and success of the creative process, and
3. the evaluation, acceptance, and appreciation of a creative product.

Since creativity is a substantial core of a concept of giftedness this proposed components model may become considered a general model of giftedness.

In reference to the need of high responsibility in creative thinking and acting, mentioned above, I have embedded this components model of creativity into a larger model structure, called the "Responsible Createlligence®" described elsewhere (Urban, 2000, 2002).

Nurturing Creativity–Education for Creativity

If we consider creativity development and education for creativity with such a complex view—as I think we should do—evidently there are consequences for assessment, nurturing and education of creativity. Accordingly, the question of how to nurture creative functions and abilities becomes difficult and complex. Education for creativity is not a matter of just getting better or having as many ideas as possible in the shortest time. Education for creativity concerns the whole person and refers to the development of the whole person.

A debatable question is about if we can improve general creativity skills regardless of contents, or if there is really a transfer of skills to

various problem solving situations. As far as the methodological validity of training-control studies is concerned (Hany, 1992), the discussion on the above in the literature is controversial and not that encouraging.

Divergent thinking should be an integrated, essential component of all teaching and learning. I know that to integrate divergent thinking into all teaching and learning is a challenge to many teachers, educators and university faculties. This challenge affects not only their professional qualifications but also their individual personality and professional roles in the educational system, class, school and neighborhood. Divergent thinking could be used in acquiring content area specific knowledge (component 3). One could ask, for example, how to execute an act in different ways ("Let's find other ways besides the prescribed one to solve this mathematical problem.")

The normal 45-minutes class schedule can often destroy or impede the development of a deeper interest in a topic, of long lasting task focus and commitment (component 4), and of intrinsic motivation (component 5).

The component of openness and tolerance of ambiguity (component 6) is much neglected in schools. What we learn in school is how to do things correctly, to find the one and only right answer. Learning how to avoid mistakes prevents us from being open for other experiences. Risk taking, socially and cognitively, is often being rewarded negatively. Working in a group or a class does not seem to go along with non-conformity. School is normally not considered to be the place for relaxation.

In general, I believe, that the pedagogical concept of open teaching and learning, open school and open instruction, recognizing the ecological/environmental living and learning conditions, seems to provide essential conditions for an all-round education toward creativity.

About 25 recommendations are listed below for stimulating and nurturing creativity in school and other settings.

1. Stimulate and keep a creative group atmosphere, which allows speaking, thinking, and working in a condition free of stress and anxiety as well as without fear of sanctions.

Agree upon common rules, such as "brainstorming" and/or begin with a task/play of divergent thinking. Postpone instantaneous evaluation and time pressure of achievement. The teacher does not act as an evaluator, an organiser, a censor, or an institution, but as a person, a partner, a guide, a stimulator, and an expert.

2. Avoid group pressure and envy of competition, but allow and support a socio-co-operative climate and a, "together-competition."

Group pressure means level down and uniformity, which impedes innovative thinking and acting. Determine goals and work together. Allow, challenge, and support personal involvement, especially if it is generally accepted that everybody is unique in his(her) way. Envy of competition confines energy and increases positive work tension.

3. Try to avoid and prevent negative reactions or sanctions by classmates.

In the first instant new ideas and thoughts may look somewhat ridiculous, crazy, rickety or insane and may give rise to ridiculous laughter. Everyone should be given the rights to have his/her ideas and thoughts taken seriously.

4. Provide an adequate change of active and relaxed periods which allow musing.

Taking Einstein as an example, Lesgold (1989) showed the necessity of "focused" and "defocused" phases. A positive work tension (eustress) may be kept on a high level only for a certain time interval. As individuals' rhythms differ from one another tremendously, it is not that helpful to have regulated breaks, especially according to fixed time intervals.

5. Demonstrate and appreciate humor.

Various studies discuss a strong relationship between humor and creativity. Humour provides both distance and closeness towards a subject. It allows and displays a more-perspective consideration in the presence of an emotional component.

6. Stimulate and support free playing and manipulating of objects and ideas (e.g. "What if..?").

Promote finding and use of analogies and metaphors. The question "What if …?" or "What would have been if …?" allows for free and object-oriented fantasy, as well as wakes and keeps up curiosity. Other techniques are minimizing, maximizing, converting, contrasting, reformulating, analyzing and taking into pieces, combining, and synthesizing.

7. Support self-initiated questioning and learning.

As a rule, asking a question is not an attempt to disturb, but to demonstrate individual endeavors in seeking meaning and truth. Reactions hindering creativity could be "This belongs to quite another topic!", "That's not our job!", "That's for later!" or "You will learn that next year!". A possible better response might be, for example, "Why do you think, that your question might be important at this moment?"

8. Provoke and provide for situations challenging, stimulating, and requiring creative behavior.

Use role play and simulations. Offer a certain contextual and situational constellation—and then? Or give the "end"/result and ask for the way (for example, "four" or "three pink chair-legs" or…).

9. Be careful with/hold back (too) quick feedback of certain (rigid) patterns of behavior or solutions.

10. Act as a model for supporting questioning rules or seemingly indispensable facts or patterns.

Let students find examples or situations for/in which certain rules are no longer true or valuable. Try language rules, traffic regulations, communication practices, and others.

11. Try as much as possible to avoid "suggestive" questions or questions, which require a mere "yes/no"-answer.

12. Instead of questions try to formulate statements, which may stimulate or provoke questions by the students.

13. Do not give ways or strategies for solutions too quickly, but give hints step-by-step to stimulate independent thinking.

14. Allow errors and mistakes (as long as they are not physically or psychologically harmful to the child or to others).

You can learn from mistakes, because they are active steps on the way to a solution.

15. Interpret errors as signs of individual and constructive efforts towards a self-detected solution.

Wrong solutions are—if not just guessed—the results of wrong or falsely applied strategies, having been actively constructed by the pupil.

16. Try to find out the "other", deviant, poor or wrong strategy (qualitative error analysis).

For example, what could have been the thinking strategy for giving the seemingly wrong answer "five" to the question "How many wheels has a car?".

17. Try to make students sensitive to stimuli from (material, symbolic, social) environment.

18. Support interests, perception and acquisition of knowledge in a broad variety and in different areas.

19. Give stimulations and examples to systematic investigation, redefining, altering of ideas, stories, statements, and presentations. (e.g., using language games).

20. Demonstrate tolerance and appreciation of unusual thoughts, original ideas, creative products.

Even if the teacher does not play the role of an evaluator or a censor, his/her behavior functions as a model. It is important if it is not only the product as a manifest achievement is in the focus of evaluation, but also the individual efforts toward a solution. That means that the (whole) personality of the student is taken seriously and appreciated.

21. Encourage the students to accept, acknowledge and appreciate their own creative thinking, acting, and producing. Do likewise for other people.

See 20. Self-confidence, a positive self-concept, self-appreciation are important pre-suppositions, same as results of creative activities.

22. Provide manifold and stimulating materials for the elaboration of ideas.

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23. Support and attach the importance to full elaboration or realisation (of all implications) of creative ideas.

     Ideas, staying in the head, do not have much use until they are communicated. Really good ideas will only become obvious through practical transformation and realization.

24. Develop and demonstrate constructive criticism, not just criticism.

     Criticism becomes constructive only when it emerges from personal appreciation; then it can be accepted without doing much harm.

25. Make students sensitive for possible implications and consequences of solutions.

     This is true for reality-oriented solutions and for thinking games and simulations. Potential and real implications of the non-real situation of simulations should become obvious and discussed during a post-reflection phase.

In education for creativity and in other learning/teaching situations the full appreciation of (the potentials of) the individual personality should be the leading principle.

Assessing Creative Potentials

To address challenges, stimulation, and furthering provisions in an individually preferred way the teacher needs to know about the learning status, the open or manifest, and the hidden potentials of his/her students. It is nonetheless not enough just to administer one just available instrument and to get a figure for each student according to which he/she is assigned or selected to a special group with special treatment.

    Such an assessment and evaluation should be part of a "further-diagnostic" process under the following conditions:

    – where furthering/promotion and diagnostic are integrated,

    – where diagnostics are not a purpose in itself, for labelling or classification, but as an individual information basis to improve educational provisions,

    – where preceding stimulation and furthering are presuppositions for meaningful assessment mentioned at the beginning. In this sense,

creativity tests may give important additional information for assessing creative abilities. They may, for instance, function as useful screening instruments.

In addition to natural observation during class work, evaluation of creative products in various areas—not only in the arts!—it may be helpful to use an assessment instrument which is easy to administer. Accordingly, I design an instrument: The "Test for Creative Thinking–Drawing Production TCT–DP" (Urban and Jellen, 1996).

The Test for Creative Thinking–Drawing Production (TCT–DP)

Traditional creativity tests mostly give mere quantitative information about a restricted aspect of creativity. The TCT–DP may be seen as an attempt to apply a more holistic and gestalt-oriented approach to diagnostics of creativity. We intend to consider not only divergent or limited, quantitative aspects, but also aspects of quality, such as content, "gestalt", composition, and elaboration. Other components stressed in the literature are such as (mental) risk-taking, unconventionality, affection, and humor.

The "Test for Creative Thinking–Drawing Production (TCT–DP)" is meant to be a screening instrument which allows for a first simple and economic assessment of a person's creative potential. The test is easy to administer, by a teacher, an educator, and a psychologist. It is applicable to the whole age range, from pre-school children to the elderly people. It may serve to identify highly creative potentials and to recognize individuals with under-developed or retarded creative abilities, who are in need of getting promotion, challenge, and support. Besides self-evident aspects of content and quality, the following are deem important for the development and design of the instrument: Criteria of simple administration and evaluation, economic application, and broad usefulness. The modality of drawing should guarantee the highest degree of culture fairness, which normally is not possible with verbal creativity tests.

On the test sheets some special figural fragments are "offered" stimulating further drawing in a free and open way. The drawing product

is evaluated and scored by means of 14 evaluation criteria representing the test construct:

Continuations (Cn): Continuation or extension of the six given figural fragments.

Completion (Cm): Additions, completions, complements, supplements.

New elements (Ne): Any new figure, symbol, or element.

Connections with a line (Cl): Between one figural fragment or figure and another.

Connections by content (Cth): Any figure contributing to a compositional theme or "gestalt".

Boundary breaking, fragment dependent (Bfd): Use of the "small open square" located outside the square frame.

Boundary breaking, fragment independent (Bfi). Anything else located outside the square frame.

Perspective (Pe): Any breaking away from two-dimensionality.

Humour and affectivity (Hu): Humorous responses, affection, emotion, strong expressive power.

Unconventionality A (Uca): Any manipulation of the material.

Unconventionality B (Ucb): Any surrealistic, fictional and/or abstract elements or drawings.

Unconventionality C (Ucc): Any usage of symbols or signs.

Unconventionality D (Ucd): Use of unconventional, non-stereotypical figures.

Speed (Sp): A breakdown of points, beyond a certain score-limit, according to the time spent on the drawing production.

The summed up total scores give brief assessment figures of the creative potential; the scores may be used to compare with figures in the norm tables reflecting the results of various German populations (total $N > 2500$) classified by age, grade, and others. Besides, a brief classification percentiles and T-scores are provided if needed. Empirical studies of reliability and validity are documented in the detailed manual.

The test is available in two forms A and B, normally given one after the other in one session, applicable in single or group testing with persons between 5 and 95 years of age. The administration needs
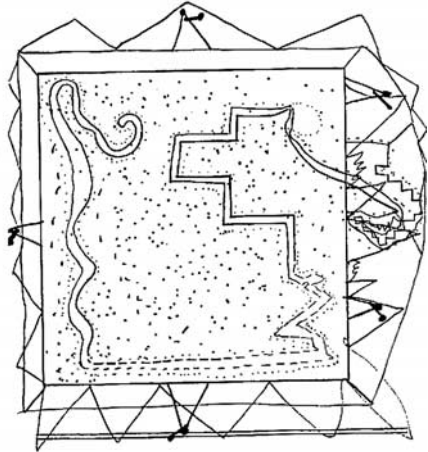
Fig. 9.2.   Two drawing productions, both on the basis of testsheet A.

15 minutes (or less) for each form. The scoring using the comprehensive and extensive description of evaluation procedures takes another 2–5 minutes after some training.

Here are two examples of drawings (Form A) from the manual (Fig. 9.2), which score reasonably high:

The test is available now from Harcourt, via internet: http://harcourtassessment.com > "Find it" > A to Z Product List > "T" > Test of Creative Thinking – Drawing Production or http://harcourtassessment.com > Psychological > …complete catalog > "Cognition–Intelligence" > Test of Creative Thinking–Drawing Production

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Part Two
Nurturing Creativity

Section IV
Experiences with
Children with Talents

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Education Toward the Future: Asking Questions

*Erika Landau**

Introduction

In the first stages of early childhood, *one of the important ways* children experience their environment is through touching. Most of the attempts to make contact and communicate start with touch, it separates the "I" from the environment, and at the same time establishes contact. When we enable a child to smell a flower, look at a tree with all its details, stroke a cat — we take our first steps towards creativity. The child should be taught to use his(her) eyes not only to see, but also to observe and search; use his(her) ears not only to hear, but also to closely listen; and use his(her) hands not only to grab but also to sense, touch and feel. When a child acquires sensitivity to problems and flexibility in art, s/he also gains confidence and can later on transfer it to other domains. His(her) confidence in one area enables him(her) to dare approach other domains.

The child should know s/he is expected to be creative. To be creative, means to look at the known from different aspects, to find new relationships between things unrelated before, to find in the given frame new alternatives. This includes being open to one's environment, being with one's own feelings and creating one's experience.

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Others are such as the following:

- To start with the known to the unknown
- Joy from the process and not only from the achievement
- To teach how to ask questions not only facts of knowledge
- Interdisciplinary thinking and not only in narrow categories
- Orientation towards the future and not only toward the past
- Learning through games (the playful attitude)
- Social involvement and individual accomplishment

We have initiated and developed exercises to stimulate children to ask questions about their life, what they know of the past, their social involvement and the ideas they have about the future. The following are some of the tasks. One of them is about asking the children to *define general concepts* such as curiosity, openness, flexibility, imagination, surprise, and sense of humor. Then they are asked to think about the role and value of this concept. Eventually they are asked about the opposite of the concept. Another task is to ask the children to *imagine* our world in 30 years: our houses, our food, our clothes, our means of transportation, our communication system, our leisure, our work, and our family life. After each and every child thought by him(her)self about the answer, we worked together on the different possibilities. To nurture the gifted child's creative and combinatorial skills, we thought about exercises that involve comparative, paradoxical or analogical problems. For instance, an 11-year-old child was asked to choose a certain phenomenon of life and describe how it was 100 years ago, how it is today, and how it would be in 10 and 50 years.

Education through Questions

The experience of many educators shows that teaching through questions is more challenging than giving facts. It also encourages children to ask questions because it increases their curiosity. In practice, we recommend the teacher to start their lesson with a question like "what do we know on this topic? What do you think about it?" and some more leading questions on this topic. This approach might challenge

or introduce the child to new ideas, encourage him(her) to ask questions about the subject even in the earliest stages of learning, before the subject becomes more complex. This approach should be accompanied with exercises or images which in the eyes of the teacher the exercises or images match as much as possible the children's potentials and abilities. The lesson should never end with a full stop but always with a question mark. "What would you like to know more on this topic?" "Would you like to study it when you will be a university student?" When the child feels the need for a more profound discussion, s/he can start dealing with the complex, abstract or symbolic aspects of the subject. At the same time s/he asks questions where to find the sources.

Levels of Question Asking

The *first* level of questions should be *descriptive*, such as: "Who does what, how, when, and where". These questions are connected to *the present*, to the here and now and require the child to describe an existing situation. Through these questions the child learns to notice and describe things, and gains self-confidence in understanding the situation or problem. Only after a situation or a problem is thoroughly described, we can proceed to the *second* level of question asking: the *causal* "*why*?" question, which connects the "Who? How? Where? When?" questions to other information. The causal question provides an insight into information given to the child by his(her) parents, teachers, or school. These two levels of question asking are important when teaching the child to perceive, describe, link as *objectively* as possible.

Only then do we ask the *subjective* question: "What do I know about it? How do I feel about it? When did I see or experience anything like this?" These questions often demand an emotional commitment for which the children are prepared after gaining strength through the two previous levels of "*objective*" examination. The children will then approach the problem from different angles, in the form of associations and analogies that encourage flexibility and stimulate them to be involved, because they "invest" in it part of their associations, knowledge and feelings. The unfamiliar problem becomes then familiar. The

circle of questions opens up and becomes a spiral, and the children dare to go beyond the familiar and the secure.

When we reach the stage where the child dares approach a problem through his(her) intellect and emotions and dares going into the spiral when searching for an answer, we can proceed to the *imaginary* questions, such as "what will happen if we link A to B"? Different alternative answers given to this question can lead to a solution — one more step up the spiral. Now additional courage is needed — to use imagination.

Judgmental questions, such as: What is more important? What is better?" result from the alternatives and mark an additional step up the spiral. Only at this stage can judgment be exercised. If it is done earlier, the raw materials of the thinking process will be limited by the interruption of the weak association flow, associations that will probably be useful in the future. This means searching for new techniques of relating the individual causes of a problem to its alternative solutions. These questions represent the fourth level of the thinking process.

Although, we already have a solution, we would like to keep the child in suspense to prepare him(her) for the continuity between present and future. Therefore we ask him(her) the following questions: "What else interests you about this problem?, What can you do with it"? The question poses a challenge to the child, arouses his(her) curiosity, and stimulates his(her) imagination to discover his(her) capabilities and boundaries. This question is highly important, because it inspires hope in his(her) heart in relation to his(her) achievements and to his(her) participation in the future and continuity of humanity.

The child is encouraged to make progress, whether lateral, in depth or in details, according to his(her) own personal abilities. Pleasant encouragement helps the child to be able to accept the fact that s/he does not understand everything, but s/he could ask questions about what surprises him(her). This can serve as a challenge and a basis for wondering and speaking about the future.

Creative Questions about the Future

Through questions, we stimulate children to take action, first on an intellectual level, which becomes motivation, and then on a practical

Future — What else can I do?

Judgment — What is more important, better?

Imagination — What happens if...?

Subjective — How do I feel about it...?

Causal — Why?

Descriptive — Who, what, where, when, how?
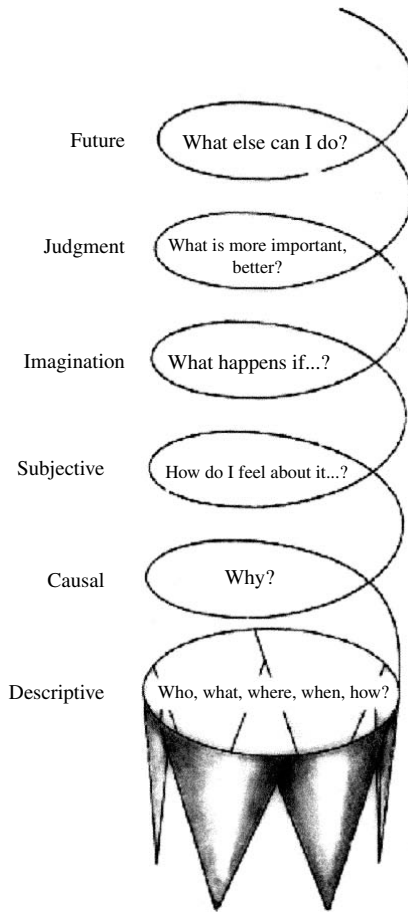
Fig. 10.1.   Spiral of creative questioning.

level. By asking questions, they dare look for more questions and thus, get closer to the essence of the problem and its consequences. This helps children to become responsible for them and toward society.

Although, we can not teach children the facts of future, we can bridge the gap between facts of today and the challenges of tomorrow through creative questions. Rather than teaching them what to *think*, we should teach them how to ask questions that can lead the way to finding answers. Through question asking, we can teach children how

to satisfy their curiosity, despite the fear of the unknown or unacceptable accompanying each new question. Not only does this form of education stimulate the child's intellectual capability, it also contributes to his(her) emotional development. And above all it stimulates his courage to test his(her) skills and capabilities. It provides him(her) with tools for dealing with e problems of the future.

By encouraging children to ask questions we can preserve their natural curiosity, stimulate their imagination and their sense of adventurism, while ensuring an enjoyable learning process. When children enjoy learning, they get more involved and dare ask more questions. This contributes to their continuing joy of learning and to making progress. We can therefore help them to acquire mental tools for better dealing with the future.

This creative attitude makes a difference between a scientist and a technician, between an artist and a copyist. It does not, however, provide solutions, but rather enables us to formulate the problem, which is a discovery in itself. The nature of the problem and the creative question this problem raises determine the creative solution.

By teaching children how to ask questions, we teach them to "fish" knowledge and experience. This situation is analogous to the following ancient Chinese legend: about a hungry beggar who once asked a fisherman to give him a fish so he can satisfy his great hunger. The fisherman refused to do so and instead offered to teach him how to fish. If he gives the beggar a fish today, he explained, the beggar will be hungry the next day, but if he teaches him how to fish, the beggar will never be hungry again.

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Creativity in Special Education

Ching-Chih Kuo

Introduction

Creativity in the context of special education includes developing talents of both gifted students and students with the potential of development, but facing disadvantages due to their biological dispositions and/or socio-cultural environments. In the literature, developing talents and creativity has been a topic of attraction to educators and teachers. The significance of teaching creativity in the area of education can be traced back to the introduction of the Structure of Intellect model by Guilford (1959) in which the cognitive processes of convergent thinking, divergent thinking, transformation, and evaluation were highlighted. Getzels and Jackson (1962) argued that creative potentials need a certain threshold of intelligence, but not necessarily high intelligence. At a certain level, creativity can be an entity that is psychologically distinct from intelligence.

In the field of gifted education, Gowan (1980) proposed the developmental stage of theory to assist gifted students to be more creative. Taylor (1984) contributed a great deal to develop multiple talents. Renzulli's (1986) concept of giftedness includes creativity, task commitment and above average ability. The highly able students are expected to be more creative, active, and productive, regardless if s/he is good at divergent thinking. These views argue for the discussion and exercise of thinking, teaching and modeling creativity and creative problem-solving abilities (Maker, 1962; Parnes, 1977).

Discovering and nurturing creativity for children with disabilities is a new experience. Traditionally, students with disabilities are only given remediation education in the areas identified as deficit or negligent of

excellence. Baldwin(1978) and Frasier (1980) however introduced the relationship of giftedness and cultural diverse and economically disadvantaged. Whitemore (1980) and Maker (1977) raised the importance of discovering giftedness from the students with disabilities. As long as these students received appropriate supports and development, their giftedness can be developed. Among those who are with special needs, the group of students who were recognized as "*twice-exceptional*" would receive more opportunities to make their best and attract educators to discover their creative performances (Whitmore, 1980; Schiff, Kaufman and Kaufman, 1981; Baum, 1984). Schiff, Kaufman and Kaufman (1981) pointed out that "uneven gifted" students were often creative producers in the arts and sciences. Children with Asperger's Syndrome are found to be full of originality and creativity in their selected field (Tsai, 1992). Currently, educators have begun to turn their attention to special groups of students who are typically underrepresented and who are yet to be recognized or met in the gifted programs.

In the context of special education, teaching creativity to the gifted and to students with disabilities especially those in the category of "twice-exceptional" shall be given more attention. Identifying the gifted potential using the non-traditional assessment approach is a challenge. We would like to share the following enrichment program at the Special Education Centre, National Taiwan Normal University.

The program was established between 2003 and 2006 to develop young gifted children with multiple intelligences, their problem solving abilities and creativity. The program offers opportunities for children to develop talents of the gifted but less advantaged pre-schoolers. The enrichment programs runs on every Saturday from 9 a.m. to noon and 1.30–4.30 p.m. Courses include "Exploring DISCOVER" and "Group Activity" in the first half of the day, and "Talent Development" and "Self-Chosen Activity" in the second half of the day (see the brief description below).

Exploring DISCOVER: A course combined with multiple intelligences and problem solving ability.

Group Activity: Providing opportunities for children to do social intercourse and play.

Talent Development: Including six different areas to develop the strength of each child. The areas are mathematics, natural science, linguistics, music, art and bodily-kinesthetic.

Self-Chosen Activity: Allowing each child to choose different corners to explore his(her) interests and progress in self-choosing ability and learning. Parents receive courses with the aim to improve their quality of parental education.

The Framework of an Enrichment Program

Exploring DISCOVER

The framework of an enrichment program for the children with special needs adapts the multiple intelligence theory proposed by Gardner. The teachers who design the curricula are requested to expand their existing knowledge and technique beyond the verbal and logical domains of the regular classroom. All curricula of the enrichment program include at least two areas of the eight multiple intelligences (linguistics, logico-mathematical, bodily-kinesthetic, spatial, inter-personal, intra-personal, musical, and naturalist). The framework combines with the teaching of problem-solving ability adapted from the DISCOVER program designed by June Maker, University of Arizona. Problem-solving ability is the main part in DISCOVER curriculum, and the foundation of its assessment and curricular design.

In the DISCOVER curricula, five types of questions were introduced:

Type 1: Questions are simple and closed. The presenter and problem solvers know the formula. The problem solvers need to find out the solution independent from the presenter's assistance. The question can be as simple as the following: $3 + 4 = ?$

Type 2: Questions are simple and closed. The presenter knows the problem method and solution. The problem solvers, nonetheless only know the question. Examples of questions are the following: There are 10 cookies in the can. You ate two of them. How many cookies are left in the can?

Type 3: Questions are disclosed but more open and complicated. There are several formulas to solve the questions. Presenters

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know the formulas and solutions. The problem-solvers are requested to find out the solution. For example, use 3, 5, and 2 to write down as many mathematical statements as you can.

Type 4: Questions are made known, but the presenters and the problem-solvers do not know either the method or the solution. For example, what is the best way to cross the river? There is one specific target to solve this type of question. The problem-solvers are required to collect ample amount of information to find out possible methods and solutions.

Type 5: Questions, methods, and solutions are not defined clearly to the presenters and the problem-solvers. Questions are open and complicated. For instance, what is the most serious problem human beings face today and how to deal with it? There is one specific question. It is acceptable to open explanation by analyzing possible methods and solutions, as well as by creating different solutions.

Group Activity

To implement the goals and objectives of curricula for the pre-schoolers, it is important to plan activities according to the theme units. Teaching by theme units provides a mechanism to co-ordinate activities that strengthen and reinforce desired concept. In a year, six themes are assigned a class. The pre-schooler curricula comprise six main themes: Cycles, change, pattern, relationship, environment, and individuality. An example of the six unit themes for a class over a period of one year is the following: Colors and shapes, others and I, growing up, seasons, festivals and holidays, and families.

Table 11.1 below shows an example of five types of questions in the theme " colors and shapes". Table 11.2 shows some work of children gifted in art.

Talent Development

The curricular design of the six themes identified by each class is based on the combination of multiple intelligences. The class solves different

Table 11.1. Questions within the Theme—Colors and Shapes, Unit—King of Cookies.

Unit	Objectives	Contents	Problem type	Multiple intelligence implication	Adjustment
King of cookies	1. Appreciating the artworks of Arcimboldo at 16th century 2. Observing artwork's outline and making connection 3. Allocating and matching by using cookies and candies	1. Appreciation Appreciation of artworks such as "Gardener", "Librarian", "Four seasons", "Element" 2. Comparing the connection between the outline of the object and facial features 3. Creating one imaginary Arcimboldo's creature 4. Creating a portrait of king (or queen, princess) of cookies after observing cookies' shapes clearly	Type 1: Observing clearly and describing components of objects Type V: Creating a story about people by using foods and animals Type IV: Using cookies or candies to create a portrait of kind (queen or princess)	Naturalist Observation Visual Spatial Visual Spatial	Type V: Suggesting weak-performed students to start out creating connection of objects' shapes and bodies while trying "material portraits" Type IV: Reminding strong-performed students to notice the changes in colors while creating "king of cookies"

(Curricular designer: Chang-Sheng Wu)

Table 11.2.   Some artworks of children.
Type V—"Material Portrait" and Type IV—"King of Cookies".

Photos of Artworks	Description
	Ying's work is about "animal person" with lion's head, bunny and cat's shoulder, snake's hair; the animal person is ready to serve tea for friends.
	Ting's work is "fruit person," who has apple head, grape eyes, banana hair, and carrot nose and water-drop lips. Along with blackboard and eraser, the fruit person is ready for class.
	Jack's work is "insect person." His hair, nose and body are made of rhinoceros beetle and stag beetle; ladybugs are his eyes, and oak's roots are his beards.
	Joan's work is "fruit person." Cherry and apple become eyes and chin; woodblock is nose, and mouth is "poisonous" banana.

(*Continued*)

Table 11.2. *(Continued)*

Photos of Artworks	Description
	Ying's "king of cookies" has pentagonal face and triangle hat with long-shaped cookies; facial features are mostly made of round cookies and two-side-of chins by potato chips. After finishing the head part, Ying adds two arms for the "king" and explained that "one (arm is) for eating, and another is for reading."
	Ting's "Queen of Cookies" has quadrangular face and web-shaped hair. Her wave-shaped potato chip lips are smiling.
	Jack's "King of Cookies" has full-of-mouth beard, round eyes and nose, having triangle cookie-crown and a sword.
	Joan uses round cookies as face, long-shaped beans as body and hair to create "an angel." However, Joan is not very attentive but busy eating candies, when she is creating the "angel."

types of problems that offer the opportunities for children to create. Taking linguistic teaching, for instance, Ms Lin (pseudoname) emphasized the significance of linguistic teaching for children. She insisted on providing a rich linguistic learning environment and a comfortable and secured environment for children to become competent in language and literature. She introduced various means for the children to practice, what they learn from the linguistic teaching in a spontaneous manner. Linguistic activities in her program include the following:

Teaching models: Teachers demonstrated reading and writing. They emphasized sharing in reading. Teachers told stories by reading picture books, telling stories directly, and demonstrating listening, story telling and reading. Children were encouraged to participate. They were urged to pronounce the title, the names of a painter and of a translator before opening the books, guessing at possible stories by reading the title or the picture on the picture book. Whether children were able to read or not, every child had a fair opportunity to make the best of him(her)self.

Collaboration: Teachers are parts of the activity of collaboration. They were able to nurture children's linguistic development and enrich the games.

Exercise or role play: Linguistic teaching provides children with the opportunities to express verbally and to role play. When the child plays the role of a witch, for instance, s/he pretends that s/he waves the magic wand, whispering spells and bewitching. The role play on "the paper bag dolls" excited the children as they design headgears.

Telling story by reading pictures: Children were given opportunities to introduce their creations, to practise expressing verbally, and to tell stories by reading pictures. Ms Lin included in all activities story telling by reading pictures. Regardless of whether the child was able to read, this activity made the best of children to develop their imagination and multiple abilities. Story telling evokes responses from everyday experiences. For instance, story telling on the theme "butterflies" called for the imagination of color. Story telling on the theme "we are good friends" provided the children opportunities to recognize the significance of sharing. With the theme " I am growing up," the activity brought out emotions of being a child in his(her) world.

Self Chosen Activity

The following is an account of Yao who had a reputation for being an attractive and perfectionist. Yao demonstrated delicate observation ability and ability in mastering materials given to him for arts. Focusing on a task for two hours, Yao searched for extra materials himself to complete his task. He considered the limitation of his task, and ensured the task was complete.

In another example, Yeh showed his self-chosen ability too. In DISCOVER, when making "my career draft" Yeh was given two sheets of paper. He did not limit his thinking to the size of the paper. When he wished to express exceeding the space of the paper, he asked for scissors and glue. He patched up the pieces. When he ran out of paper, he came up with different solutions. He recycled the back of the paper. When he presented his work verbally, Yeh specified environmentally friendliness. Yeh volunteered to show his work and shared his ambition to be a football player. He mastered abstract concepts, and possessed positive attitudes toward life.

Creativity in Children with Special Needs: Two Cases

Case 1: Ming

Ming is five and a half years old. She is vigorous, active, and friendly. She loves to meet friends and shows extreme interest and curiosity to explore and learn new things. Ming is very enthusiastic and responsive to every kind of learning activity. Although she lost her sights, Ming learns with the help of her teachers who adjust teaching materials and activities for her. Teachers, for instance, used auditory and tactile stimuli to guide Ming to be aware of the tone difference and to well pronounce and response actively. While the class was working in individual or group, Ming received assistance from her teachers. Her performance was evaluated based on her strengths. A teaching assistant or observer was assigned to explain to Ming visional material or to repeat to her what teachers just said.

Ming is passionate. She is popular among the students and teachers. She greets every classmate and teacher by their names, even though

Ming met them infrequently. When Ming meets a new teacher, she introduces herself voluntarily and be friendly. Parents and teachers are attracted to her by her good manners. Teachers are sometimes challenged to balance Ming's highly spontaneous discovery and questioning with other children's needs or with pace of designed activities. In this case, the presence of the teaching assistance is helpful to ensure that learning without hindrance for Ming and without interruption for the other children.

Just like all gifted children, Ming is enthusiastic in participating in every activity. She is good at performing and demonstrating. She is eager to be involved and to have her ideas and creativity displayed. She co-operates actively. She asks for help whenever needed during group activities and peer interaction. Other children in the class overcame the initial uncertainty and gave Ming a helping hand voluntarily, when they began to understand Ming's learning needs.

In "Talent Development", Ming is highly recommended for musical, bodily kinesthetic, and logico-mathematical talents. Especially for her high auditory sensitivity and extreme potential on music, she was suggested to focus her talents on music through one-to-one coaching. Her high self-expectation, self-discipline, and strong enthusiasm on music were fully developed in the course. Ming used auditory and tactile sensory to memorize songs. She performs finely and adds her creation. She is offered to learn music Braille with the hope that she can develop fully. (See Figure 11.1).

Just like other gifted children, Ming's perfectionism gives her difficulty when meeting unexpected situations such as forgetting to bring required photograph or being late. Teachers gradually make her aware and understand the importance of being relaxed and adjustment.

From our one year teaching, Ming displayed her infinite creativity and always surprises our members in the program. She composed songs and made records from time to time. She was not taught in our program to compose songs. But, she was provided with more opportunities to create and to fulfill her potentials.

Fig. 11.1.   Ming with piano and violin.

Case 2: Jack

Jack is a 5-year-old boy who is good in observing natural environment. He was shy in the beginning of our program. He showed nonetheless his passion and was extrovert when he became familiar with others. Jack was diagnosed with Asperger Syndrome before joining our program. In the intellectual test, he scored 134 for the occupational part, 89 for linguistic part, and hence his total score was 112. Jack had thus obvious inner difference. The scores showed his unusual but abundant potentials in spatial and mechanical intelligences. Jack was noticed by the unfamiliarity with the environment and difficulty in interaction. His talents in visual and spatial domains and creation had not limited him to be praised by his arts teachers.

To allow Jack to be familiar with the class environment and activities, we analyzed Jack's learning patterns in kindergarten and at home and Jack's interaction with parent. We consulted these analyses with what was observed by a professional and an observer. The professional observed Jack's behavior and provided suggestions and direction in time for the observer to assist Jack's learning. After guidance for a couple of weeks, gradually Jack was familiar with the environment and progressed in the activity. He was able to join the class activities voluntarily.

Jack's contiguous interference by his barriers and talents affect his learning. He was acute in observing, depth of knowledge in natural sciences with his creative and profound answers, which brought surprises to the teachers frequently. Jack's obstinate personality influenced his participation. He obsessed on one particular activity or interesting experience weeks ago. Constant reminders were crucial to guide Jack to focus on the current requirement. We were amazed by Jack's excellence in painting.

In the Figure 11.2, "Growing 1", Jack displayed the process of growing up for beans; he described a sequence of bean, such as root, stem, and leaves in detail. Specifically, in the Figure 11.3, "Growing 2", different colors were in particular used to describe different structure of apple tree.

In Figure 11.4, the artwork explained the Formosan Landlocked Salmon, unusual fish in Taiwan, grew up from the eggs to big Salmon and return to the sea. This painting also pointed out the characteristics of Formosan Landlocked Salmon, which is chin in air.

In the Figure 11.5, Jack described the bodies of the Formosan Landlocked Salmon changed colors accompanying with the change of
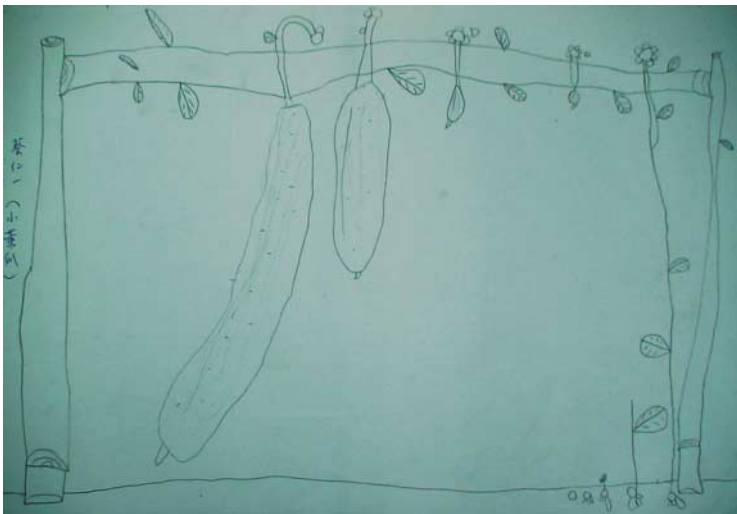
Fig. 11.2.   "Growing 1".
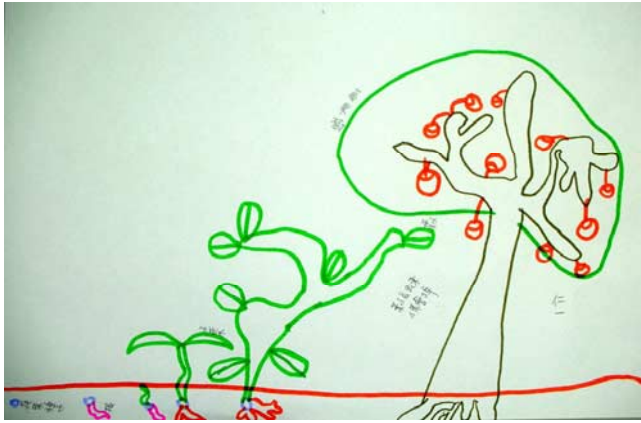
Fig. 11.3.   "Growing 2".
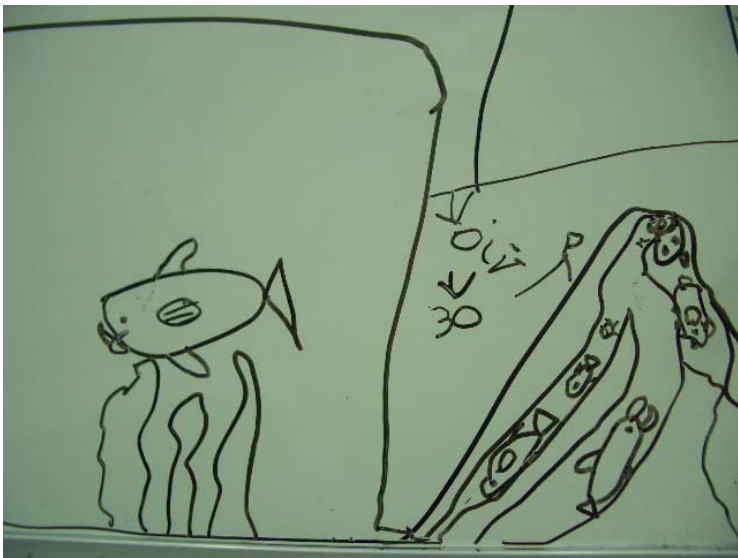
Fig. 11.4.   "Little fish mountain climbing 1".

weather when climbing. Jack in this painting indicated the "snow line" Salmon encountered.

In the Figure 11.6, the painting told the process of going down-hill and the color of bodies changed back to the original color the Formosan Landlocked Salmon had.
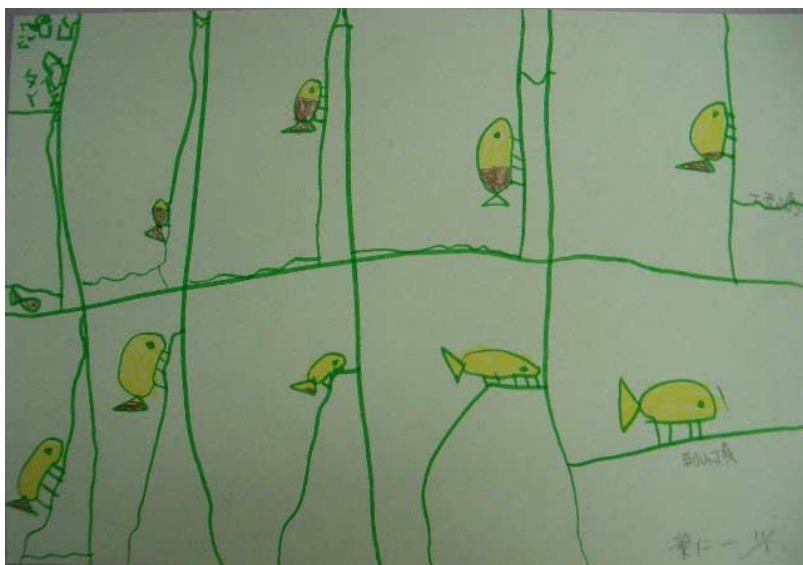
Fig. 11.5. "Little fish mountain climbing 2".

Fig. 11.6. "Little fish mountain climbing 3".

Concluding Remarks

Providing developmentally appropriate environment and positive family supporting system are essential for talented children to reach their limits of long time hard work. To perform children's talents fully, schools are highly recommended to allow multiple learning processes, implement rich and a variety of teaching materials and strategies, set appropriate challenges and provide side counseling and supports for gifted children. Parental education is highlighted and advocated for socio-emotional development of children including means to develop their anticipated talents to their benefits.

The enrichment program introduced by the Special Education Centre of the National Taiwan Normal University has attracted students. The program adopts flexible curricula, multiple teaching methods and strategies, and active learning activities. The gifted preschoolers favor especially the curricula of "talent development" and "self-chosen activity". They are always active, and encouraged to be active to explore and develop their interests and talents. Based on the observation of the young children of the program, we found that young gifted children show many cognitive characteristics such as interests, task commitment, and willingness to challenge various kinds of tasks. Our investigation and observation from our enrichment program so far have convinced that regardless if the child is gifted or not, a child can develop self-confidence and active in learning if they are given opportunities to discover and nurture their multiple talents. The program accepts gifted children with disabilities, understands their limitations and strengths, and design appropriate curricula for time to develop their potentials beyond their barriers.

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Using Assessment to Foster Creativity

Arthur Cropley and David Cropley

Introduction

At their meeting in Cologne in June 1999 the members of the Group of Eight (Britain, Canada, France, Germany, Italy, Japan, Russia, and the United States)—essentially the world's biggest economies—identified "entrepreneurship" as the key property that needs to be developed in human beings to secure each nation's economic and industrial welfare. In a newspaper interview a few days before his election on May 23, 2004 the incoming president of the Federal Republic of Germany called for "a new spirit of initiative" to enable Germany to deal with problems of contemporary life. Important social issues are demographic (e.g., ageing of the population, changing family patterns), social (e.g., inequality, adaptation of labor migrants and refugees), environmental (e.g., global warming, gene-modified crops), medical (e.g., biotechnology), political (e.g., terrorism, achieving fairness in international relations), and industrial (e.g., offshore manufacturing, globalization). The fear is that societies will stagnate, even deteriorate, unless their leaders, and thinkers find creative ways of dealing with issues of the kind just outlined.

The Creativity Problem

Despite such calls, the 1996 report of the Alliance of Artists' Communities (1996) concluded that "American creativity" is "at risk." The problem is not confined to the U.S.A., and goes beyond artistic/esthetic areas. Tilbury, Reid, and Podger (2003) reported that an employer survey in Australia concluded that Australian graduates

lack *creativity* (p. viii). Cooper, Altman and Garner (2002) argued that in the U.K. the educational system discourages innovation—the British General Medical Council, for instance, recognized that medical education is overloaded with factual material that discourages higher order cognitive functions such as evaluation, synthesis and problem-solving, and engenders an attitude of passivity.

Cropley and Cropley (2005) reviewed findings on fostering creativity in engineering education in the United States of America, and concluded that there is little support for creative students. It is true that there has been some effort in recent years to encourage creativity in colleges and universities: For instance, in 1990 the National Science Foundation (NSF) established the Engineering Coalition of Schools for Excellence and Leadership (ECSEL). This has the goal of transforming undergraduate engineering education. However, a recent review of current practice throughout higher education in the United States (Fasko, 2000–2001) pointed out that the available information indicates that deliberate training in creativity is rare.

Although the European Union has established programs bearing the names of famous innovators, such as, SOCRATES or LEONARDO, it is astonishing that in the guidelines for the development of education in the Community the concept "creativity" simply does not exist. At least until recently, the Max Planck Institute for Human Development, Germany's leading research institute for the development of talent in research in the social sciences, had never supported a project on the topic of creativity. In a letter from the office of the President of the Max Planck Society dated April 26, 2006, it was confirmed that the society does not regard creativity as a significant research area. It seems that, despite widespread lip service, creativity continues to be neglected in practice.

As Cropley (2001) pointed out, the situation is not much better in schools. Despite the fact that research more than 30 years ago showed that already then most teachers claimed to have a positive attitude to creativity, even today in classrooms in many different countries, many teachers frown upon traits associated with creativity, or even actively dislike characteristics such as boldness, desire for novelty or originality. Cropley (2001) showed that, from almost the beginning of relevant

research, teachers have expressed a preference for courteousness, punctuality, obedience, and receptiveness to other people's (the teacher's) ideas. In the area of thinking, high-skill in memorization and accurate recall are often preferred to critical thinking or independent decision-making. Even in Grade 2 (i.e., a level where it might be expected that a certain amount of divergence from everyday norms would be tolerated), children who scored highest on tests of creativity were the ones most often in trouble with teachers.

Findings of this kind have continued to be reported in a variety of countries such as Australia (Howieson, 1984), Nigeria (Obuche, 1986), and Turkey (Oral and Guncer, 1993), despite great emphasis on creativity over the last 30–40 years. Oral and Guncer (1993) reported that highly creative children were seen by Turkish teachers as being belligerent and defiant and Westby and Dawson (1995) found that teachers described creative children as being similar to the kind of child they liked least. Scott (1999) summarized a number of relevant recent studies that supported this view and in addition showed in her own research that American elementary school teachers rated creative pupils as more disruptive than less creative youngsters.

It is not being suggested here that undisciplined, disruptive, defiant, ignorant, aggressive, or humiliating behavior should be accepted in the name of fostering creativity. Punctuality, obedience, and consideration for others on the one hand, or good memory, speed, and accuracy on the other, are obviously important characteristics both for school and for life itself. However, when such properties are over-emphasized, and discovering, branching out, speculating, experimenting, or innovating rejected, it can be said that teaching has become excessively one-sided. What teachers need are guidelines on what is meant by creativity in the classroom and on what to do to foster its further development.

Creativity and School Achievement: An Apparent Clash

Cropley and Cropley (in press) concluded that many teachers are theoretically willing to promote creativity in their students, but uncertain what to do in practice. An enduring problem for teachers is the tension between traditional educational goals (such as possession of

large numbers of facts, accurate recall of memorized material, correct application of standard techniques) and creativity-oriented goals (e.g., discovering problems, inventing unexpected answers, linking tradition-ally separate areas). The former are of such obvious value that their worth scarcely needs to be defended, but the latter are less widely accepted. Indeed, they are sometimes seen as antipathetic to academic rigor.

Two linked case studies cited by Cropley and Cropley (in press) demonstrate the problem of this clash (although they do not directly involve creativity). Both involved the University of Adelaide in Australia, but at two points 100 years apart 100 years ago, there was no university in Perth, and Western Australian high school students who wished to complete tertiary education had to take the matricula-tion examination for admission to the University of Adelaide. In 1904 there was an unusually high failure rate among these people. The uni-versity had suddenly set assignments such as "Evaluate the historical accuracy of Sir Walter Scott's novels," whereas the protesting parents and teachers in Perth had expected tasks like "List three examples of anachronisms in the novel *Ivanhoe*." This led to an intense public dis-cussion (Morning Herald, 1904). The complaint was straightforward: It was not possible to learn the answer to tasks such as "Evaluate the historical accuracy of Sir Walter Scott's novels" by heart; students would have had to use their own judgment, with the uncertainties that this entails. Protesting parents and educators made it plain that they were not demanding an *easy* examination, but one that they saw as predictable, objective, and fair (and solvable by means of honest hard work).

Almost 100 years later, in 1996, the University of Adelaide changed the criteria for admission to medical school—generally speaking, stu-dents in Australia enter medical school directly from high school, and the number of applications exceeds by far the number of places avail-able. As a result, students are traditionally awarded places on the basis of their high school grades—exceptionally high grades mean admis-sion, regardless of other properties that may be relevant to being a doctor. The new criteria involved a combination of excellent school grades, scores on an aptitude test, and results of an interview. Among

other things, the latter two procedures assessed problem-solving ability, communication skills, and ability to work in teams.

There was a public outcry. Some candidates with extraordinarily good high school grades did not obtain a place, and the university was depicted in the press as being anti-academic. Some parents even went to the South Australian ombudsman (without success). In 1996, as in 1904, the thrust of the objections was that (a) problem-solving ability and the like are ill-defined and subjective, (b) the new approach meant that what students needed to know to obtain good grades could not be reduced to predefined factual knowledge that teachers know in advance and can pass on to students, and (c) the necessary qualities (problem solving, teamwork) cannot be acquired through honest toil over textbooks, whereas "the facts" of physics, chemistry, and biology can. Emphasis on creativity introduces uncertainty and ambivalence into a situation where people want certainty and predictability.

Serious concern on the part of teachers, students and parents about the issues just listed is completely understandable. Children and their parents may be facing life-changing events such as admission or not to a particular program of in higher education, for which the family may have made considerable sacrifices and the child have worked long hard hours. Naturally, they wish to know what is required of them (so that they can prepare), to receive differentiated guidance on how to prepare, to be shown where their strengths and weaknesses are, and the like. They also wish to be sure that disappointing grades are based on performance, not on assessors' whims and moods. The grading scheme proposed below goes some way toward dealing with these issues.

Before proceeding, it is important to note there, emphasis on creativity does not reflect a desire to make teaching less stringent or to do away with academic rigor. In fact, Ai (1999) pointed out that many empirical studies have shown a connection between creativity and *improved* school grades. Teaching and learning methods that emphasize creativity can also have strongly beneficial effects on pupils' motivation as well as their attitudes to school and their self-image. This has been known since early research such as that of Suchman (1961), who showed that children taught by inquiry methods acquired as much

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knowledge of physics as those taught by conventional methods and were significantly more curious about science. More recently, Langer, (1989) and Yager (1989) obtained similar findings about discovery methods and acquisition of facts, while also demonstrating greater motivation to learn and increased intrinsic motivation among the children in question.

A striking fairly recent example of differences between the effects of reproductive, routinized teaching and creativity-facilitating teaching is to be seen in differences in the mathematics performance of American and German secondary school students in comparison with their Japanese counterparts in the now almost infamous TIMSS study (Stigler and Hiebert, 1997). Analyses of videotapes showed that typical behavior of German and American mathematics teachers was to start by presenting a problem, demonstrate the standard solution to this problem, then give the students further problems of the given type, requiring them to re-apply the solution just learned in a cookbook manner. In contrast, Japanese teachers started by giving the students problems they had not seen before, and challenged them to work out their own understanding of the problem, specify what was needed for a solution, and then develop a solution along the lines they had just worked out. Japanese children were the third best mathematics achievers out of 41 countries in the project, whereas the Germans reached the place 23 and the Americans place 28. Thus, learning based on principles of creativity such as problem recognition, solution construction, transfer to new settings, and the like, is not anti-achievement but, in fact, facilitates academic performance.

The Grading Problem

This does not mean, however, that there are no difficulties associated with the implementation of such teaching. The problem on which we will concentrate here is that of assessment/grading. The specific problem is that in the case of traditional material, teachers can say in advance what should be reproduced in assignments, and indicate clearly and concretely in their grading when and where such material is missing or

is incorrect. The necessary knowledge and skills that have been specified in advance can be acquired by diligent learning and practice, and can be checked out in practice runs. The core of creativity, however, is novelty: Students cannot locate existing solutions on the internet and check them out with their teachers, since they would cease to be novel as soon as they were posted on the worldwide web!

The whole thrust of the way assignments are set and graded and results communicated is based on the idea that there is a set of body material, and that answers in an assignment can be compared with this and found to be either "correct" or "incorrect."

The heart of the matter is specific, concrete information and objective correctness/incorrectness. Creativity, on the other hand, emphasizes novelty, ambiguity, uncertainty, and the like. Not only do teachers and students dislike this, but also it raises the risk of *disagreement over the value of answers* (if they are not correct/incorrect, how is one better than another?), *subjectiveness* (are differences in answers dependent more upon the knowledge, beliefs and values of a particular assessor than on some objective criteria), and *arbitrariness* (are grades affected by whims, changing moods, short-term fads, etc?).

Recent years have seen an increasing tendency in a number of countries for parents and students to demand reassurance on such matters, even by resorting to litigation! Thus, in urging teachers to foster creativity in the classroom, educational theorists need to look at the issue of grading, especially how to set and grade assignments in ways that emphasize creativity, and to do this using concepts that can be taught to students, and indicators that can be recognized by people other than the grader. Such an assessment system should also offer feedback on the nature of strengths and weaknesses and necessary changes resulting from these (i.e., be formative as well as summative).

It is often assumed, however, that evaluation is inherently inimical to creativity. Amabile's research (e.g., 1996) is frequently taken to have established that extrinsic rewards inhibit creativity and thus to have shown that grades (since they are given by the teacher, not by students themselves, and are thus extrinsic) are bad for creativity. However, Eisenberger and Armeli (1997) showed that the giving of grades can

promote creativity, even in such intrinsically "creative" areas as music, provided that:

(a) instructors know what it is that they are trying to promote and
(b) students know what it is that they are expected to do differently in order to be creative.

This means that the extrinsic assessment should contain a strong element of *information*, not simply an indication of approval or disapproval, and that this information should be as differentiated as possible.

Although it must be admitted that the area of the effects of external evaluation is still beset by differences of opinion (e.g., Joussemet and Koestner, 1999), what seems to be important for teachers is that they are familiar with what it is that they want students to do in assignments and that they can

(a) recognize aspects of students' work that can be said to be "creative,"
(b) identify these for students in an understandable and concrete way,
(c) show them where they have fallen down, and
(d) give guidelines on how to do better.

We will move now to a discussion of how to do these things.

What is Creativity?

The first task in working out a system of external evaluation to foster creativity requires a statement of what is meant by "creativity." We will focus on what Cropley and Cropley (2005) called "functional creativity", and to avoid an excessively broad discussion we will restrict ourselves to creativity of school assignments. We see these as *products* constructed in response to specifications laid down by a teacher. Thus, the key question is: How do we recognize the creativity of products? In the last 40 years, products have not received as much attention in discussions of creativity as might be expected, perhaps because modern research has been dominated by psychologists and educators, who are often more interested in process or person.

Some writers have even concluded that it is too difficult to define creative products in a practical, objective way, because the concept is so subjective, and have recommended focusing instead on creative *processes* and characteristics of the creative *person*. However, MacKinnon (1978, p. 187) concluded that "analysis of creative products" is "the bedrock of all studies of creativity," and Bailin (1988) criticized the tendency to look at creativity purely in terms of psychological processes as "misleading" and "dangerous." Indeed, we will show below that the creativity of products is not as diffuse a concept as might at first appear to be the case.

The Fundamental Criteria of the Creativity of Products

It seems more or less self-evident that the first characteristic of a creative product is *novelty*—creativity always leads to something new. Despite its importance, however, novelty is not sufficient on its own. If it were, every crazy idea or absurd suggestion would be creative. Amabile and Tighe (1993, p.9) emphasized that products must be "appropriate," "correct," "useful," or "valuable." Thus, creative products must not only be novel, but must also do what they were designed for: They must be *relevant* and *effective*. Cattell and Butcher (1968, p. 271) popularized the term "pseudo-creativity" to refer to variability whose novelty derives only from non-conformity, lack of discipline, blind rejection of what already exists, and simply letting oneself go. To this can be added "quasi-creativity" (Cropley, 1997, p. 89, translating Heinelt, 1974), which has many of the elements of genuine creativity—such as a high level of fantasy—but only a tenuous connection with reality. An example would be the novelty generated in daydreams. Other writers also emphasized the importance of distinguishing between relevant and effective creativity and mere facileness, glibness or slickness. These may be observed in some genuinely creative people and thus confused with creativity, but they are not actually part of it.

The order of these criteria is not arbitrary: Although novelty seems intuitively to take precedence over effectiveness, our view is that there can be no discussion of creativity without first dealing with the issue of effectiveness. To take a simple example, a bridge must first solve

the problem of getting traffic across a river. If it does not do what the engineers were hired to build it for, it is a bad product, no matter how beautiful or how surprising it is. Even in artistic domains effectiveness is important. Vincent Van Gogh lacked technical skill in painting, and had to return at the age of 32 to the Academy of Art in Antwerp, where he learned techniques for expressing his flair for colour and light in an effective way. He did not have to learn how to generate novelty, but how to communicate it effectively to others.

At the level of school assignments, products (responses to assignments) must deal in a relevant and effective way with the task set by the teacher: In the example of the essay on Sir Walter Scott given above, the children had to write about Scott's work, not for instance that of some other author. An essay about Wordsworth would not have displayed *relevance*, no matter how good! They also had to focus on historical aspects of Scott's novels, not let us say, their descriptions of the countryside, and argue cogently and convincingly (*effectiveness*). It hardly seems likely that a student could do this without *knowledge* not only of the writings of Sir Walter Scott, but also of the historical facts of incidents mentioned in Scott's novels, thus emphasizing the importance of knowledge in achieving relevance and effectiveness. However, a major additional task is that of organizing the knowledge, seeing connections, assessing and evaluating, coming up with novel points of view, and so on. Criteria for assessing such aspects of an assignment are discussed in the following section.

Further Criteria of the Creativity of Products

We propose two additional criteria of the creativity of products.

Elegance: Einstein argued that it is not difficult to find novel solutions to problems: The difficult part is finding solutions that are *elegant* (Miller, 1992). Grudin (1990) reinforced this idea when he referred to "the *grace* of great things [our italics]". Such solutions not infrequently cause a more or less instantaneous "shock of recognition" when they occur, and provoke a "Why didn't I think of that?" reaction. Indeed, an elegant solution may look so simple and obvious—after the fact—that viewers may underrate its creativity or denigrate it as "banal".

Generalizability: In 1605 Francis Bacon developed a binary cipher using only "five bit" combinations of the letters a and b, thus showing that complex messages could be represented without loss of information, using only two values. Gottfried Leibnitz built on this to invent the binary number system late in the same century. The two could scarcely have conceived of modern computers, but they laid the foundation for modern digital computing. This is a dramatic example of *generalizability*".

The special quality of generalizable novelty is that it not only offers new possibilities for the situation for which the novelty was generated, but also

1. is applicable in other apparently unrelated situations (i.e., it is *transferable* to other situations, whether or not the creative person intended this at the time);
2. introduces a new way of conceptualizing a whole area, or opens up new approaches to existing problems, possibly in many areas (i.e., it is *germinal*);
3. demonstrates the existence of previously unnoticed problems and suggests the need for new work (i.e. it is seminal);
   lays a foundation for later innovations for which the original novelty is necessary, although the original innovator may have had no idea of the future innovation (i.e., it is *foundational*).

The Hierarchical Organization of Creative Products

One way of classifying products is to use the four dimensions just listed to arrange them in a hierarchy ranging from the "routine" product (characterized by effectiveness alone) at one pole to the "innovative" product (characterized by effectiveness, novelty, elegance and generalizability) at the other, with "original" and "elegant" products between these poles. This relationship is shown in Table 12.1, where a plus sign means that a property is necessary for this kind of product, a minus sign that it is not. The schematic in Table 12.1 can also be used to demonstrate the position of pseudo- and quasi-creativity, where the only *necessary* property of products seems to be novelty. The table shows that each product higher in the hierarchy incorporates all the

Table 12.1.   The hierarchical organization of products.

Criterion	Kind of Product				
	Routine	Original	Elegant	Innovative	Pseudo-/quasi-creativity
Effectiveness	+	+	+	+	?
Novelty	−	+	+	+	+
Elegance	−	−	+	+	?
Generalizability	−	−	−	+	?

properties of products at lower levels, but adds something to them. According to our criteria, routine products are not creative, because the second necessary criterion (novelty) is missing. This does not mean, however, that such products are useless.

The hierarchical organization of products shown in Table 12.1 introduces an important principle into the discussion of assessing creativity: Creativity is not an all-or-nothing quality of a product, but there are both *levels* (quantitative criterion) and *kinds* (qualitative criterion) of creativity. It is not something that products either have or do not have. Different products can have creativity to greater or lesser degrees, or they can display different kinds of it. We have already suggested different labels for various *kinds* of creativity ("original," "elegant," "innovative"), while the hierarchical organization of these kinds of creativity means that there are also *levels* of creativity (innovative is more creative than elegant, while elegant is more creative than original).

The Importance of Existing Knowledge in Creativity

Although some writers (e.g., Hausman, 1984) have argued that true creativity is always so novel that it is *unprecedented*, and thus has no connection to anything that went before, others such as Bailin (1988) have concluded that creative products are always conceived by both the creative person and external observers in terms of existing knowledge. Indeed, it is clear (see also below) that many novel ideas are based on

what already exists, even if existing knowledge is transferred to a field quite different from the one in which it is already known.

Even many of the innovations introduced by America's most distinguished inventor, Thomas Alva Edison, were improvements on existing technology or ideas. Edison worked with a large staff of engineers and technicians who constantly improved their own existing ideas: For instance, over the course of time they took out more than 100 patents for the electric light bulb alone. Indeed, the Canadian Intellectual Property Office reported (http://strategis.gc.ca/sc_mrksv/cipo/patents/pat_gd_protect-e.html#sec2) that 90% of new patents are improvements of existing patents. In an aphorism that was printed in *Harper's Monthly* in 1932, Edison concluded that "genius is 1% inspiration, 99% perspiration," thus coming down squarely on the side of convergent thinking.

A further example from a more "artistic" field is also useful here: Much of Coleridge's exotic imagery in *The Rime of the Ancient Mariner* is taken from ideas he found in the course of his wide and eclectic reading. He did not invent the ideas, so to speak from nowhere, but adapted existing images to suit his new purpose, the writing of the poem. Weisberg (2003) showed that even an extraordinarily radical product such as Picasso's *Les demoiselles d'Avignon* arose out of what Picasso had experienced up until the time he painted it. Thus, there is a link between novelty and the already known, even in artistic/aesthetic fields.

Lubart (2000–2001) expressed the link between knowledge and creativity in a homely but convincing way: He suggested that there may well be no difference between the *processes* of divergent and convergent thinking, but that differences in outcome may depend instead on " … the quality of the material (e.g., knowledge) (p. 301)". Lubart extended this thought with the concrete metaphor: "The engine is the same, but some people use better grade fuel (p. 301)." Those who have only limited or narrow knowledge (the poorer grade of fuel) would not be able to combine ideas, make unexpected associations between pieces of knowledge, or synthesize apparently unrelated facts, since they would not possess the ideas, knowledge or facts upon which to operate.

Scott (1999) listed a number of creativity researchers who all give a prominent place to knowledge in creativity (e.g., Campbell, Wallas, Mednick, Chi, Weisberg, Amabile, Simonton, Albert, and Gruber). Ericsson and Lehmann (1999, p. 706) summarized the link between knowledge and creativity by concluding that:

> … the empirical evidence on creative achievement shows that individuals have not been able to make generally recognized creative contributions to a domain unless they had mastered the relevant knowledge and skills in the course of a long preparatory period

They repeated (1999, p. 700) the idea that there is a "10 year rule": An apprenticeship of at least 10 years is necessary for acquiring the fund of knowledge and skills necessary for creativity.

Indicators of Creativity

In his "propulsion" model, Sternberg (1999) turned to the question of the processes through which existing knowledge is used to produce creativity. He introduced the useful idea of creativity as "propelling a field (p. 83)," and suggested a number of ways in which this can occur: These include *conceptual replication* (the known is transferred to a news setting), *redefinition* (the known is seen in a new way), *incrementation* (the known is extended), *redirection*, *reconstruction*, and *reinitiation*. Of these, only the last involves something quite new. All the others are based on modifying what already exists. Savransky (2000) also discussed the processes through which existing knowledge is used to develop effective novelty: He argued that inventive solutions to problems always involve a change in what already exists. He discerned six ways in which this can occur, including, slightly modified for present purposes, *improvement*, *diagnostics*, *synthesis*, and *genesis*. (This list is incomplete and focuses on elements that are of direct interest here.) As was the case with Sternberg's list, only the last of these involves something fundamentally new.

Psychologists have developed instruments based on ratings for systematically (but not objectively, it must be admitted) determining

the creativity of products. An early example is Taylor's (1975) *Creative Product Inventory*, which measures the dimensions Generation, Reformulation, Originality, Relevancy, Hedonics, Complexity, and Condensation. The criterion of hedonics raises an interesting issue: It is reminiscent of Jackson and Messick's (1965) very early distinction between *external* criteria of the effectiveness of a novel product (i.e., does it work?) and *internal* criteria such as logic, harmony among the elements of the product, and pleasingness (i.e., is it beautiful?). Taylor thus added to the definition of the functional creativity of solutions what are to some extent *aesthetic* criteria. More recently, Besemer and O'Quin (1987) developed the *Creative Product Semantic Scale*, which is based on three dimensions: Novelty (the product is original, surprising and germinal), Resolution (the product is valuable, logical, useful, and understandable), and Elaboration and Synthesis (the product is organic, elegant, complex, and well-crafted).

It is true that the criteria mentioned above, such as surprisingness, complexity or germinality, seem to be highly intuitive or subjective, but psychological research has shown that even untrained judges, working without knowledge of what other judges are saying, can reach much the same conclusions about the prominence of many of the criteria in a solution (inter-rater reliability), and can do this in a consistent (reliable) way, making similar ratings if they are asked to re-rate the same products at a later date. Hennessey (1994) reported inter-rater agreement ranging up to 0.93 even among untrained undergraduates who rated geometric designs or Picasso drawings on Creativity of Product and Creativity of Process on a 7-point scale, simply applying their own subjective understanding of these qualities. Internal reliabilities of the ratings of creativity ranged from 0.73 to 0.93 and level of inter-rater agreement was up to 0.93. Vosburg (1998) reported that untrained judges who rated products on 7-point scales such as "Very complex—"Not at all complex" or "Very understandable"—"Not at all understandable" achieved inter-rater reliabilities of about 0.90. In other words, people have a common and reliable understanding of novelty, complexity, elegance, and the like, can recognize them when they see them, and can express their judgments of the level of the characteristics in a quantifiable way.

Assessing Creativity

Cropley (2005) mapped indicators such as incrementation, diagnostics, or complexity (see above) onto the four criteria developed by Cropley and Cropley (2005), and used this to develop guidelines for grading assignments in a way that encourages creativity. These can be used for assessing both the *amount* of creativity and also the *kind* (i.e., both quantitatively and also qualitatively). The criteria are shown in Table 12.2. The rows in the tables (relevance and effectiveness, novelty, elegance, generalizability) are derived from Table 12.1 (see above). The columns represent a progression from more general, abstract *criteria* to increasingly specific and concrete *indicators*. These guidelines and criteria are not meant to be treated as exhaustive, but only as an indication of what is needed and a first step towards establishing concrete indicators.

Table 12.2. Guidelines for assessing the creativity of solutions.

Principle	Kind of solution	Criterion	Indicator
Relevance and Effectiveness	routine solution	Satisfying requirements in the problem statement	• *correctness* (solution accurately reflects conventional knowledge and/or techniques) • *effectiveness* (solution does what it is supposed to) • *appropriateness* (solution fits within task constraints)
Novelty	original solution	Problematization	• *diagnosis* (solution draws attention to shortcomings in what already exists) • *prescription* (solution indicates how what already exists could be improved) • *prognosis* (solution indicates likely effects of changes)

(Continued)

Table 12.2.   *(Continued)*

Principle	Kind of Solution	Criterion	Indicator
		Adding to existing knowledge	• *replication* (the known is transferred to a new setting) • *redefinition* (the known is seen or used in a new way) • *combination* (generation of new mixtures of existing elements); • *incrementation* (the known is extended in an existing direction) • *reconstruction* (an approach previously abandoned is shown to be useful)
		Developing new knowledge	• *redirection* (the known is extended in a new direction) • *reinitiation* (solution indicates a radically new approach) • *generation* (construction of fundamentally new—but at least potentially effective—solutions)
Elegance	elegant solution	External elegance: Effect on other people	• *recognition* (the beholder sees at once that the solution has something) • *convincingness* (the beholder is convinced by the solution) • *pleasingness* (the beholder finds the solution "beautiful")
		Internal elegance: Ideas are well-worked out and hang together	• *completeness* (the solution is well-worked out and rounded, not just fragmentary) • *harmoniousness* (elements of the solution fit together in an internally consistent way)

(Continued)

Table 12.2.   *(Continued)*

Principle	Kind of Solution	Criterion	Indicator
Generalizability	generalizable solution	Ideas go beyond the immediate problem	• *foundationality* (solution lays down a general basis for further work) • *transferability* (solution offers ideas for other, apparently unrelated problems) • *germinality* (solution suggests new ways of looking at existing issues or problems) • *seminality* (solution draws attention to previously unnoticed problems)

Applying the Indicators to Rating Assignments

This list of indicators can be used as a checklist for rating assignments. In the simplest application, each indicator can be checked as either present or absent, the product receiving one point if an indicator is present, zero points of it is not. This yields a maximum score of 23 points, 3 for relevance and effectiveness, 11 for novelty, 5 for elegance and 4 for generalizability. Of course the indicators could be weighted, for instance to give more recognition to knowledge (relevance and effectiveness) or more to elegance, and so on. We have so far used the checklist, which we refer to as the "Creativity Assessment Scale," as a simple "Present/Absent" = 1/0 points scale.

The Creativity Assessment Scale was tried out in a small study in which it was used by 13 schoolteachers (9 women and 4 men) with a wide age range (20–50) to rate two models built by students (details of these models are to be found in Cropley, 2005). The mean score for the more obviously "routine" model was 11.50 (SD = 2.87) and for the intuitively more "creative" one 16.07 (SD = 2.25). These scores correspond closely to our own ratings made prior to meeting the teachers: We gave the routine model 11 points and the creative

one 17. Thus, the teachers' ratings agreed very well with what might loosely be called "expert ratings," which supports the validity of their assessment: After a two-hour training session, the teachers rated the models a second time, and 8 of 13 (about 60%) gave the creative model a *reduced* score (4 increased, 1 unchanged), while 5 (around 40%) *increased* their rating of the routine model (6 decreased, 2 unchanged).

These changes in ratings resulted from the fact that a number of the teachers gave the more obviously creative model a very high score on the first rating, because if its sheer surprisingness, but were more differentiated in their assessment once they had used the grading system. For instance, although this model was surprising and contained some generalizable novelty, it was crudely constructed and in essence unfinished (i.e., there were defects in the area of elegance), and the teachers could now recognize and discuss these, reducing the grade accordingly. The routine model was very well finished (elegant) and highly effective in doing what it was supposed to do, but it lacked novelty and generalizability. The teachers were able to pinpoint both its strengths and its weaknesses and use these to indicate what needed to be done to make the model more creative.

This grading system was used (in an early form) by Cropley and Cropley (2000) in a university level engineering class. Students could be given differentiated and relatively objective feedback of both quantitative and qualitative nature on their assignments (i.e. an overall grade and also guidelines on how to improve their work). They were able to make sense of this feedback and see what the instructors were trying to teach them, i.e., students' acceptance was high. The transparency of the indicators was enhanced by the fact that instruction in the class in question had introduced numerous case studies and concrete examples of *prognosis*, *reconstruction*, *foundationality*, and the like. Although the use of the instrument in Table 12.2 is in its infancy, we believe that it can be applied by teachers at all levels and in all disciplines, adapted as necessary.

It is most obviously useful, however, when used with an altered approach to *setting* assignments, which Cropley (2005) called "underdefinition": The "new" kind of English assignment (new for 1904) for

writing about the work of Sir Walter Scott is a step in the direction of under-defined assignments. The setting of assignments (as against their grading) is discussed more fully in Cropley (2005) and Cropley and Cropley (in press). Finally, setting under-defined assignments and grading them on the basis of the creativity indicators listed in Table 12.2 (or similar properties) helps deal with what many teachers are increasingly experiencing as a problem in the area of assessment: plagiarism, especially copying factual material from the internet. It is easy to find facts on the internet but not easy to find pre-existing applications of these facts to generate relevant and effective, elegant, and generalizable novelty in response to under-defined problem statements. The link among assessment procedures, instructional content and methods, and day-to-day problems such as cheating emphasizes that fostering creativity in schools requires a comprehensive approach in which all aspects of education need to be considered, not just an hour a week of creativity training.

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Possibility Thinking in the Early Years and Primary Classroom

Anna Craft

Introduction

Creativity in Education Policy

Since the late 1990s, creativity in education has been recognized as increasingly significant by policy makers in many parts of the world. Attention and resource is being given to this aspect of children's learning (Jeffrey and Craft, 2001; Craft, 2002, 2005) in learning contexts both within and beyond schools. This wave of interest is set firmly in the context of economic and cultural development (Bentley, 1998, Jeffery, 2005, Seltzer and Bentley, 1999), setting it aside from previous periods of attention paid to creativity in education (Craft, 2002). Current policy perspectives on creativity see it as developing hand in hand with cultural development, both feeding from, and helping develop, the economy. The case is made explicitly in policy initiatives in many parts of the world, including Australia (Australia Council for the Arts, 2005), Canada (as discussed by Woods, 2002), the Far East (Hong Kong and China are discussed by Cheng, 2004a, b; Cheng and Chan, 2002, Singapore by Tan, 2004, the far East and Pacific Rim by Fryer, 2003; Hill, 2006; Lau, Hui and Ng, 2005; Ng, 2003). More recently in the popular press, Friedman, 2006, compares policy makers' concerns in China and India with regard to their capacity to maintain boom/expansion in their economies. Concern is equally intense in the United States (Education Commission of the States, 2005) Northern, Southern, and Central Europe (International Federation of Arts Council and Culture Agencies, 2005) and the Middle East, for example,

Qatar (Supreme Council of Information and Communication Technology, 2006).

In England, the 1997 White Paper, *Excellence in Schools* (Department for Education and Employment, DFEE, 1997) focused on preparing young people 'successfully for the 21st century' by recognizing the different talents of all people. This position was extended by the work of the National Advisory Committee for Creative and Cultural Education (NACCCE, 1999) which talked of the need to provide young people with skills and approaches required by employers. The report acknowledged that alongside high standards of academic achievement, employers now required 'people who can adapt, see connections, innovate, communicate, and work with others' (National Advisory Committee on Creative Education, NACCCE, 1999, p. 13).

Significantly, the NACCCE Report brought together educational and cultural policy-making in the context of learning and indeed brought together two government departments: the Department for Education and Skills (DfES), and the Department for Culture, Media and Sport (DCMS). Whilst the two arenas are related, they clearly are subtly different in their purposes and their goals. Yet, proposals in the NACCCE Report can be seen as having provided a foundation for other, more recent, educational policy moves in UK, many of which have been implemented. These include:

— Structural changes, such as the funding of specialist schools from the mid 1990s as documented by both the Department for Education and Skills and the Specialist Schools' Trust, itself established in 1987 (Specialist Schools' Trust, 2006, DfES, 2006).
— The funding of creativity-focused initiatives, such as two generously funded national programmes, Creative Partnerships (Creative Partnerships, 2006a) and Creative Action Research Awards (Creative Partnerships, 2006b).
— Shifts in the wider policy agenda, such as the introduction of *Every Child Matters* from 2003 (Every Child Matters, 2003, 2005)—a government initiative designed to ensure the well-being of children and young people from birth to age 19, by supporting the development of resilience and resourcefulness (Craft, 2005).

— Focused engagement by policy makers and policy advisers, such as the establishment of The Qualifications and Curriculum Authority Creativity Project (QCA 2005a, b), followed by a curriculum review for 11–19 year olds, also the publishing by DfES of the booklet, *Excellence and Enjoyment*, for primary schools, in May 2003 (DfES, 2003), exhorting primary schools to take creative and innovative approaches to the curriculum and to place creativity high on their agendas, followed by materials (DfES, 2004) to encourage this. In late 2005 and early 2006, a further government review of creativity and the economy was undertaken.

— Curriculum change. From early 2000s onward, increasing attention was paid to creativity in the curriculum. The introduction of Creative Development into the early years curriculum for 3–5 year olds in 2000, and the codifying of creative thinking skills in the national curriculum for 5–16 year olds, was followed from 2005 by at least two key reviews. These included a complete review of the curriculum for 0–5 year olds (due to open for consultation at the time of writing—April, 2006), proposing a seamless care and education policy in which creativity was to play a key role, also recommendations on the 11–19 curriculum, being considered by government ministers in the Spring of 2006.

— Engagement by national leadership bodies, such as the National College for School Leadership, through a series of Leading Edge Creativity seminars from 2002 onward, and ongoing work on projects exploring the nature of leadership for creativity and creativity for learning in schools (National College for School Leadership, NCSL 2006).

— Engagement of the education inspectorate with creativity, such as the interest taken in creativity by the national schools inspection service, OFSTED (2003a, 2003b), in the early years of the 21st century prompted by government and summarized by the (then) Secretary of State for Education, in declaring 'Inspection should value innovation ... we want to encourage creativity and new approaches to learning. Not all innovations will be successful and it is very important not to penalise schools for taking a risk with a particular innovation' (Clarke, 2002, p. 5).

It has been argued that the swing in policy to include creativity in the spotlight represents a contrast with former (and continuing) audit-culture, performative policies, which imbue low-trust in professional judgment, in favor of technician-oriented pedagogies and technicist-oriented curricula (Ball, 2003; Boyd, 2005; Jeffrey and Woods, 1998, 2003). The contrast is such that as Boyd (2005) notes, some practitioners find themselves 'frozen' as if blinded by the headlights, unsure whether the changed values of empowerment, agency, engagement, and generativity are real or imagined, to be short-lived or long-standing. Some commentators (e.g., Maisuria, 2005) emphasize the almost impossible tension with which teachers in UK live, being encouraged on the one hand to innovate, take risks and foster creativity, and on the other being highly accountable, and subject to a powerful performative evaluation culture played out through the publication of school league tables based on national assessment data, alongside inspection and performance-related career progression. Nevertheless, there is evidence that many classroom practitioners—and creative partners from the creative and cultural sector—are inspired by the changing landscape to emphasize the fostering of creativity in the children that they teach (Jeffrey and Woods, 2003; Arts Council and CapeUK, 2005; Jeffery, 2005).

These wide ranging policy initiatives have focused on all phases of education from the early years through to higher education. And yet, common across them is the commitment to what I have called 'little c' creativity (Craft, 2000, 2001, 2002), i.e., everyday, lifewide creativity as well as the creativity inherent within domains studied as subjects in schools. There is a democratic assumption built in to much of the policy work stemming from the NACCCE Report (1999), in suggesting that everyone can be creative in multiple domains at an everyday level, if nurtured and encouraged to be so. It is suggested that we are all capable of creative engagement, and that all subjects learned in the classroom involve elements of creativity, in bringing imagination to shape and produce outcomes that are original and of value, according to appropriate judges.

Scope

This chapter introduces the notion of "possibility thinking" as at the heart of everyday, lifewide creativity (Craft, 2000, 2001, 2002; Jeffrey and Craft, 2004), relevant across the curriculum. Drawing on conceptual and empirical work undertaken over the last 10 years mainly in UK, the chapter offers both a rationale and practical classroom implications for early years and primary practitioners committed to fostering learner creativity. Involving the finding and solving of problems (Jeffrey, 2004, 2005), questions are also raised about the possible cultural boundaries to "possibility thinking".

Possibility at the Heart of Creativity

Against this increasing activity and concern for creativity from the early years onward, I have been asking questions over the last 10 years or so, around what, if anything is the common thread between domains and phases of learning, where creativity is concerned. In response to these questions, I have argued 'possibility thinking' is the common core, between these domains, the means by which questions are posed or puzzles surfaced, through multiple manifestations of 'what if?' (Craft, 2000, 2001, 2002).

'What if?' may be posed as a conscious question or may be experienced much more unconsciously in the flow of engagement, and possibility thinking is as vital to 'high c' creativity (for example, in the work of a choreographer, or the creative engagement of a physicist) as it is at the other end of the spectrum, 'little c' (for example, in a 5-year-old working out how to make exactly the color of paint that they are seeking, or an adult working out how to make a meal from an unexpectedly limited number of ingredients).

My conceptual work on the role of possibility thinking in 'little c' creativity (for example, Craft, 2000, 2001) has been validated through empirical studies of possibility thinking in early years and primary classrooms, in a variety of subject domains (Burnard, Craft and Grainger, 2006; Craft, Burnard and Grainger, 2005; Grainger, Burnard and Graft, in preparation; Jeffrey and Craft, 2004).

Implicit within possibility thinking, is a shift from recognition—i.e., 'what is this?' to exploration—i.e., 'what can I do with this?' It involves the finding and honing of problems as well as the solving of them, a conceptual distinction explored and validated through empirical work in primary classrooms (Jeffrey, 2004, 2005, Jeffrey and Craft, 2004).

A Dynamic Interplay between Children and Teachers

Building on early conceptual work (Craft, 2001, 2002), a recent qualitative study on possibility thinking in a small number of classrooms in UK with children aged 3–7 (Burnard, Craft and Grainger, In Press; Craft, Burnard and Grainger, 2005), has documented a dynamic interplay between learners and teachers, within a richly enabling context.

Working collaboratively to with teaching staff in three separate settings to investigate both their pedagogic practices and children's learning, the research team has identified a number of distinct but interlinked core features[1] of learners' and teachers' engagement are valued and fostered, as follows.

- Posing questions—the team documented both audible and inaudible questions. Many in the latter category are surfaced through close observation of the behaviors of young children together with a concerned, deep knowledge of each as an individual. Teachers of young children in these settings frequently modelled genuine audible enquiry, with the explicit intention of developing the children's self-determination. Children's questions were treated with respect and interest by these professionals. In our data, multiple examples were recorded of unusual questions arising from children, and being

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[1] Thanks are due to my research partners in this project, Teresa Grainger (Canterbury Christ Church University and Pamela Burnard (Cambridge University), as well as Susanne Jasilek, Consultant Researcher to the Open University, Anne Meredith, Consultant Researcher to the Open University, Bernadette Duffy and Ruth Hanson Thomas Coram Early Childhood Centre, London, Jean Keene and Lindsay Haynes Cunningham Hill Infant school, Hertfordshire, Dawn Burns Hackleton Primary School, Northamptonshire, for their contribution to the analysis summarized here.

celebrated by staff and by other learners. Posing questions sometimes incorporated 'as if' (imaginative) thinking. In addition, the posing of questions, in an 'as if' space, were evidenced, in particular during children's play and playfulness, through children making connections through prediction, compensation, improvisation and testing. The posing of questions as well as the solving of them, is highlighted also in the empirical work of Jeffrey (2004, 2005), studying children in primary schools.

- Play—children in these settings were offered opportunities to play for extended periods of time in particular activities. Such opportunities were returned to and revisited frequently. The provision of extended time allowed children's ideas to incubate and allowed questions to merge through their playful encounters with each other and with the available materials. Motivated by their own knowledge and interests, and supported by the space and scope offered for exploration, children often traveled far in their play. They were often observed as being, as Vygotsky might say, 'a head taller than themselves' (Vygotsky, 1978), as in playful situations they extended boundaries and stepped into un-charted waters with high engagement, interest, and motivation. Such creative play was paradoxically often very serious. It arose from social interaction and engagement with ideas and experience within a generative, problem-solving and imaginatively involving context. Their affective engagement in this 'third area', as Winnicott (1974) calls the deep play of childhood, the engagement in a 'potential space', was rooted in the body and the senses, prompting an openness to learning which their teachers built upon.[2]

- Immersion—the children's immersion in a 'benign environment' seemed particularly significant in each of the settings studied, especially where fostering creativity was concerned. As writers within the psychoanalytic tradition (Freud, 1914; Winnicott, 1974) have noted, allowing ideas to come spontaneously from inside exposes the child (and adults too) to levels of insecurity and possible anxiety

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[2]Grateful thanks to John Keene for his insights into Winnicott's analysis.

in the moment of encounter with something new, so that particular care has to be taken to make the situation as free from criticism and mockery as possible.[3] The provision of a caring, positive, and benign environment in each classroom studied was an intentional element of pedagogy.

- Innovation—children in these three settings were strongly encouraged to engage in making connections between ideas in their own ways, often through playful engagement, and in so doing, to construct knowledge of their own. Their teachers observed closely the innovations in each child's thinking, evidenced through their talk and behaviors, offering provocations to stimulate the children's connection-making and making opportunities to probe and explore children's growing understandings.

- Being imaginative—both imagining and being imaginative were evidenced extensively in these classrooms. Children imagined what might be, adopted roles and imagined world frames, often inventing imaginary worlds. Being imaginative in this way often enabled children to take a position as a decision-maker in a way that was perhaps not normally available to them in other kinds of classroom activity. Rather in being imaginative children were seen positioning themselves as decision-makers about the quality of ideas, content of their learning tasks, and ways of conducting them. Children melded their imagination with the curriculum content, thus creating their own entries into, experiences of, and possibilities of approaching, learning activities.

- Self-determination and risk-taking—children's deep involvement was encouraged, as was the taking of risks. In these open environments observed, where the indoors and the outdoors, and the school as a whole including its community, were seen as resources for learning, the children seemed to grow in confidence, developing both intellectual and physical ownership of the learning space. Children developed the courage to take risks, working in safe, secure and supportive environments in which they were

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[3]Again, with grateful thanks to John Keene for his insights on this point.

expected to exercise independence and agency in making decisions and where their contributions were manifestly valued. In each of these classrooms, the adults supporting children's learning sought to make learning from experience both empowering and generative, providing a safe, known and trusted environment—enabling children to move with confidence into original and creative spaces, and to take risks. An element of this was use of and conception of time. Each classroom practitioner worked to remove to an extent the time pressure, seeking not to rush children's engagement.

An Enabling Context within and Beyond the Setting

The study also highlighted the significance of the *enabling context* in the classroom setting and wider school environment. External and internal enabling factors clearly influenced and surrounded the playful endeavors of teachers and children and fostered the development of self confidence and self esteem. This facilitated young children in asking a variety of kinds of questions and developing their disposition to learn creatively, through possibility thinking (Burnard, Craft and Grainger, 2006).

Implications for Practitioners

The practices of children and teachers documented in the study described above, emphasize co-participative processes, involving deep respect for children's perspectives, which the practitioners in the study brought to fostering children's possibility thinking. The same qualities were also highlighted in a study of an internationally renowned first school in England, educating children aged 3–7 (Jeffrey and Craft, 2004). That study highlighted the degree to which children were offered opportunities to take control, and to act innovatively, so that children experienced ownership in their learning.

Fostering children's possibility thinking involves what has been called a 'learner inclusive' pedagogy (Craft, 2003a, b; Craft and Jeffrey, 2004). This involves the construction of a learning environment

appropriate to the children in it and where children are often included in determining what is discovered, investigated and valued. Their creativity is nurtured and developed through co-participative approaches to valuing the children's possibility thinking. Co-participative approaches as documented in the Reggio Emilia pre-schools of Northern Italy, enable children to be involved collaboratively, in relationship with both other children and adults working with them, in the sharing of and creation of knowledge (Jeffrey and Woods 2003; Woods and Jeffrey, 1996).

It has been argued that pedagogies which are learner-inclusive is important because as the child contributes to the uncovering of knowledge they take ownership of it and if control over the investigation of knowledge is handed back to the learner (Jeffrey and Craft, 2004) they have the opportunity and authority to be innovative. A learner-inclusive approach includes children in determining what is to be investigated, values their experiences, their imagination and their evaluation (Jeffrey, 2001). The provision of such a learner-inclusive context involves children experimenting and playing with ideas (Craft, 2002) and as children become more and more involved, the degree of inclusion increases.

In the possibility thinking study discussed above (Burnard, Craft and Grainger, in press; Craft, Burnard and Grainger, 2005), in which analysis is ongoing (Cremin *et al.*, 2006), pedagogical strategies included practitioners modeling possibility thinking, in an environment which fostered the teaching of independence, in a well-resourced indoor and outdoor space, where children had access to many simple and often inexpensive resources, and in a purposeful, engaged atmosphere. Children's curiosity and playful engagement was strongly encouraged by these practitioners, and children's ideas taken seriously. Children were offered sufficient time, control and negotiative opportunities with practitioners, to co-determine when their enquiries were complete. These practitioners were engaged in standing back, yet deeply and responsively engaged in the children's learning, responsive to their ideas, engaging in what Schon (1987) called reflection-in-action.

Possibility Thinking as Culturally Situated?

One feature of the international interest in creativity in education is the development of what has been called a 'universalized' language and rationale for it (Jeffrey and Craft, 2001). Creativity is called for in the context of liberal individualism closely tied to the marketplace (Craft, 2005) and in UK many reforms have been tied to the New Labour agenda of a Third Way which ties public and private enterprises more closely together than hitherto (Hill, 2006; Mulderrig, 2003). The form of creativity called for, then, is one that represents that political stance of liberal individualism. In other words, the discourse around creativity is one in which high value is placed on individuality and being open to thinking generatively outside of social and other norms. This point is made by several commentators in UK (Davis, 2000; Kimbell, 2000; Craft, 2005), some of whom have argued that this emphasis has impacted negatively on the nature of creativity fostered in classrooms. But even at this level of analysis to what extent we may be talking about different notions of what it means to be creative, depending on the broader socio-cultural context? For as Runco (2004) has argued in proposing his theory of personal creativity, definitions of 'appropriateness' vary across contexts.

'Thinking outside of the box' is a phrase frequently used at a lay level. As Ng (2001), writing in Singapore, has argued, creativity expressed as such suggests a form of individuated behavior. Essential to creativity is, he suggests, critical thinking, i.e., rejection of some sort of norm. And yet, perspectives on creativity differ, as highlighted also by Ng (2003), and Ng and Smith (2004), drawing on evidence from his own studies and those of others, to show that Eastern cultures in particular bring a different and contrasting perspective to the creativity discourse. This is echoed by the work of others (for example, Markus and Kitayama, 1991, 1994; Rudowicz, 2004). Lim (2004), discussing Ng's work, suggests 'the Asian view traditionally emphasizes control by the environment so that the individual adapts; the Western view emphasizes the individual so that the individual changes the environment' (Lim, 2004, p. 4). Lim also notes that in the Western model, there is a large emphasis on encouraging the individual to

'become themselves', where uniqueness is identified and celebrated. By contrast, and like Ng, he suggests that the traditional Eastern model is collectivist, and conformist, tending to weed out attributes which could prevent social cohesion and fitting in with the social group.

Ng's (2002) empirical work suggests that the teacher's attitude toward learners has an impact on their effectiveness in fostering creativity in the classroom, such that 'conservative-autocratic' teachers who expect obedience and respect rather than challenge from their students, and who see themselves as the ultimate authority, place little emphasis on developing students' individual autonomy. 'Creative' responses are punished and not rewarded. On the other hand 'liberal-democratic' teachers work from the assumption that their role is to help every child reach their inner potential, and thus encourage and reward creative behavior in the classroom. Ng's findings are paralleled by other studies undertaken both previously and since in India (Reddy and Latha, 2005; Sarsani and Hallam, 2005), India, Malaysia, the Philippines and Indonesia (Lau, Hui and Ng, 2004); and in China and England (Martin, Craft and Zhang, 2001; Martin, Craft and Tillema, 2002; Zhang *et al.*, 2004).

In parallel with the empirical work by Ng and others exploring East–West differences, it has been argued (Craft, 2003c, 2005, 2006) that the reification of the market (i.e., the Western capitalist model of 'market as God') pervades the universalised notions of creativity, which we see in the Western policy and research literatures, and may be inappropriate in terms of the values that it represents. Clearly values are culturally embedded. An approach to creativity which propagates lifestyles which rely on constant innovation and consumption, where obsolescence is built in at the design stage in many consumer goods, and where fashion dictates the need for constant updating, is both born of and contributes to, a global market economy, which, it could be argued, has little regard for possible differences in cultural and subcultural perspectives.

Such perspectives are also found in the work of Sen and Sharma (2004) who explored the perspectives of school teachers in India on creativity. Sen and Sharma (2004), also acknowledge the wider values context to creativity, i.e., that the Eastern view of creativity is

frequently seen as involving expression of 'inner essence or ultimate reality' (p. 153), 'a state of personal fulfillment, connection to the primordial realm . . . and spiritual and religious self-expression rather than an innovative solution to a problem'. This is also found by Sarsani and Hallam (2005), who report work on Indian teachers' views of creativity and how it can be developed, although it should also be acknowledged that creativity is still given low priority in Indian education (Reddy, 2005).

There are clearly potential pitfalls in assuming the notion of possibility thinking may be a culture-free notion. And, in a globalized world where acculturation occurs across national and cultural boundaries, we may find a mix of cultures within one setting. For example, within today's China, we can find evidence of more closed, conformist traditions where creativity may be more likely to be stifled, alongside a growing value placed on capitalism, with its demands for innovation, creativity and change, as argued (Craft, 2005; Lubart and Georgsdottir, 2004). Tan (2004) highlights the mix of ethnicities and religious belief-systems in Singapore at the turn of the 21st Century. Cheung et al (2004) report that we also may not always find what we expect as regards values, as two fairly recent large-scale far Eastern studies of attitudes to creativity demonstrate. The studies, by Berndt *et al.* (1993) and Cheung *et al.* (1992), conducted in Taiwan, mainland China and Hong Kong, revealed differences in adult attitudes toward creativity such that the least positive attitude was in fact demonstrated in Hong Kong. In India, Sen and Sharma (2004) also discuss the perspective advanced by Bharati (1985) that there is evidence among the Indian population of people being both the collectivist and individualist at the same time, acknowledging the dangers of over-simplifying cultural differences in a society which is itself plural, and made up of many sub-cultural groups.

To talk about possibility thinking without reference to the complexities of the cultural context in which it is elaborated and evidenced, may be then, problematic. And as to the implications of a universalized language for creativity in a culturally plural world, whereas one response would be to differentiate the conceptual frame by context (Craft, 2005); another, as acknowledged by Leung, Au and Leung (2004)

would be to adopt a universalized perspective as having greater 'usefulness or functionality ... for a modern, globalizing world' (p.127). However, Leung, Au and Leung (2004) also note that broad cultural differences may mean that 'elements that hinder creativity in the West may prove to be harmless in their effect on creativity in Chinese societies' (p. 127).

An important question for possibility thinking, is how appropriate is this concept in its explanatory power around children's generative engagements, and how culturally specific may the implications be for supporting the learning of children in early years and primary education?

Conclusion

In this chapter, the notion of possibility thinking has been explored with reference to early years and primary education, drawing on recent and current research seeking to document both children's learning and the pedagogies involved. Implications for practitioners have been discussed. Finally, and perhaps most significantly, questions have been raised about the possible cultural saturation of possibility thinking—sa question which should be addressed in further, culturally diverse, empirical work.

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Training Methods of Creative Learning and Practice

Horst Kasper

Introduction

This chapter presents a quest we asked about what makes learning more successful for our students. The quest began in the early 1980s, when we experienced in our schools children whose initial eagerness in learning began to lose. We started a search into means to supplement our system. We were keen to have ideas and options which would allow us to design effective lessons. Our search led us to examine among others themes such as motivation, stress relief, balanced diet and physical exercise, communication and co-operation among all people involved in learning. In particular, we focused on the relation between relaxation and learning, motivation and techniques that make learning enjoyable and efficient. These themes should be according to our view the core tasks in school. Our aim is to enable possibly all students in the author's school to graduate successfully. Our chapter outlines some examples of our attempts toward this goal.

Nurturing "Learning Teachers"

"*Mankind is continuously learning. We can't help it*!" (Manfred Spitzer). We learn continuously from the moment we are born. We believe that an infant experiences joy when s/he acquires new abilities such as standing, walking, and speaking. If s/he meets a supportive and caring teacher, s/he likely learns with interest to read, write, and to be with the world around him(her).

We discovered valuable elements that might support us to expand and continuously develop our educational system (i.e., components of education), which likely changed our educational practices. We think relaxation can be integrated into the lessons. Prior to tests, relaxation likely improves learning or increase the joy of learning.

We found out, for instance, that a relaxed learning environment likely work well for many children. When the methods of relaxation were introduced to teachers of our school, in a short period nearly 60 teachers displayed willingness to try them out, first for themselves and then together with the children. In this manner, teachers became "learning teachers."

Coincidently, the relaxation method, according to the teachers who engaged in it, had a positive effect on their health. In some of our classes, relaxation was taught to both students and the teacher. Children were showed how to do simple relaxation exercises any time, whenever they need. After learning children were independent from the instructor and teacher, they learned to manage agitation, and prevent themselves from experiencing stress. It is important for every child to experience and maintain calmness and to focus on learning.

Developing Positive Belief Systems in Teachers and Children

"*Whether you believe you can do a thing or not, you are right*" (Henry Ford). Our experiences showed that teachers, who had trust in their students' capacities to fulfill the requirements, indeed enhanced confidence in students' learning. We learned that more confident children likely face difficulties positively, hence, with joy. The following is a technique we recommended to these students: *Remember successful learning.*

> *Close your eyes and remember the time, when you were a small child. Remember, what it was like, when you managed to do something new. Maybe, when you could write your name for the first time or tie your shoelaces or swim. No matter, what it was. Make yourself aware. Do you feel the joy you had, when you succeeded, that great feeling? I can do it! Let yourself sink into this feeling and enjoy it…*

> *If you come back now into this room, you can keeps this feeling in mind. You can now resort to it at any time in future and say to yourself: I can do it!*
>
> *Open your eyes look around and be right here again.*

The "remember successful learning" is an exercise that should be accompanied by quiet, calm music (e.g., *Träumerei* [Dreaming] by Robert Schumann, *Liebestraum* [Love Dream] by Franz Liszt or *Thais* by Jules Massenet). First, try the "remember successful learning" as a teacher or in a group of like-minded group members. Then, assign one of the group members to be an instructor for other groups.

The "*remember successful learning*" is an example of creative work conducted by our teachers aiming to strengthen learning, motivation and self-confidence of children. You can find more examples on this subject matter in our handbook (Horst, 2006a).

Active Association

"*Help me, to do it myself!*" (Maria Montessori) Learning is not carried out by *instruction*, but by *construction*, i.e., construction of knowledge and abilities. Learning refers to mental and physical activities of the learner. Learning is not passive assimilation of information. Linking existing knowledge with new information is a conscious application of the ability to associate or active association (abbreviated ACT-ASS). The following represents some of the techniques used to enable active association:

- Create mnemonics
- Use rhythms as memory aids
- Link sounds and syllabli with images
- Combine reference numbers with images
- Loci technique
- Learning index cards

Details of the techniques are presented below.

Creating Mnemonics

Mnemonics are to network knowledge, which incorporate all possible stimuli: rhymes, rhythms, alliterations, initial letters, made-up words (from the initial letters of a mnemonic or multi-part terms), songs, attractions, figures, signs, and symbols. One suggestion to school leaders is to encourage teachers to collect mnemonics to be displayed in the teacher's lounge (Kasper, 2006b).

The most widely used mnemonics are probably the first-letter mnemonics. The first alphabet of each word in a meaningful phrase are used to a mnemonic for another word — such as "Every Good Boy Does Fine," for the names of the notes on the lines of the treble clef e-g-b-d-f. We can memorize a meaningful sentence much easier than single letters. Here is a suggested mnemonic for the list of planets of our solar system (Sun, Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto): "My Very Easy Mnemonic Just Summed Up Nine Planets" or "My Very Eager Mother Just Served Us Nine Pizzas". First letter mnemonics are effective recalling the *order* of well-recited items. Using a cueing strategy we are reminded of what we have known. Children are encouraged to create their own mnemonics. The *mnemonics brainstorming* can be introduced to the class. The benefit of this technique is the following:

- First, children learn to create their own "memory tool" to represent the new subject matter independently and autonomously.
- The intense search for a new mnemonic implies several incidental repetitions of the learning content.
- Fantasy is stimulated considerably, as mnemonics are of particular value if there is something special about them. Anything that is unique is likely to be memorized.
- Finally, examining facts with high intensity enhances memorizing and facilitating remembering, too.

Using Rhythms as Memory Aids

Active association, *ACT-ASS*, can help consolidate links of existing knowledge to new information. How can a child remember historical

facts such as when Columbus sailed to America? We might remember the event of discovery of America, when the narrative lesson spurred our fantasy. How can one remember the date of this event? The following rhyme can be helpful: "*In 1492, Columbus sailed the ocean blue.*" The fun of learning continues with further questions. Do you know the difference between stalagmites and stalactites? Which are the dripstones in stalactites caves? If you make a mental note of "Tits hang", this might be salacious, but you will never forget the difference again.

Linking Sounds and Syllabi with Images

The author once came across a newspaper report on the study of the happiest and saddest peoples in the world. It was reported that the inhabitants of the Pacific island *Vanuatu* ranked first. To memorize the word "*Vanuatu*", the following representations for the sounds and syllabi were employed:

Va reminds us of a *vase*,
Nu of a *canoe*,
A stands for *apple*, and
Tu is a *tuba*, a special trumpet.

In the report, the information on the contentment of the inhabitants of *Vanuatu* was positive: They were satisfied with very little. The association emerged from the above representations were a simple vase, a canoe, an apple, and a tuba which might be able to ensure satisfaction and hence happiness of the inhabitants of *Vanuatu*. Try and practice to create this kind of association. You might be able to memorize a few things a day. In this way you likely remember new terms, or even abstract terms. Repetition that link sound and syllabi with images can assist memorization. Recite the rhythm three times. Be aware of the act of reciting. Increase the number of times of recitation, when needed, for the following three days. In this manner the story of happy people in *Vanuatu* is remembered.

A suggestion for teachers is to pass the method of creating active association to students in lessons for any subject matter. Association using sounds might be of help for students to make their learning

more effective. Making associations to new knowledge likely creates an enjoyable atmosphere. Here is an example of how this technique is used to learn grammar:

The term *adjective* has got three syllabi:

ad – like addition in math's

jec – reminds us of a jet, an airplane that is circulating. That's why we exchange the t for a c.

tive – can be memorized by attentive.

An associative image can be the following: When we do additions in math I let a jet circulate in the classroom, which keeps everybody from being attentive.

Spelling is regarded as phonetic aids to one's memory. If we assign an image for every alphabet and practise it, children are likely to internalize the image associated with the alphabet. It is worthwhile an enterprise to look for image-related words at least for the 80 to 100 most frequently used syllabli. Image-related words likely engage our ability to retrieve analogous information. As such, learning is not only considerably facilitated by means of active association, but also active imagination.

Combining Reference Numbers and Images

Effective ways of processing information are for instance linking with existing knowledge structures and linking with mental images. To remember knowledge logically or in a sequence, the numerical series from one to 20 can be of help.

Number-Image-Series

The number series one to 10 seem to be less meaningful, if we just consider them plainly numbers. The numbers will change as soon as we link an image to each number. So, let us relate an image to each number. You are free to select any image for this series. As an example, you can apply the following number-image-series. If you decide to take over the entire series, then this will simplify things for you.

- For one, I imagine a modern street light. Its silhouette actually resembles the number one.
- The pair reminds me of the number two. I choose the shoe.
- The four leaf clover stands for the lucky number three.
- The cow stands on four legs. Its milk comes from four teats.
- My hand has got five fingers.
- The pig's ring-tail shape resembles the number six and a good luck pig might even let me win the pick six lotteries.
- The seven dwarfs from the fairy tale provide the symbol for the number seven, the dwarf.
- The eight oars, a racing shell symbolizes number eight.
- Nine bowling pins are required for this popular game.
- The arrow hits the bull's eye, the ten.
- Eleven players play football.
- The clock displays twelve hours.
- In America's skyscrapers there is no thirteenth floor in the lift.
- The Eiffel Tower symbolizes Paris. They celebrate their national holiday on the 14th of July.
- End of the 15th century, the letterpress was invented. The bible of Luther is the best-known book of the early times.
- The Teenager is 16.
- A popular card game is 17 and 4 (Blackjack).
- The ballot box is a symbol for the age of consent at 18.
- The driving school car stands for the driving license that someone has passed at the age of 19.
- The television symbolizes the 20-hour news.

The following are some of applications of this technique for any content knowledge one likes to keep in mind. This technique can be of help to remember a series of connected historical events which include the 12 countries of the European Union, the five classes of the vertebrates, a group of chemical elements, the nine planets, the states of Central America, the 10 highest mountains on earth, the four lobes of each hemisphere of the cerebral cortex and 10 commandments. The technique can be used to remember things one wants to do daily (without having to make notes), the seven, 15 or more things one wants to

buy, or the news broadcasted on TV. In fact, the technique can be taken as a tool to organize and memorize information relevant to us, a special form of *ACT-ASS*. The list of images is like a "card" with 20 elements in our mind, which can record any contents in a certain sequence, or like a cloth rail with twenty hangers.

Learn the list of twenty, first; then the "list with the lanterns": Which were the first five images? At this point, please take a piece of paper and try to remember the images without looking them up. Be calm (*Learn smart, not hard!*).

If this does not work well… maybe you could only remember two images… never mind! Look them up and take another blank sheet for the first five images. What was image number 6? … image number 7? … image number 8? … image number nine? … image number 10?

Repeat the first ten images once or twice, until you know them all by heart.

Continue with the next five images, until you have learned 15 images well. In the next step you proceed to learning the images 16–20.

This list is the basis for many learning processes. Therefore, repeat it until you can do it naturally.

One can practise the above technique with the radio news broadcasted every hour, i.e., TV news in prime time (15 or more minutes). For every piece of news, imagine the number-image in the correct sequence. Allow your mind to associate to each single image and to the news itself. Take a break immediately after the news. Try to remember every single piece of news with the appropriate image in the correct sequence (with 1st, 2nd, 3rd, etc.). You will require some attempts until you can remember all 10–15 messages. Recollect the sequence of the news once more before going to bed. Apply the above list to your daily shopping or to a book you read. Prepare a short presentation of the book and link the content to the images in your list.

Loci Technique

In ancient Greece savants made use of a special feature of the human mind, for memorizing details of a speech: the fantastic competence of orientation within a room. They linked the content of the speech with objects and specific points in their environment. Take any classroom and look around. Which objects are generally found there? Here is a possible list of objects:

- A pointer
- A blackboard
- A set square
- A cupboard
- An overhead projector
- A map stand
- A side-board
- A washbasin
- Chalk
- An eraser

The loci technique proposed by Staub (2006) can be introduced to children in the elementary schools to acquire a list with 100 images with the support of the teacher. According to Staub, every room in one's own flat or house is used to oriente 10 images started with the number 21. The first 20 images are provided by the "lantern-list" (Staub's called it a "tree-list"). For instance, one may take the bathroom (21–30), the kitchen (31–40), the living-room (41–50), the children's room (51–60), the parent's room (61–70) and so on. In a workshop, the classroom or any assigned room can be used to orientate the information. Staub also proposes the use of the body-list, which covers the numbers 91–100:

- Foot
- Knee
- Thigh (also trouser pocket)
- Hip (also hip pocket)
- Waist (also navel, belt)
- Breast (also heart)

- Shoulder
- Neck (also throat)
- Face
- Parting (also hair)

It might take several weeks, to acquire a good command of such a memory system and provide the appropriate image for every number from one to one hundred. Here is a basic guide accompanied learning:

- Learning requires some form of recitation up to for instance three times within minutes or can be up to an hour. Always ask: Am I doing it right? If not, simply recite the content again. Do positive talk! I know the content! I can learn it!
- Recite the contents the next day. Check again: Can I do it right? If necessary, recite another time.
- Further recitation within the first three days. Then the learned subject matter is likely better organized for a longer period of memorization. After one or two weeks of learning, an occasional spot test can be of help. Recite again, if necessary.

List of hundred in actions: If you have started, memorizing the daily information or subject matters by means of these hundred images, you can relate new resources to support your increasingly improving learning:

- For the PIN number, I relate (like Staub) two-digit figures to the appropriate images. By writing "scale" and "coffee machine" onto my bank card, I know exactly, to which the two numbers are referred. Some people do not need this form of support, as the images are present.
- Children at elementary schools learn the multiplication tables. It is fun to recall the image series any time by heart. Example of my personal row of four: cow — eight — clock — teenager — television — encyclopedia — palm tree — hatch — fridge — fume hood. You might notice that I must have been in the kitchen at the end. You can invent a short, imaginative story from each row.

- Historical dates and data are easier to organize. The image of the school car according to our list is attached to everything beginning with the 19th century — incidentally an invention of this century.
- The 10 parts of speech in German grammar are easy to remember, when they are allocated to the body-list. The system can be expanded for sub-divisions, like the three genders of nouns or seven types of pronouns, at the appropriate places by means of the room-list.
- Which adult can differentiate the first 20 and most important articles of the constitutional law? Use the lantern-list.

Some colleagues argue, this would only be "learning by heart".

Learning Index Cards

In 1972, Sebastian Leitner, from Vienna, Austria, introduced learning index cards developed initially for his children. Leitner's learning index cards came in packs of different sizes and were particularly well received among the students. Today, the cards are available in various shapes and sizes, and in practical folding boxes: plain index cards or pre-printed ones in the formats DIN A7 to DIN A9. Hundreds of learning index cards made of wood, available in the 1980s used by teachers for teaching languages.

Conclusion

One way to teach creatively is to enrich traditional lessons by integrating *instruction* with *construction* of knowledge, such as in partner and team work, independent learning with guided materials, working in a weekly schedule. To achieve this, learning cycles and the organization of learning processes in terms of multidisciplinary projects have to be conducted. The active learning time of pupils should be given a high priority. Active listening, nonetheless, is an important ability for lifelong learning.

Every differentiation in lessons of single, partner, or team work contributes to the joint activity of all which includes working hours pupils need to focus. The children need learning time in school.

Learning in projects can become a normal form of the lessons. This does not mean that there is an outbreak of unlimited liberty. The questions are the following: How can learning in projects not taking the structure of the lesson, but the structure of the present problem that determines the organization and work?

Learning cycles provide materials and tasks for independent learning of a given subject or in small groups. Many types of tasks can adopt the learning cycle method. Here are some of the examples: Reading to others, acquiring information by reading and summarizing in one's own words, listening information from a cassette and relating it to others, gaining information from a reference, a map or other sources and writing it down, carrying out an exercise according to predetermined specifications, and conducting training tasks in a group.

The advantage of a learning cycle is the extensive individualization of learning, which not only enhances motivation, but also the chances to determine the speed and intensity of learning individually.

School is still in its humble beginning of creativity development. Maybe it has not even begun at your school, yet? Implement one or more ideas presented here. Start with the identified idea without hesitation immediately. Your satisfaction at work, your motivation and particularly your success as a teacher shall be the award for you to take up this challenge. Wishing you successes!

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Use of Word Symbol Puzzles to Foster Creativity Among Students

R. Subramaniam, Ngoh-Khang Goh and Lian-Sai Chia

Introduction

In recent times, creativity has become a buzz word in the educational and entrepreneurial literature, not surprisingly since this attribute has the potential to unlock certain innate qualities in a person. Technological developments that have shaped today' society, and entrepreneurial endeavors that have created wealth for nations are all by-products of creative minds. This explains why significant efforts are underway in schools to foster creativity among students through various initiatives and programs.

The research literature does not convey an unequivocal definition of what exactly creativity means though there is consensual agreement on what it implies. The Oxford dictionary defines creativity as the ability to develop new ideas, make new kinds of things and find new ways of doing things. Theories of creativity often include generation of new ideas as an important aspect of defining creativity (Sternberg, 1999). Creativity has also been defined as the originality, fluency and flexibility of thinking, and the capacity to generate original and unorthodox ideas (Runco and Pritzker, 1999; Lubart, 2001–2002). At the tangible level, creativity is more pronounced—for example, works of art, invention, design, writing, and so on.

Various approaches have been documented in the literature on how creativity can be promoted—for example, use of enrichment activities (Reiss and Renzull, 2003) and brain-storming sessions

(Clapham, 2003). Formal creativity training programs are also conducted by various institutions, including private companies keen on tapping the creativity wave.

In the Singapore context, the importance of creativity in the educational scene has been recognized for quite some time. Many initiatives are underway to foster a creative mindset among students. For example, invention initiatives present a concrete platform for students to showcase the products of their imagination. The Tan Kah Kee Young Inventor's Award and the Sony Creative Science Award have been playing useful roles in helping students to use their creative thinking prowess to invent products and toys. The inclusion of these events in the education calendar since 1986 and 1998, respectively, is testament that the platform of invention is a useful way to channel the intellectual energies of students into productive pursuits (Tan and Subramaniam, 2002). Entrepreneurial endeavors are another useful tributary to showcase the tremendous potential that such pursuits can play in promoting creativity among students. It is not commonly realized that the student community in Singapore has a number of businessmen in their midst—for example, a student studying in Anglo-Chinese College had a dating website that earned him US$12,000 a month while two other secondary school students each earned US$3,000 a month from their web design business (Tan and Subramaniam, 2002; 2003). Project work offers another opportunity for students to exercise their creative thinking faculties when solving scientific problems. In this context, the Young Scientist Badgeand Questa Club schemes administered by the Singapore Science Centre since 1982 and 1987, respectively, have popularized project work among students long before this has become a compulsory feature of the school system (Tan and Subramaniam, 1999).

Whilst these initiatives have served to entrench the mindset of creativity more firmly among students, there is a parallel need for a more grassroots approach to promote creativity in a fun and easy manner. In this context, the present authors have pioneered the use of word symbol puzzles to promote creativity among science students for the past 10 years (Subramaniam, Goh and Chia, 1998, 1999a, b, c). Word symbol puzzles are a new addition to the nomenclature of brain teasers

and traditional puzzles, and their potential to promote creativity has not been fully exploited.

The principal objective of this chapter is to share our experiences with teachers on how word symbol puzzles can be used to promote creativity (and creative thinking) among students. Though the terms creativity and creative thinking are distinctly different from a definitional perspective, the conceptual base from which they spring are the same. We shall therefore use the terms interchangeably depending on the context of the discussion.

Word Symbol Puzzles

A word symbol puzzle is a brain teaser crafted using words, numerals, symbols, and/or signs in such a manner that it conveys an idea; the challenge is to unravel its meaning. A few self-explanatory examples will serve to illustrate its nuances and intricacies:

BAN │ ANA	Banana split
YY4U	Too wise for you
Get, Get, Get, Get	Forget

Our focus has, however, been in the field of science education. Some word symbol puzzles in the disciplines of primary science, physics, chemistry, biology, and mathematics are presented in this section along with their meanings.

Primary Science
1.   *conductor*
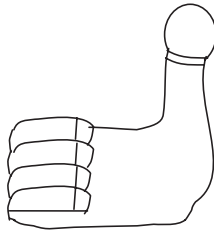
(Good conductor)

2. G R A V I T Y

(Centre of gravity)

3. C I R C U I T —— C I R C U I T—— C I R C U I T

(Series circuit)

4. C I R C U I T

(Open circuit)

5. 4 , 4 , 4 , 4

(Force, that is, 4's)

Physics

1

(Spectrum)

2 ᴸE N S

(Magnifying lens)

3 C U R R E N T, T E N R R U C, C U R R E N T, T E N R R U C

(Alternating current)

4 B O D Y

(Black body)

5 INSULATION
   INSULATION

(Double insulation)

Chemistry

1 A G E N T
  A G E N T
  A G E N T
  A G E N T

(Reducing agent)
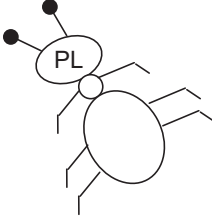
2   H I J K L M N O
(water, that is, H to O, or H_2O)
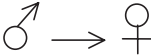
3   •2
(Period 2, that is, of the Periodic Table)

4   MOLECULE – OO7 – MOLECULE

(Intermolecular bond)

5

ALYST

(Catalyst)

Biology

1

(Plant)

2

(Sex change)

3

(Food chain)

4   ENZYME
ENZYME
ENZYME
ENZYME
(Reducing enzyme)

5   1 0 1 0 1 0 0 1
(Binary fission)

Mathematics

1   T H E ● R E M

(Midpoint theorem)

2   arithmetic, arithmetic, arithmetic, …
(Arithmetic progression)

3
(Bisector)

SEC | TOR

4   E Q U A L __ T Y

(Inequality)

5   M
     A
     T R I X
(Orthogonal matrix)

On Constructing Word Symbol Puzzles

Exposure to a few typical puzzles is sufficient to obtain an understanding of what word symbol puzzles are and to get pupils started in this creative activity. In our recent book on word symbol puzzles, we enumerated 34 rules of nomenclature for constructing such puzzles (Subramaniam, Goh and Chia, 2005). Understanding the rules of nomenclature, which are rather general by nature, affords a systematic way of coming up with a suite of puzzles in any discipline provided, of course, domain knowledge in the discipline is gained. These rules of nomenclature are not comprehensive, and more await to be discovered.

Some of the rules of nomenclature are presented in Table 15.1. It can be seen that in each case cognizance is borne of common everyday root words which find resonance in the lingo of the various disciplines. It is this etymological basis of the root words that help to jump-start the creation of word symbol puzzles in the various subjects.

Table 15.1. Some rules of nomenclature for creating word symbol puzzles.

Root word	Word symbol puzzle	Subject	Meaning
Semi	circle/2	Mathematics	Semicircle
Degree	B.Sc., M.Sc	Mathematics	$2°$
Bond	007	Chemistry	Triple bond
	007		
	007		
Free	$0 Energy	Chemistry	Free energy
Reverse	fme	Physics	Reverse emf
Couple	thermo-thermo	Physics	Thermocouple
Chain	food-food-food	Biology	Food chain
Double Helix	Helix	Biology	Double helix

Better understanding of the rules of nomenclature presents scope for coming up with further rules for creating word symbol puzzles as well as using a systematic way of creating these puzzles. However, it is not necessary that these rules of nomenclature be borne in mind or introduced to students as we have noticed that students and teachers untutored in these rules but exposed to some typical puzzles are still able to create many word symbol puzzles. A recent example is the following word symbol puzzle which dumb-founded many students and teachers, including us:

+ /   Plastic (plus + tick)

Oftentimes, a concept lends itself to multiple representations when using word symbol puzzles, as exemplified by the following examples:

Micro-organism

Organism $\times 10^{-30}$

organism

Proton

H^+

PRO1000KG   (Recall that 1 ton is equivalent to 1000 kg)

The same root word or symbol, when applied to creating word symbol puzzles in other disciplines, lends itself to different interpretations. The following examples are illustrative of this observation:

Equation   Equation   Balancing (chemical) equations
          △

N_2 N_2 Nitrogen balance
          △

probability   probability   Balance of probabilities
          △
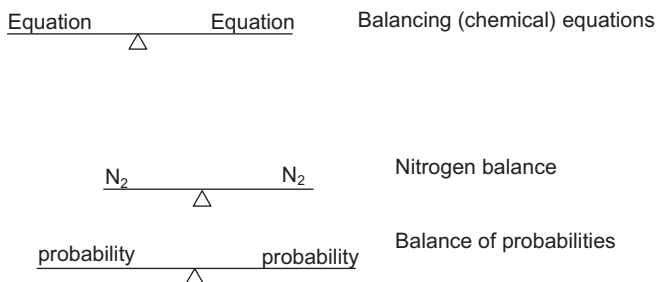
Use of Word Symbol Puzzles to Foster Creativity

Though a full-fledged study on the potential of word symbol puzzles to promote creativity has not been done so far, a commentary in this light based on our experience in promoting it through various workshops and sharing sessions with students and teachers over the past 10 years is not our of place.

Formulating Word Symbol Puzzles Promotes Creative Thinking

The act of constructing word symbol puzzles is an intellectual activity. However, before a word symbol puzzle can be formulated, domain knowledge—be it in a topic in physics, chemistry, biology, or mathematics, is needed. Owing to the fun nature of creating word symbol puzzles during a lesson in class, several teachers have noted that generally students are keen to pay more attention to a lesson once they are told that they will have to come up with at least a word symbol puzzle after the lesson. Whilst the extra effort that students have to put in has cognitive implications in terms of learning gains, it also has the advantage that students get a chance to exercise their creative thinking skills in formulating the puzzles.

Each word symbol puzzle that a student comes up with is an exercise in creative thinking—how to recognize the theoretical constructs

of a topic and use the general rules of nomenclature where applicable in creating the puzzle. Such acts of creation, can serve to raise the self esteem of the students as well as foster a sense of ownership in the created product. After all, the endeavor is basically equivalent to creating new knowledge in the field of word symbol puzzles. The psychological literature is replete with references where instances which serve to foster a feeling of ownership are rejuvenating to an individual. As the act of creation of these puzzles does not require the accoutrements and paraphernalia that are commonly associated with other activities such as creating music, inventing products or making designs, the approach thus offers a no-cost way of fostering creative thinking (or creativity). Oftentimes, a brain wave may strike a student when a lesson is in progress—and bingo, a word symbol puzzle becomes apparent and is crafted on paper in a mater of seconds! We have received several feedback from science teachers on how this has served to stimulate further discussion on a topic and also to help to refine the word symbol puzzles further.

Unraveling Word Symbol Puzzles to Promotes Creative Problem-Solving

As each word symbol puzzle is the product of intellectual effort, it therefore follows that solving it is an exercise in problem-solving. The act of problem-solving involves thinking in a manner, which cognizes the epistemological foundations inherent in the domain area of interest as well as deciphering the structural elements in the puzzle in tandem with the former—this is certainly an exercise in creative thinking. It is not easy to solve a word symbol puzzle in a discipline if domain knowledge is lacking. Based on some feedback given to us by teachers, it has been the case that when a teacher-initiated word symbol puzzle is introduced at the start of a lesson (with the caveat that paying attention to the lesson in progress is necessary, before the cognitive dimensions of the topic lends itself to decoding the puzzle), it is generally the case that students are co-operative. The discussions that accompany the decoding of the puzzle, be it when the lesson is in progress or beyond

lesson time, have been reported by teachers to be fun and invigorating, and promoting a sense of classroom community.

Discussion

The literature on promotion of creativity among students suggests that there are multiple approaches for fostering the desired mindset among them. These approaches have their merits and drawbacks. For example, invention initiatives are very useful in imbuing students with new age skills for the knowledge economy, but has the drawback that considerable effort, time and resources—often beyond curriculum time, need to be devoted; also, it may not be suitable for all students. Entrepreneurial initiatives are also clearly not for all. Whilst these initiatives must continue and target those who are inclined toward such endeavors, there is a need for a more grassroots approach that can introduce creativity (and creative thinking) among students in a way that is inclusive—targets all students in a class, is inexpensive—use of little resources, and is fun and interesting. We have suggested in this chapter that the creating and solving of word symbol puzzles can be such an approach.

The act of creating word symbol puzzles is preceded by a phase of ideation in which the epistemological connotations inherent in the concept taught in a science class finds expression in a design framework that leads to the construction of the puzzle. It is very much an individual activity and the product of creation allows scope for refinement, either at the individual or group level. The endeavor in constructing a word symbol puzzle and refining it on the basis of feedback given by others or upon self-reflection are in consonance with the studies of Sternberg and Lubart (1995) where three intelligence-related skills are identified—synthetic intelligence, that spawns new ideas; analytic intelligence, that can identify and craft a problem; and practical intelligence, that helps to refine ideas on the basis of critique from others.

The use of word symbol puzzles has the advantage that it can be weaved into curriculum time as a pleasurable interlude in the teaching and learning process. Initiatives, which are not seen as unduly intrusive and require very little implementation machinery for introduction need to be given due importance and must be recognized

as constituting a tributary to the mainstream of creativity promotion. The all-encompassing nature of this approach in that all students can indulge in creating word symbol puzzles or solving them within the framework of the curriculum has the further advantage of promoting inclusivity in the educational process. Educationists have often reiterated the need to ensure that no student is left out in a class during teaching (Buncick, Betts and Horgan, 2001).

In our 10 years of popularizing word symbol puzzles among students and teachers, we have noted that they have been used:

- as items in competitions
- for filling spare time gaps during lesson delivery
- as bonus assignments for pupils who have completed class exercises ahead of time
- for starting off or ending a lesson

Encouragement given by teachers to foster creation of word symbol puzzles during short breaks in a lesson also has the advantage that introduces or promotes creativity is a simple manner. In this context, it is worth recalling Torrance (1970, 1981) who cautioned that teachers' insensitivity to creativity or discouraging of creativity can lead to marginalization of creative students. Whilst his observation is directed at teachers of gifted students, it is applicable to other educational settings as well.

We have also experimented with approaches that call for students to submit a portfolio of word symbol puzzles on a range of scientific concepts that they have learnt in school. Such initiatives are equivalent to getting students to experience creativity and putting it into action (Csikszentmihalyi and Wolfe, 2000). Building up a portfolio to showcase the ideational pathways undertaken by the student in constructing a word symbol puzzle is an important mechanism to document the creative experience. We have noted from teachers' feedback that irrespective of the age level of the students (Primary 5 to Junior College 2), most are able to come up with desired suite and number of puzzles. The conceptual base in the sciences is obviously comprehensive enough for the creative exercise to be engaged in at all levels. This is an important consideration as it has implications for students—a topic

or subject that does not admit of a plurality of word symbol puzzles for creation may not be a wise way to foster such puzzles. However, it must be recognized that even for such topics, inability to come up with word symbol puzzles is not necessarily a reflection of the knowledge base of the discipline for such efforts, but rather than creative thinking at a higher level and beyond the confines of the traditional rules of nomenclature are required to overcome the constraints. Indeed, Amabile (1996) has stressed that skills related to creativity must subsume approaches, which include decomposition of perceptual sets, exploring of new pathways, veering away from traditional frameworks and embracing a paradigm shift.

An aspect of word symbol puzzle that may be perceived as precluding its mass appeal is that domain knowledge in the subject area is required for its construction and interpretation. Productive problem-solving in any discipline is not possible without relevant prior knowledge (Chi and Greeno, 1987), and word symbol puzzles are no exception. In this context, educational psychologists have often emphasized the value proposition of a person's prior knowledge and knowledge base in maximizing the development of a person's cerebral resources (Kholodnaya, 2002; Scneider, 1993). In decoding the word symbol puzzles, the value of prior knowledge lies in its facilitating the use of appropriate mental frameworks and strategies to map on the structural design of the puzzle in such a way to unravel its meaning. The feedback that we have from teachers is, that when it is made clear to students to understand a topic, at least at the superficial level, is required for solving the puzzle, the curiosity and urge to know what it represents and the fact that it will lead to a solution are sufficient motivating factors for them to exercise their creative thinking skills during a lesson. In the study of problem-solving, the issue of problem perception—whether the problem is seen as an opportunity and thus translating into a potential gain or whether it is seen as a threat and thus leading to a potential loss, has attracted significant attention (Getzels and Csikszentmihalyi, 1976; Kaufmann, 1988; Thomas, Clark and Ginca, 1993). The research reported in these studies has shown that there are differences in cognitive processing, depending on whether the problem is perceived as an opportunity or threat. When

the problem is perceived as an opportunity, the extent of cognitive processing proceeds at a more open level and is underpinned by a firm conviction in one's innate worth; in contradistinction, a threat perception leads to diminished information processing and is girded by a belief in one's inability to rise to the occasion (Jackson and Duton, 1988). Juxtaposing the foregoing arguments, a case can be made out that solving word symbol puzzles depends on the perception that students bring to bear on the nature of the problem. It is generally true that with some effort, most word symbol puzzles can be solved by students.

Whilst word symbol puzzles cannot be used for teaching and learning of science, and must perforce remain subservient to the locus of established delivery methods and technologies for didactic discourse, they are useful tools when employed judiciously. The task of teaching can no longer be confined to the usual chalk-and-talk approach, and there is a need to include a diversity of approaches which can capture attention, ignite interest and rekindle enthusiasm among students. Word symbol puzzles can be used in this regard.

We are not suggesting that the use of word symbol puzzles is the way to promote creativity among students but is one of the approaches that can be used. Its particular advantages have been enumerated earlier—no cost, can be easily integrated into teaching and learning, is fun, promotes thinking skills, and allows for mass participation. Whether formulating or solving word symbol puzzles, thinking is needed and approaches which promote creative thinking need to be in the repertoire of teaching strategies of teachers.

The intriguing approaches word symbol puzzles offer for word play makes their use fun and enjoyable. When activities come under this remit, they are not seen as intrusive and students are likely to warm toward them. The process of immersion and gratification that accompanies acts of creation of word symbol puzzles can be likened to a state of engagement that has been described as 'flow' by Csikszentmihalyi (1996). When students relish such activities, they are likely to continue doing so. This provides opportunities for teachers to engage students at both the curricular level during lesson time and at the enrichment level outside curriculum time.

Whilst the study reported in this chapter has been culled from our experiences in using word symbol puzzles among school students, trainee teachers, undergraduates and teachers for the past 10 years, a limitation has been that it has not been the basis of a rigorous study. We believe that there are broader implications of this study notwithstanding the caveat in the foregoing statement. The domain specific nature of the puzzles can be easily replicated in other disciplines using the rules of nomenclature outlined earlier.

Conclusion

Word symbol puzzles can be a simple and useful way to promote creativity (and creative thinking) among students. It is an approach which can be easily learnt by perusing just a few illustrative examples. The fun approach that affords for word play, either in class or during leisure time, is particularly a unique aspect of these puzzles when compared to other classes of brain teasers. In effect, the act of creating a word symbol puzzle is equivalent to deriving a metaphor for the concept in mind while the act of solving the puzzle is an analytical effort, with both these actions depending on the creativity that the student brings to the effort. By integrating such efforts in educational and co-curricular settings, the scope for promoting creativity among students in a fun, enjoyable and simple manner is can be enhanced further.

Acknowledgements

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Part Two
Nurturing Creativity

Section V
Experience with Adults in Enhancing
Thinking Skills for Creative Problem
Solving

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Enhancing Thinking and Leadership Skills through Creative Problem Solving

Gerard J. Puccio and Susan Keller-Mathers

Introduction

The Need for Creative Thinking

In 1953 Alex Osborn published his groundbreaking book *Applied Imagination: Principles and Procedures of Creative Problem-Solving*. In this book, Osborn introduced the Creative Problem Solving (CPS), and through this creative process model he outlined a set of principles and procedures that could be used to deliberately facilitate creative thinking. Certainly, the most well-known procedure described in this book is the creative thinking tool Brainstorming.

Osborn's book was truly radical for its day. Its main argument departed significantly from standard views of creativity; the belief held by many that creativity could not be systematically nurtured or drawn out—rather it is a gift that emanates from an unknown source. As noted by Sternberg and Lubart (1999):

> "Perhaps the earliest accounts of creativity were based on divine intervention. The creative person was seen as an empty vessel that a divine being would fill with inspiration. The individual would then pour out the inspired ideas, forming an otherworldly product." (p. 5)

The main message of Osborn's book was, creative thinking could be developed, that people, through practice, could deliberately improve their creative thinking skills. Furthermore, Osborn democratized creativity. Contrary to the popular belief that only certain people possessed

the innate talent to be creative, Osborn argued that creative potential was universal. Osborn (1963) suggested:

> Scientific tests for aptitudes have revealed the relative univer-sality of creative potential. The Human Engineering Laboratories analysed the talents of large groups of rank-and-file *mechanics*, and found that two-thirds of these rated *above* average in cre-ative capacity. An analysis of almost all the psychological tests ever made points to the conclusion that creative talent is nor-mally distributed—that *all* of us possess this talent to a lesser or greater degree—and that our creative efficacy varies more in ratio to our output of mental energy that in ratio to our inborn talent. (p. 15)

What compelled this advertising man to write a book that promoted the view that creativity could be developed? As a businessman Osborn saw the critical value of creative thinking; how the application of cre-ative thought in the workplace could result in finding ways to reduce costs, improve safety, and drive profits. On a broader scale, Osborn recognized the need for creative thinking for community, domestic and international challenges. In short, Osborn wanted to uplift peo-ple's capacity to creatively respond to complex challenges. From this recognition, grew a dream to have an impact on the educational sys-tem. To provide educators, at all levels, with the means to nurture the creative talents of their students, so they could become contributing members of society, to be in a better position to actively bring their creative talents to bear at work, in their communities, and on national and international challenges.

The first edition of Osborn's book was published more than 50 years ago, and it would seem that the same factors that necessitated the need for creative thinking then are even more present in our world today. In the face of global competition companies now pay great attention to the need for innovation. Organizations scramble to find new products and services they can get to the market place. And it is widely accepted that the wells-pring for organizational innovation is the creative capacity of an organizations' employees. As Amabile, Burnside and Gryskiewicz (1999) suggested, "Creativity is the crucial

'front-end' of the innovation process; before innovation can happen, the creative ideas must be generated by individuals and teams, so that they can be successfully implemented" (p. 1). And on a broader scale economist Florida (2002) argued that, "Human creativity is the ultimate economic resource. The ability to come up with new ideas and better ways of doing things is ultimately what raises productivity and thus living standards" (p. xiii). But we would argue that creativity is not just about driving the economic engine of our societies, it has great value in our daily lives. As Guilford (1968a) offered, "(t)o live is to have problems and to solve problems is to grow creatively" (p. 12). As humans we contend with an ever-increasing amount of change. Our lives are filled with more choices, more information, more novelty, and greater levels of complexity. For these reasons, we have argued elsewhere that creative thinking is an essential life skill (Puccio and Murdock, 2001).

If so, many agree that the capacity to think creatively is critical in both our professional and personal lives, we need to then ask ourselves, how well do our educational systems develop this important skill in students? Do our current educational systems and practices do a significantly better job in developing creative thinking than the systems and practices in place when Osborn wrote his book more than 50 years ago? How well do we as educators arm our students with the kinds of skills that will enable them to be successful in an increasingly complex world? Certainly, one clear advancement has been the creation of processes and methodologies that can be used deliberately to nurture the creative talents of individuals. Since Osborn's introduction of CPS in *Applied Imagination* this creative process model has undergone both ongoing research and development. In regard to research, CPS has been shown to be one of the most effective methods for enhancing creativity skills (Scott, Leritz and Mumford, 2004). In terms of the model itself, insights gained through research and practice, both inside and outside the classroom, have been used to continuously refine the model. In this chapter, we present the latest version of the CPS model and discuss implications for the use of CPS in schools.

Creative Problem Solving: The Thinking Skills Model

Since its introduction in 1953 the CPS model has undergone numerous changes (for a review of the various versions of CPS see Puccio, Murdock and Mance, 2005, and Isaksen and Treffinger, 2004). We refer to our present view of CPS as the Thinking Skills Model, as our goal has been to articulate what we believe are the various kinds of thinking skills that are called upon while engaged in this deliberate creative process. The current graphic model of CPS is shown in Figure 16.1. We will briefly describe this model and the associated skills. For a more elaborate description see Puccio, Murdock and Mance (2005, 2007).

Before describing the specific elements with the CPS process, we will first define each word in the three-letter acronym 'CPS' (Puccio, Murdock and Mance, 2007). By *creative*, we mean the production of novel ideas that serve some purpose or offer some value. By *problem*,
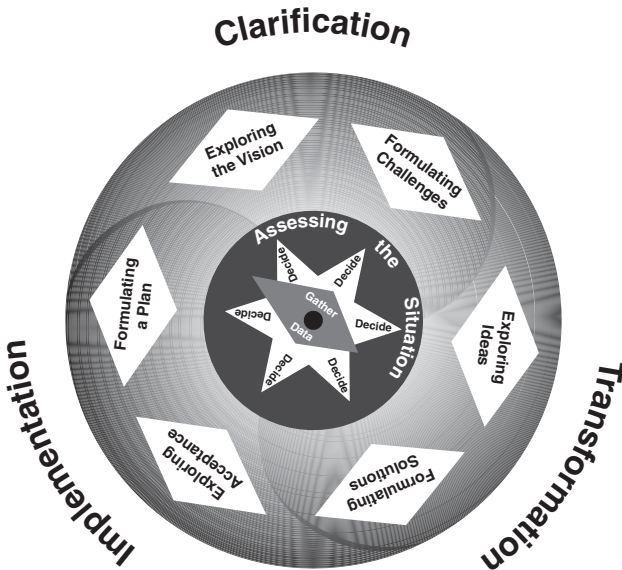
Fig. 16.1.   Creative problem solving: The thinking skills model.

we mean the discrepancy between what you have and what you want. A problem can either be a predicament or an opportunity. In the case of a predicament, a person, team or organization is reacting to a change that threatens current levels of performance, e.g., students' test scores are falling, market share is on the decline, or changing demographics are placing a burden on social services. An opportunity, in contrast, is a proactive pursuit of a promising goal that is brought about by a favorable juncture of circumstances, e.g., a new headmaster has a very open-minded leadership style and as a consequence teachers bring forward a set of progressive educational programs, as the result of a flawed experiment a scientist strikes upon a new invention, or observations of teenagers' behavior leads a company to develop a new product idea. Finally, by *solving*, we mean taking action, not only actively searching for solutions, but being committed to resolving the situation through the application of imaginative thought.

We describe CPS as a creative process. By ***process***, we mean a particular method of doing something, generally involving a number of steps or operations (Puccio, Murdock and Mance, 2007). Thus, we offer CPS as a deliberate creative process that is based on humans' natural intuitive response to open-ended problems and moves them from trial and error to targeted strategies. One of the advantages of CPS is, that it makes our natural creative thinking more explicit by building on how the mind works when focused on predicaments and opportunities.

In our current view of CPS, the model features six steps that can be organized into three stages that reflect the natural creative process that humans engage in when responding to problems that do not have immediately clear solutions. The three stages that describe the natural flow of human creativity are Clarification, Transformation, and Implementation. The first natural step in the creative process is to become aware of a predicament or opportunity. We refer to this as Clarification. Once a challenge or opportunity is defined, we begin to generate ideas that are transformed through analysis into solutions. Finally, in the Implementation stage that we consider what steps must be taken to successfully carry out our solution.

We believe these three stages reflect, at the broadest level, people's natural approach to open-ended challenges. For instance, Mintzberg,

Duru and Theoret's (1976) examination of real-life problem-solving yielded three major phases that they called "identification" (understanding the problem), "development" (creating potential solutions), and "selection" (deciding among the solutions). Other researchers have yielded similar results (Johnson and Jennings, 1963; Simon 1965; 1977), and in reviewing such studies Kaufmann (1988) concluded, "There is a striking agreement in the literature describing the phases of a problem-solving event. Normally, three major phases are identified." (p. 98)

Our goal is to reflect this natural process in the structure of CPS and to use these three stages to organize the more deliberate steps featured within the CPS framework. There are seven steps within the CPS model. The initial step or what we refer to as the executive step is found in the center of the model. We call this step as Assessing the Situation. This is referred to as the executive step as it serves a metacognitive function. This step has two purposes: (1) to gather data about a predicament or opportunity; and (2) to use this data to make a decision about where to enter into the CPS framework. Through the diagnosis that is associated with Assessing the Situation an individual, team or organization can determine whether they need to begin the application of CPS with one of the steps associated with Clarification (i.e., Exploring the Vision and Formulating Challenges), Transformation (i.e., Exploring Ideas and Formulating Solutions) or Implementation (i.e., Exploring Acceptance and Formulating a Plan). So although CPS has a natural process flow, problem solvers can begin anywhere within the process depending on what they need. Descriptions of the function for each of the remaining steps are found in Table 16.1.

We believe, and others agree, that there are real benefits associated with teaching students process skills through such deliberate creativity frameworks as CPS (Torrance, 1972, 1987; Scott, Leritz, and Mumford, 2004). To capture the value of teaching thinking skills associated with creativity we will build off of an analogy put forward by de Bono (1994). de Bono, a well-known creativity writer and practitioner, used the operation of a car to describe why it is important to teach thinking. He suggested that our innate intelligence is like

Table 16.1. Major thinking skills associated with CPS.

Step	Assessing the situation (executive step)	Exploring the vision	Formulating challenges	Exploring ideas	Formulating solutions	Exploring acceptance	Formulating a plan
Purpose	1. To describe and identify relevant data 2. To determine next process step	To develop a vision of a desired outcome	To identify the gaps that must be closed to achieve the desired outcome	To generate novel ideas that address important challenges	To move from ideas to solutions	To increase the likelihood of success	To develop an implementa-tion plan
Thinking skill	Diagnostic thinking	Visionary thinking	Strategic Thinking	Ideational thinking	Evaluative thinking	Contextual thinking	Tactical thinking
	Making a careful examination of a situation, describing the nature of a problem and making decisions about appropriate process steps to be taken	Articulating a vivid image of what you desire to create	Identifying the critical issues that must be addressed and pathways needed to move towards the desired future	Producing original mental images and thoughts that respond to important challenges	Assessing the reasonable-ness and quality of ideas in order to develop workable solutions	Under-standing the interrelated conditions and circum-stances that will support or hinder success	Devising a plan that includes specific and measurable steps for attaining a desired end and methods for monitoring its effectiveness

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Enhancing Thinking and Leadership Skills

the horsepower of a car's engine. The performance of a car does not depend solely on its horsepower, but rests largely on the skill of the person driving the car. de Bono suggested that thinking is analogous to how skillfully a driver operates the car. From this analogy de Bono argued that whether you have a powerful engine or not, high intelligence or not, it is critically important to learn how to think in order to maximize the effectiveness of your mental horsepower. We suggest that learning the process skills associated with the CPS framework is a direct way of enhancing the thinking skills associated with creativity.

We believe, and others agree (Presseisen, 2001; Swartz, 2001), that creative thinking is a higher-order thinking skill. In other words, creative thinking is a complex process that subsumes other basic thinking skills that are used for a particular purpose. Pressseisen (2001), for instance, provided the following definition of creative thinking, "Using basic thinking processes to develop or invent novel, esthetic, constructive ideas, or products from percepts as well as concepts" (p. 50). Perhaps, the most significant development in our own efforts to refine CPS to date has been the articulation of the thinking skills associated with the steps in this creative process (Barbero-Switalski, 2003; Puccio, Murdock and Mance, 2005, 2007). Table 1 provides a description of the main thinking skill associated with the steps in CPS.

Several benefits can be derived from the identification of the thinking skills in CPS. They are:

- As a process designed to deliberately encourage creative thinking, the identification of the basic thinking skills in CPS parallels the suggestions that creative thinking is a higher order thinking skill.
- Allows educators and trainers to better describe the skills involved in CPS.
- Enables educators and trainers to describe the types of thinking skills that are developed through CPS instruction.
- Permits educators and trainers to draw on, offer, and organize a large variety of problem-solving and decision-making tools designed to carry out the respective thinking skills associated with the CPS steps

(i.e., opens up the CPS process to be more inclusive of thinking tools not typically associated with this model).

In the next section, we focus our attention to the literature that describes the use of CPS in schools and the results of such efforts.

Developing Creative Thinking in Schools

Early 1916, Dewey (1944) described the importance of "fostering in schools good habits of thinking" (p. 152). At the same time, philosophical approaches to education such as Montessori (1964) articulated educational needs that were a natural complement to creative learning. Approaches like Montessori include an understanding of the importance of nurturing each child's unique creative self, and have resulted in the purposeful teaching of deliberate creative processes in education. Like general trends in education, support for creative learning and teaching fluctuates. The will to maintain a consistent level of integration of creative thinking and problem-solving in education has not occurred. Rather, creativity education varies in accordance to the degree to which the latest educational movements, philosophies and approaches embrace the importance of creative thinking and problem-solving. We would argue that it is possible to embrace creative learning in very diverse educational contexts that hold to a wide variety of educational philosophies if appreciation of the worth of creative learning and the recognition of the potential for positively impacting the education of children is recognized.

The current interest in multiple intelligences (Solomon, Powell and Gardner, 1999) provides an example of an educational movement that positively influences the pursuit of infusing creativity into education. Early work by Guilford (1968b, 1977) on the Structure-of-Intellect (SOI) broadened our view of the facets of intelligence and components of creativity, providing a richer view of our thinking related to the operations of divergent and convergent production, as well as structure of information in the form of transformations and implications. Taylor's (1968, 1986) seminal work in multiple talents also included creativity as an essential aspect of his theory. Taylor's theory, for example included

productive thinking talent, defined creativity as generating many, varied ideas or solutions and adding details to improve them. Using such theories as a foundation, a variety of education materials have been put in place to assist teachers in systematically fostering the creative thinking skills of their students. Meeker's (1969, 1973) practical applications of the SOI theory have served as the foundation to work carried out by SOI Systems internationally, an organization focused on using the SOI Model for Learning to assess and develop student skills, abilities and competencies to meet various learning situations. Schlichter's (1986) work delivers Taylor's Talents to the classroom through Talents Unlimited and serves as another example of a long-standing program with a strong creativity component. As current educational institutions embrace a wider view of intelligence, we would suggest there is promise that the need for and benefits of creativity becomes more evident to the wider educational establishment as a whole. This recognition of the importance and value in teaching creative thinking may lead educators to adopt existing instructional material in the field of creativity into their classrooms and/or encourage the creation of new material.

Creative Problem Solving Resources and Research in Education

Earlier we referred to the seminal work of Osborn and his introduction of the CPS model. Recall we indicated that Osborn's broad vision was to impact educational systems so that they would be more proactive in deliberately promoting creative thinking skills among their students. Initial work within educational systems focused on the development and use of CPS material and instruction with university students (Noller, Parnes and Biondi; 1976; Parnes, 1967; Parnes and Meadow, 1959, 1960; Parnes, Noller and Biondi, 1977). Since this early work, CPS material and instruction have been adopted in classrooms from kindergarten to high school. An example of some of the early CPS material originally developed for younger students in the 1970s and 1980s can be found in Eberle's (1996a) book on the SCAMPER tool, as well as Eberle and Stanish's (1996) CPS for kids.

CPS remains a popular methodology for promoting creative thinking in classrooms, as such teacher support material continues to be developed (e.g. Draze, 2005; Eberle, 1996b; Stanish and Eberle, 1997; Treffinger, 2000a, b, c; Treffinger and Nassab, 2000a, b) and researchers continue to explore the impact and value of such instruction. Current trends in research-based CPS support material for use with children include the development of specific materials designed for use at various levels of education. They include research with elementary age children (Duling, 1980; Puccio, 1994) and materials to teach CPS tools to children in the primary grades (Keller-Mathers and Puccio, 2000). They also include resources to train elementary age students in the complete CPS process using imaginary problems (Duling, 1985,1986,1988,1989), as well as resources to implement training using real problem-solving with young children (Puccio, Keller-Mathers and Treffinger, 2000). Additional resources for older students include materials for applying CPS with teens (Elwell, 1986, 1993), as well as resources to support CPS training with older elementary and middle school students (Treffinger, 2000c; Treffinger and Nassab, 2000b).

CPS has been one of the most widely used creativity training programs in classrooms, but what has been the impact of such training? We now turn our attention to studies that have directly tested the effect of CPS training on students. Early research in creativity in education included Torrance's (1972) classic analysis of 142 creativity studies addressing the question "Can we teach children to think creatively?" Torrance specifically assessed the impact of creativity training associated with the following programs: Osborn-Parnes CPS process or modification; other disciplined approaches; complex programs such as the Purdue Creativity Program; arts, media, and reading; arrangements to foster conditions for creative thinking; teacher-classroom variables; motivation, reward and competition; and testing conditions. It was found that the 22 studies that used the Osborn-Parnes approach had a 91% success rate. Torrance (1987) later examined 166 additional studies and reported the results of seven more CPS studies with an 88% success rate. Torrance reported that the success rate for CPS programs was higher than other creativity programs. Although he reported in

the later study that the number of CPS studies in education declined, "it is somewhat misleading as many of the other types of training programs rely upon the Osborn-Parnes procedures as a general system and combine it with other strategies"(Torrance, 1987, p. 205).

CPS continues to be a leading framework that has been adopted into various educational programs, such as Odyssey of the Mind and Destination Imagination. Since Torrance's assessment of the research, additional studies have examined the effects of deliberate training in CPS. The Future Problem-Solving Program is an example of a long-standing research-based program that utilizes CPS (Torrance and Torrance, 1978).

The research support for CPS in education is grounded in the classic Creative Studies Project (Parnes and Noller, 1972a, b, 1973; Parnes, 1987). The study involved an intensive, two-year sequence of undergraduate courses that included a variety of creativity models, theories, and tools. This quasi-experimental study clearly demonstrated that instruction in creative thinking benefited students in the experimental group, those randomly assigned to the creativity courses, versus the control group, those who received no such training. Those who received creativity training out-performed the control group in a variety of ways, from measures of cognitive ability to tests of real-life problem-solving skills. Although studies carried out since the Creative Studies Project have not matched the depth of this elaborate investigation, they have added to our understanding of the impact of CPS training, especially with younger students. For example, in Puccio's (1994) study of first graders, students were introduced to creativity concepts, trained in both divergent and convergent thinking as well as the stages of the CPS process. This investigation followed the Creative Learning Model (Treffinger, Isaksen and Firestien, 1982) with regard to training students in the CPS process first out of context, introducing tools, weaving tools into the process, and ultimately working on real problems. Puccio found that as a result of 12 CPS sessions guided by a trained facilitator, the students were able to use the CPS process to solve real problems.

Two studies at the middle school level focused on the effectiveness of CPS training on problem solving abilities (Baer, 1988;

Schack, 1993). In each study, students were trained in the CPS process by working on out of context and/or subject-based problems, as well as student-generated challenges. Each study is described in more detail below.

Baer (1988) examined the effects of creativity training on 48 students from two classes of high ability 8th graders. Instruction for the experimental group consisted of CPS training delivered over three days and two nights at an outdoor school. Students worked on both subject specific problems, as well as challenges that related to students' experiences outside of school. A pre- and post-test, consisted of four parts focused on Data-finding, Problem-Finding, Idea-Finding and Solution-Finding activities to assess the students' ability to use these stages of the CPS process. The post-test was administered six months after the training. Average gains from the pre-to the post-test were 1.5% for the total battery for the control group and 19.1% for the experimental group. Baer found that the "increase in the problem-solving skills of the experimental group was both substantial and statistically significant" (p. 191).

Schack (1993) examined the effects of CPS curriculum on 276, studying 6th, 7th and 8th grade students. Students participated in 45 lessons on group dynamics, instruction in the CPS tools and a six stage CPS process. In the final part of the unit, students used CPS to solve real problems. Experimental and control groups were matched by grade level. Furthermore, the investigation considered whether ability level would show different training effects, therefore, experimental and control groups were also drawn from students involved in the gifted and honors programs. Students were assessed on five areas of problem-solving ability before and after training. They included problem-fluency, solution fluency, flexibility, originality, and use of criteria. The means for the treatment group showed greater gains in overall problem solving. There were no differences among regular, honors and gifted students, indicating that students of all ability levels can benefit from CPS training.

Additional studies used the CPS process as the main intervention but integrated into other forms of instruction. These include two studies by McCluskey and his colleagues (McCluskey, Baker and

McCluskey, 2005) in which at risk-high teenagers were trained in CPS and received mentoring and career counseling. Cramond, Martin and Shaw (1990) conducted a study using CPS training and transfer skills, focusing on whether students could transfer their training to other situations. Manning (1984), in a study of reading disabled 3rd graders, examined CPS and cognitive monitoring as an aid to oral comprehension. Each of these studies is described below.

Lost Prizes (McCluskey *et al.* 1998), a three-year study of at-risk teens in Canada, involved 88 talented troubled high school dropouts from three school districts. The project focused on CPS training combined with career counseling and mentoring to "reclaim" these at-risk students; that is the goal was to enable these teens to make better future choices for their education, career, and life. Students received CPS training at off-school sites from a trained facilitator as a part of a month long for credit project followed by a job placement experience. The school districts involved worked co-operatively with business partners who were also given the opportunity to receive training in mentoring and CPS. Sixty-five percent of the students who participated went on to complete high school and either entered post-secondary programs or obtained full time employment.

A more recent study with the same school districts, the Northern Lights Project, targeted the plight of disenfranchised Canadian Aboriginal youth (McCluskey, Baker and McCluskey, 2005). The project, like Lost Prizes, provided CPS training and work experiences for talented youth. The curriculum also incorporated content on native culture, which included a focus on traditional values and heritage. At the start of this study, these students were to be removed from school for academic, behavioral or attendance issues. As a result of the program, 38 or 65% of the original 58 students returned to school, graduated, or found employment.

Manning (1984) examined whether problem-solving instruction would positively influence oral comprehensive among 100 reading disabled 3rd graders. Four groups consisting of a control group, a CPS group, a Cognitive Monitoring group and a group who received both treatments were administered the Boehm Test of Basic Concepts. The CPS training involved 30-minute CPS training session carried out over

10 consecutive school days. The results for the treatments showed significantly higher mean scores on the Boehm test than the control with the combination group showing consistently higher mean scores than the others.

Cramond, Martin and Shaw (1990) examined the generalizability of CPS training to real world problems presented outside of the context of the training session and whether transfer skills would enhance the value of CPS training. Seventy-five gifted middle school students were assigned to either CPS training, CPS training with transfer strategies infused or the control group who received training in various memory, analogical and logic activities. Transfer strategies included strategies to assist with transfer when similar problems are encountered. It also included "high-road" transfer strategies to assist with the conscious abstraction of an idea and application with contexts that are dissimilar to training problems. Students in the transfer group also participated in activities that would better enhance their ability to monitor themselves while engaged in problem-solving efforts. The students in the transfer group students were trained to differentiate between problems appropriate for exploring many potential options through the use of the CPS process and those, such as logic problems, that employed other strategies. Each group of students received two 40-minute training sessions a week for 8 weeks. Students were individually observed solving six real-world problems after the training, three that were appropriate to CPS and three that were not. Each student was interviewed after the testing to confirm observations of the strategies and steps of the CPS process used. The transfer group had the highest percentage of students applying aspects of the CPS process, followed by the CPS group and then the controls. There was a statistically significant difference between the transfer group and the control group, with the transfer group more often applying steps of the CPS process. The authors concluded that the incorporation of transfer skills enhances the use of CPS after training.

As stated earlier, we believe there is a need for creative thinking and problem-solving in education. In an increasing complex world, the ability to acquire and utilize knowledge combined with the ability to produce new thinking will be essential. Studies carried out thus far

indicate that CPS training can go a long way in developing the types of problem-solving and thinking skills required to be personally and professionally successful in the new millennium. We would further contend that CPS training does much to improve individuals' leadership skills. It is becoming apparent that because leaders face complex problems, they need to be skillful creative problem-solvers. In the concluding section of this paper, we explore the link between CPS and leadership.

Conclusion

Developing Creative Leaders

A relatively, new area of exploration with respect to creativity is the link between creative thinking and leadership. We believe there are some conceptual points of convergence between the fields of leadership and creativity. In his review of leadership theories, Northouse (2004) presented four fundamental components of leadership:

- Leadership is a process;
- Leadership involves influence;
- Leadership occurs within a group context; and
- Leadership involves goal attainment (p. 3).

These observations led Northouse (2004) to define leadership as "a process whereby an individual influences a group of individuals to achieve a common goal" (p. 3). This contemporary view of leadership seems to draw strong connections to what is the essence of creativity. Looking back at the bullet points regarding the fundamental aspects of leadership, one could easily replace the word "Leadership" with "Creativity" and still maintain meaning for each of these four points. Creativity is viewed as a process that enables individuals to address significant challenges as they move toward a goal.

Perhaps the most direct connection between creativity and leadership has been forged through the work of Mumford and his colleagues (Mumford, 2000). In their capacity model of leadership, these authors argued that leaders are responsible for solving complex social problems. According to Mumford and his colleagues, complex problems are characterized by three qualities. They are ill-defined, ambiguous,

and novel. To solve such problems, Mumford and his colleagues have argued that leaders must have well-developed creative problem-solving skills. As they concluded, "(t)he available evidence indicates that creative problem-solving may indeed represent an important influence on leader performance" (Mumford *et al.*, 2000, p. 18).

Since leaders are called upon to solve complex problems, and since CPS is a deliberate method for addressing complex problems that require a solution to be invented, we maintain that CPS training can do much by the way of leadership development in the schools (Puccio, Murdock and Mance, 2007). Thus, we would argue that if schools believe their role is to help produce future leaders for society, it would seem wise to include creativity and CPS instruction in their curricula. If we wish our students to be able to successfully facilitate others toward meaningful goals by overcoming problems that are ill-defined, ambiguous, and novel, it would seem natural to marry the focus on gaining knowledge with the kinds of process skills that will enable them to skillfully address complex problems.

The ultimate aim of our educational systems is to develop individuals who have the skills to productively contribute to society. The fast-pace world we live in today, places a demand on individuals to be able to cope with change or to lead change. Creative thinking is the wellspring for change. Therefore, schools would be wise to explicitly weave creative thinking instruction into their curricula. By doing so, they can become much more successful at preparing young people to both respond effectively to change and to become effective leaders of change.

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Cultivating Critical and Creative Thinking Skills

Siew-Lang Kong

Introduction

"The whole of science is nothing more than the refinement of everyday thinking." *Albert Einstein.*

We solve problems everyday. Some problems are simple, but some are complex. While solving simple problems may be relatively straight-forward; complex problems tend to invoke our awareness of various thinking skills pertinent to the problem-solving processes. This chapter intends to outline what critical and creative thinking skills are and the relations between these skills and creative problem-solving.

Critical Thinking

The term critical thinking has become so prevalent in philosophy, psychology and education that it has become a 'buzzword'. For instance, critical thinking prominently shapes goals in education, whether among curriculum developers, education researchers, parents, or employers (Potts, 1994). Norris (1985) stated in his 'Synthesis of Research on Critical Thinking', that critical thinking should be an educational ideal and not just an educational option. Such a claim necessitates that students have a "moral right" to be taught how to think critically. In other words, one's education is not complete unless one has learned how to think critically. However, the concept of critical thinking is not new. It dates back at least to Socrates, and it has been a focus of educational reform movements throughout history. Of all the kinds of thinking that one can possibly identify, none has drawn

greater attention from the educational community than critical think-ing (Ennis, 1985; McPeck, 1981). An understanding of the meaning of critical thinking is important because the concept can be vague and elusive.

Conception of Critical Thinking

Critical thinking is a multifaceted and multi-dimensional cognitive abil-ity. In the 20th century, the writing of Black (1952), Dewey (1933), and Glaser (1941) gave the concept of critical thinking acclaim in education. Take Dewey's writing, for example; during the progressive movement in the 1930s, Dewey (1933) sought to explain the differ-ence between the 'process' and 'product' of thinking. When discussing the process of thinking, he coined the term 'reflective thinking', that involves two states of mind. The first is a state of doubt, hesitation, perplexity, and mental difficulty, which often time marks the origin of one's thinking activities. This then will followed by the second state of mind that involves the act of searching, hunting, and inquiring to find resources that will help to resolve the initial doubt and the mental dif-ficulty. A person who engages in reflective thinking is often active, per-sistent, and careful in considering his/her own existing belief or knowl-edge in the light of further support and evidence present. This then, enable the thinker to form and establish a firm basis of evidence and rationality, which is the product of thinking (Kurfiss, 1988). Dewey's reflective thinking is often referred to as the origin of critical thinking.

Brookfield (1987) asserted that critical thinking is a way of life, which can be seen in the context of, for example, one's relationships, work activities, and political involvements. Brookfield defined critical thinking as more than just the skills of logical analysis. Rather, criti-cal thinking involves uncovering assumptions underlying the habitual ways of thinking and acting, and then being ready to think and act differently in light of the new-found insights. Paul (1995), a critical thinking guru, defined what it means to be a well-educated person in relation to critical thinking. He postulated that a student who applies critical thinking skills is one who often asks probing questions, seeks to

figure out the logic of things, examines assumptions, analyses concepts, tests implications, and consequences.

In the 1940s, Glaser argued that the ability to think critically calls upon three different dimensions. The first dimension involves the thinker's attitude of being disposed to consider in a thoughtful way the problems and subjects that come within the range of one's experiences. The second dimension is to do with the thinker's knowledge of the methods of logical inquiry and reasoning. And the third dimension entails the skill of the thinker in applying those methods (Glaser, 1941, pp. 5–6). Glaser, along with Watson, then developed the Watson-Glaser Critical Thinking Appraisal (WGCTA) instrument to test the ability to draw inferences, to recognise assumptions, to evaluate conclusions and to determine the strength of reasons in supporting a specific argument (Kurfiss, 1988).

The Recent Conception

The current critical thinking movement can be traced back to 1962 with Ennis' landmark article, 'A Concept of Critical Thinking'. Ennis' initial conception of critical thinking focused on the correct assessment of statements based on criteria. It focused on the quality of the products of critical thinking, rather than the process. Specifically, twelve aspects of critical thinking have been identified (Ennis, 1962):

(1) Grasping the meaning of a statement;
(2) Judging whether there is ambiguity in a line of reasoning;
(3) Judging whether certain statements contradict each other;
(4) Judging whether a conclusion follows necessarily;
(5) Judging whether a statement is specific enough;
(6) Judging whether a statement is actually the application of a certain principle;
(7) Judging whether an observation statement is reliable;
(8) Judging whether an inductive conclusion is warranted;
(9) Judging whether the problem has been identified;
(10) Judging whether something is an assumption;

(11) Judging whether a definition is adequate; and

(12) Judging whether a statement made by an alleged authority is acceptable.

These 'quality-of-product-based' conceptions of critical thinking were redefined approximately 20 years later, incorporating a process of reasonable and reflective thinking, and focused on deciding what to believe or do (Ennis, 1989; Norris and Ennis, 1989). Ennis' new definition of critical thinking consists of three major parts. First, critical thinking starts as a problem-solving process in a context of interacting with the world and other people. Second, it continues as a reasoning process, informed by background knowledge and previously acceptable conclusions, and it results in drawing a number of inferences through induction, deduction, and value judging. Finally, the critical thinking process ends in a decision about what to do or believe. Ennis' new conception of critical thinking revolves around the ideas of general thinking skills, and dispositions toward critical thinking.

Ennis' taxonomy of general critical thinking skills can be summarized into five main aspects:

(1) Elementary clarification;
(2) Basic support;
(3) Inference;
(4) Advanced clarification; and
(5) Strategies and tactics.

Operating in the background of these critical thinking abilities are the elements of clarity and critical thinking dispositions. These critical thinking dispositions define the "critical spirit" (Norris and Ennis, 1989, p. 11) of the thinker, and such critical spirit is what motivates the thinker to apply critical thinking skills to his or her own thinking.

Swartz and Reagan (1998), like Ennis, also adopted the definition of critical thinking as the evaluation of reasoning and argument as reasonable, reflective thinking directed at deciding what to believe or do. These critical thinking skills, according to Swartz and Reagan, are frequently needed in our personal and professional life and they fall

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into two categories:

(1) Skills related to *basic information* that we get from a variety of sources—such as determining the accuracy and reliability of sources, and

(2) Skills related to making *inferences* by which we draw conclusions that we do not verify directly from information offered as evidence to support them.

Similarly, McPeck (1981) suggested that critical thinking could be defined as "a propensity and skill to engage in an activity with reflective scepticism" (p. 8). Paul (1993) defined critical thinking as "disciplined self-directed thinking, which exemplifies the perfections of thinking appropriate to a particular mode or domain of thinking" (p. 33). Beyer (1990) had a similar conception of critical thinking, defining it as a 'willingness' (a pre-disposition) and an ability to scrutinise and evaluate thinking to determine truth, accuracy, or worth, and to construct logical arguments to justify claims or assertions. Beyer's theory of critical thinking includes dispositions, criteria, argument, reasoning, and point of view.

From the above-mentioned conceptualization, to think critically means to suspend judgment, maintain a healthy scepticism and exercise an open mind. These three mental activities call for the active, persistent, and careful consideration of any belief or idea in light of the ground that supports it. Further, all these definitions of critical thinking (Beyer, 1990; Glaser, 1941; McPeck, 1981; Norris and Ennis, 1989; Paul, 1993; Swartz and Reagan, 1998) seem to have one main theme in common, i.e., critical thinking is a mental process that seeks to clarify as well as evaluate the action and activity that one encounters in life. The mental processes of clarification and evaluation are essential in the problem-solving and decision-making processes, which encompasses our entire daily activities.

Critical Thinking and Dispositions

Discussing the mental processes of critical thinking without mentioning one's disposition (i.e., willingness or inclination) toward it would

be an incomplete endeavor. Critical thinking dispositions refer to one's tendencies toward critical thinking behavior such as seeking clarity and being inquisitive. For example, Siegel's (1985) conception of critical thinking persuasively involved the element of attitude or dispositions. He suggested that a critical thinker is one who is appropriately moved by reasons. The thinker has a propensity or disposition to believe and act in accordance with reasons, and the ability to assess the force of reasons in many contexts. In other words, tapping into the purposes behind a certain action, and the willingness to explore those purposes and means to reach the ends is more crucial than possessing the technical and mechanical critical thinking skills and yet be unsure of the direction to be taken.

McPeck (1981) viewed critical thinking not only as the opportunity to know when to question and what to question, but also as an inclination to do so. Siegel (1988) likewise labels these attitudes, dispositions, habits of mind, and character traits as 'critical attitudes', or 'critical spirits'. Ennis (1989) also defined a critical thinking disposition in terms of the 'critical spirit,' which is a tendency to do something given certain conditions. Ennis argued that individuals must either have formed habits to use certain abilities, or overtly think and choose to use the abilities they possessed. A person with an ability to think critically under certain conditions will do so, only if so disposed.

In a similar spirit, Peter and Noreen Facione, authors of the California Critical Thinking Dispositions Inventory (CCTDI), defined critical thinking dispositions as a constellation of attitudes, intellectual virtues, and habits of mind (Facione and Facione, 1994). The definition of the concept of critical thinking used here was developed as a product of a Delphi research project involving 46 experts in thinking. This definition characterizes critical thinking as purposeful and self-regulatory judgment. In sum, critical thinking should be viewed as a set of skills and dispositions, which can be learned and improved. As critical thinking skill involves such rigorous analysis and reflection of a situation at hand, it can contribute to creative problem-solving.

Critical Thinking is Not Being Out-Spoken or Negative

One misconception people possess is to confuse critical thinking with the sharing of opinions and being out-spoken. For example, asking someone for their opinion on national healthcare policy, a response such as 'we need better than what we had' without any elaboration does not reflect on critical thinking ability. One with critical thinking ability should be able to state an opinion that is supported by strong reasoning and backing. Likewise, in a classroom context, if students are asked to express an opinion, they are not necessarily being pushed to think critically. Likewise, critical thinking is not necessary being 'critical' and negative about everything. The process of critical reasoning should produce positive and improved outcomes. In other words, the process of critical thinking should not merely stop at pointing out weaknesses but also providing alternative to the current state of the situation.

Critical Thinking Measurement

Critical thinking is a mental activity which is not directly visible as a process. As such, measuring critical thinking poses a great challenge to the experts in the field. One approach to tap into the development or changes in the quality of one's critical thinking skill is through assessing the outcomes produced by the skill. Some of the more prominent standardized critical thinking tests, which have been widely used are: the Watson-Glaser Critical Thinking Appraisal (Watson and Glaser, 1980)—aimed at grades 9 through adulthood; the Cornell Critical Thinking Test (Ennis and Millman, 1985)—aimed at grades 4 through 14; the Ennis-Weir Critical Thinking Essay Test (Ennis and Weir, 1985)—aimed at grades 7 through college; and the California Critical Thinking Test (Facione and Facione, 1994)s—aimed at college level students.

Critical Thinking as a Dynamic Tool

Critical thinking and the ability to think critically have become part of the educators' language. Professionals in every field, including education, business, engineering, nursing, journalism, the military or public

service rely on critical thinking, together with their knowledge of their field, to make good decisions 'in dealing with tactical, strategic, clinical, leadership, communication, economic, or design problems' (Facione and Facione, 1994, p. 2). This is because critical thinking serves as a dynamic tool for learning as well as for problem-solving and decision making processes. For instance, Norris and Ennis' (1989) view of critical thinking, which involves three main components reflects clearly the problem-solving processes. First, critical thinking starts as a problem-solving process in a context of interacting with the world and other people. Second, it continues as a reasoning process, informed by background knowledge and previously acceptable conclusions, and it results in drawing a number of inferences through induction, deduction, and value judging. Finally, the critical thinking process ends in a decision about what to do or believe.

Creative Thinking

"The problem of creativity is beset with mysticism, confused definitions, value judgments, psychoanalytic admonitions, and the crushing weight of philosophical speculation dating from ancient times."
Albert Rothenberg

Like critical thinking, creative thinking is also a complex, multifaceted, and multi-dimensional cognitive ability. When the term 'creative' is mentioned, it inevitably evokes other related terms such 'creativity,' 'creative thinking,' 'creativity methods,' 'creative thinking techniques,' and 'creative thinking skill.' There are perhaps three levels to the terms mentioned here. Creativity is often used to denote a more universal conception of creativeness. It is often described in terms of three main components: ability, attitude, and process (Harris, 2001). Everyone has a certain level of ability to create, but it is with the right attitude and proper skill or process that he/she arrives at a creative product. This conception of creativity is synonymous to creative thinking. All the other terms which deal with skills, methods, and techniques come under the process component of creativity/creative thinking.

Conception of Creativity/Creative Thinking

Creativity (or creative thinking; or creativeness) is often defined as a parallel construct of intelligence but differs from intelligence in that it is not restricted to cognitive or intellectual functioning or behavior (Feldhusen and Goh, 1995). Creativity is concerned with a complex mix of motivational conditions, personality factors, environmental conditions, chance factors, and even products; all contribute towards new and original ideas. It is a complex cognitive activity which involves creating something new or original (Feldhusen, 2002). Something is usually judged to be creative if it is "new" to society that is making the judgment, and if it is "useful", or otherwise admirable. We do not count all things, which are new to be "creative," they have to posses some kind of quality or esthetic beauty or usefulness. Creative thinking covers skills of flexibility, originality, elaboration, brainstorming, modification, associate thinking, attribute listing, metaphorical thinking, and so on. Some researchers take creative thinking to mean individualised cognition (Finke, Ward and Smith, 1992) which improves the likelihood of new, useful and unique thoughts occurring, involving elements of insight and invention. In short, creativity (or creativeness) is a mental process involving the generation of new ideas or concepts, or new associations between existing ideas or concepts.

The products of creative thought (sometimes referred to as divergent thought) usually have both originality and appropriateness (Perkins, 1988). Problem-finding, in its broadest sense, underlies all types of creativity. Some of the most basic research in problem finding was done with visual artists (Getzels and Csikszentmihalyi, 1976). For many, the term creativity frequently evokes the well-organised scientist, artist, writer, painter, inventor, etc., and descriptions of creative people are most often based on studies of creative products (Feldhusen, 2002). Scott, Lonergan and Mumford (2005) postulated that over the course of the last century, substantial progress has been made in identifying the core processing activities that appear to be involved in creative problem-solving. Some of these core processes include information gathering, problem finding, idea generation, idea evaluation, and conceptual combination.

Signs of Creativity

Torrance (1981) also noted several signs that indicate when creative learning occurs, such as improves motivation, alertness, curiosity, concentration, and achievement. In 1988, Torrance put forth a process model of creativity which made up of the following logical stages:

(i) sensing problems or difficulty,
(ii) making guesses or hypotheses about the problem,
(iii) evaluating the hypotheses and possibly revising them, and
(iv) communicating the results.

Another well-known model of creativity is the cognitive-affective models (Williams, 1969). This model has been developed for encouraging creativity in children. The cognitive domain consists of knowledge, reasoning skills and 'algorithmic truths,' as well as technical skills and special talents. The affective domain consists of aesthetic concerns, one's feelings, emotions, etc. This domain help facilitate a thinker's appreciation of creative productions. Along similar light, Davis and Rimm (1985) suggested that stimulating creative thinking should aim at strengthening attitudes, which are conducive to creativity. Cognitive and affective factors are involved in all creativity tasks, including all aspects of decision making as well as problem-solving in our daily lives. Davis (1982) developed a four-step model of creativity development: awareness or readiness to think creatively, understanding the topic of creativity, techniques, and self-actualisation.

Myths of Creativity

Treffinger, Isaksen and Dorval (2000) listed four common myths or misunderstanding of creativity:

(1) "I am not a creative person."—The truth of the matter is everyone, including you and I, have the potential to think of new and useful ideas, to look at a problem in a new way and find an original and workable solution, as well as to use one's mind in a productive manner to generate and apply new ideas.
(2) "Creativity is too mysterious to be taught."—In contrast to the idea of being divine, creativity should be viewed as natural and

observable. There are methods and techniques for enhancing it, and these skills are accessible to anyone who desires to learn and use them.

(3) "Creativity equals arts."—Creativity does not occur only in arts. It can be seen in any area of human endeavor, particularly when one directs his/her efforts towards new or original ideas, expanding or refining important parts of their life and surroundings, or solving ambiguous, novel, or complex problems.

(4) "Creativity is madness."—Sometimes the word creativity evokes the image of the wild, crazy, and eccentric person. In fact, Treffinger, Feldhusen and Isaken (2000) believe that a person functioning creatively is, in fact, operating in ways that can lead to personal effectiveness and good health.

Importance of Knowledge for Creativity

Runco and Chand (1995) presented a model of creative thinking that emphasise the importance of knowledge and motivation for creativity. Knowledge can be differentiated into declarative and procedural knowledge where the later can enhance creative thinking by simply providing factual information. Procedural knowledge provides instructions for strategic thinking, which they described as metacognitive ability. Feldhusen (2002) also agreed that creativity process depends mightily on a knowledge base reflecting past learning and fluency or retrieval skills. This is especially so in the 'domain specific knowledge'. He went on to argue that "flexibility is manifest mostly as a personal openness factor that enhances diverse retrieval operations, but it also probably partly a cognitive factor because it is correlated quite highly with intelligence" (p. 183).

However, Scott (2000) concluded from his review of major creativity and problem-solving theories that it is still uncertain how knowledge functions in creativity and problem-solving and how necessary it is. Scott (2000) also pointed out that for 'ill-defined problems' retrieval from long term memory calls for a wider, broader search through the

knowledge base which hopefully includes encoded information that may be relevant or related to the task at hand. Linking creativity to other cognitive functioning and environmental factors, Sternberg and Lubart, (1991) have identified six resources that facilitate creativity in children and adults:

  (i) intelligence,
 (ii) knowledge,
(iii) intellectual style,
(iv) personality,
 (v) motivation, and
(vi) environment.

They also postulated that there are two aspects of intelligence that are relevant to creativity: problem definition and redefinition, and insight skills. They argue that creative people not only solve problems, but also pose the right problems.

Obstacles to Creativity

Creativity can be easily hindered by the un-conducive learning environment. In other words, there are many ways that can 'kill' creativity, of which Hennessey and Amabile (1987) listed five:

  (i) have children work for an expected reword,
 (ii) set up competitive situations,
(iii) have children focus on expected evaluation,
(iv) use plenty of surveillance, and
 (v) set up restricted-choice situations.

These five creativity "killer" points to the one main issue of being too restrictive of children's products of thinking. It is our natural tendency to avoid making mistake. If variations in answers are often perceived as mistakes by teacher, children will focus on approaching the given task by methods which the teacher approves; rather than attempting it via different methods/ways.

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Environment Conducive for Creativity

Feldhusen and Treffinger (1980, p. 32) suggested several recommendations for establishing a classroom environment conducive to creative thinking:

(1) Support and reinforce unusual ideas and responses of students;

(2) Use failure as a positive to help students realize errors and meet acceptable standards in a supportive atmosphere;

(3) Adapt to student interests and ideas in the classroom, whenever, possible;

(4) Allow time for students to think about and develop their creative ideas; as not all creativity occurs immediately and spontaneously;

(5) Create a climate of mutual respect and acceptance between students and between students and teachers, so that students can share, develop, and learn together and from one another as well as independently;

(6) Be aware of the many facets of creativity besides arts and crafts: verbal responses, written responses both in prose and poetic style, fiction and non-fiction form. Creativity enters all curricular areas and disciplines;

(7) Encourage divergent learning activities. Be a resource provider and director;

(8) Listen and laugh with students. A warm, supportive atmosphere provides freedom and security in exploratory thinking;

(9) Allow students to have choices and be a part of decision-making process. Let them have a part in the control of their education and learning experiences;

(10) Ensure everyone get involved, and demonstrate the value of involvement by supporting student ideas and solutions to problems and projects.

Attitude and Creativity

Having creative thinking alone may not guarantee creative products (Figure 17.1). This is because within the individual, there is a complex system of cognitive skills, abilities, personality factors and motivations,
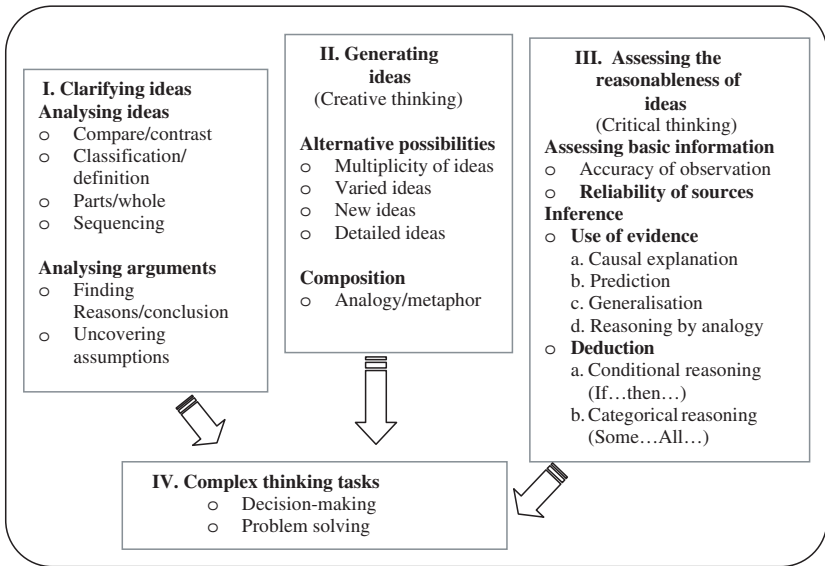
Fig. 17.1. Model of thinking skills and processes (Adapted from Swartz, Fischer and Parks, 1998, p. 7).

as well as styles, strategies, and metacognitive skills that work together to produce creative behavior (Feldhusen and Goh, 1995). Closely related to creativity research is the work of problem-finding. For instance, Getzels and Csikszentmihalyi's (1967, 1975) concluded that finding, identifying, and clarifying problems is a preceding and perhaps more creative act than the more convergent behavior of problem-solving. In light of this, the specific attitudes toward problem finding, as well one's motivation might well be crucial in determining the product of the problem-solving task.

Creativity Measurements

Since creativity involves such a multidimensional construct, measuring it can be a great challenge too. A good measurement should include not only cognitive processes of creativeness, but also, motivation, interest, attitudes, and styles associated with the individual. Further, the environment should also be taken into consideration so that a multivariate picture of the creative capacity of the individual emerges (Feldhusen

and Goh, 1995). One of the earliest instruments for measuring creativity is the Torrance Test of Creative Thinking (TTCT) (Torrance, 1975), which was designed to measure performance on a number of verbal and figural tasks. The factors include verbal and figural fluency, flexibility, originality, and elaboration. Other test measuring creativity includes the Structure of Intellect tests (Guilford, 1950, 1967), Kirton Adaptor-Innovator scale (Kirton, 1987), and the Creativity Environment Work Environment Inventory (WEI) (Amabile and Gryskiewicz, 1989). With tests for measuring creativity abound, we must not taken for granted that the ultimate criteria of creativity are measures of real-life creative achievement. Hocevar (1981), after noting that creativity is the most difficult of all psychological constructs to measure, concluded that simple and straightforward inventories of past creative achievement and activities are more defensible than any other methods of assessing creativity.

Davis and Rimm (1985) have identified 19 skills or abilities that could be used as a basis for a creativity accessing program: fluency, flexibility, originality, elaboration, sensitivity to problems, problem-finding, visualization, ability to regress, metaphorical thinking, logical thinking, evaluation, analysis, synthesis, transformation, extension of boundaries, intuition, predicting outcomes, concentration, and resistance to closure. Dacey (1989) have also identified nine personality factors in creativity: tolerance of ambiguity, stimulus freedom, functional freedom, flexibility, risk-taking, preference for complexity and disorder, positive attitude toward work, androgyny, and acceptance of being different. Dacey's description of creative factors are constructed in behavioral terms, thus leading us to the idea that creativity is modifiable, taught, developed, and improved.

Creative problem-solving

Problem-Solving

We face problems when we have a goal but do not know how this goal is to be reached. In relation to critical and creative thinking, problem-solving is often considered as a form of a higher-order

thinking process. A typical problem-solving process usually involves the following steps:

(a) recognise the existence of a problem,
(b) define the nature of the problem,
(c) explore resources to solve the problem,
(d) formulate strategies to solve the problem,
(e) brainstorm various solutions,
(f) evaluate solution, and
(g) choose the best solution.

Creative Problem-Solving

In its simplest form, 'Creative problem-solving' (CPS) involves any typical problem-solving process with an additional element of creativeness (Treffinger, Isaksen and Dorval, 2000). CPS is commonly associated with the work of Donald Treffinger and colleagues (Isaksen, Dorval and Treffinger, 1994; Treffinger, Isaken and Dorval, 2000); and had its origins in the work of Osborn (1953). If we expect our solution to be an improved version from the previous one, we need to apply creative thinking within the quest. Creative thinking is a divergent process, in which we begin at a single point, or with a single question, but extend our search in many different directions, generating a wide variety of new possibilities (Treffinger, Isaken and Dorval, 2000). At the same time, we also need to apply critical thinking to analyze, develop, as well as evaluate ideas and solutions. In the creative problem-solving view, critical and creative thinking are seem as two complimentary, mutually important ways of thinking, that work together in harmony (Treffinger, Isaken and Dorval, 2000). Therefore, critical and creative thinking work in concert in any effective problem-solving situations. The next section attempts to explore how critical and creative thinking can help in creative problem-solving.

Thinking Skills for Creative Problem-Solving

An important goal of education is to help students learn how to think more productively by combining critical thinking that aids

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ideas evaluation, and creative thinking that facilitates ideas generation. Both modes of thinking are essential for a well-rounded productive thinker.

Critical and Creative Thinking — the Great Debate

Critical and creative thinking are often seen as opposites or dichotomous; in which critical thinker is considered serious, analytical, and impersonal, whereas creative thinker is viewed as one who is wild, unstructured, and sometimes eccentric. The critical thinking model, historically much older than the creative model, is frequently referred to by people in business, education, and professional vocations when they argue that schools should teach students to think (Ruggiero, 1988). The strength of this model is that it covers in depth the requirements of logic and the analysis of ideas. Perhaps because of the thoroughness of its treatment of complex matters, the critical thinking model has tended to ignore creative thinking. In addition, the critical thinking model often makes students see thinking as a negative and reactive enterprise, thereby limiting their competency to finding fault with existing ideas rather than producing better ideas, and criticizing other people's arguments while ignoring the flaws in their own. In fact, criticizing one's own behavior is perhaps even more fundamental than criticizing that of others. But it seems that the real scenario is that many students become adept at finding fallacies in other people's arguments, sometimes so much so that their approach has been termed a 'fallacy frenzy'. On the other hand, they often regard their own arguments as above criticism (Ruggiero, 1988).

Ruggiero (1988) argue that critical thinking and creative thinking advocates have not only tolerated the gulf between their approaches, but they have also often widened the gulf by attacking each other's approach. Some creative thinking advocates blame the neglect of creativity on society's emphasis on reasoning, and critical thinking advocates respond by likening creative thinking instruction to game playing. This unfortunate squabbling among scholars and educators has its counterpart in popular literature, with its sideshow terminology of 'left-brain people' and 'right-brain people'. The larger truth

lost in this squabble, according to Ruggiero (1988), is that both critical thinking and creative thinking have been neglected, that both are needed for solving problems and resolving issues, and that each benefits from the other. Critical thinking saves creative thinking from pursuing novelty for its own sake, while creative thinking prevents critical thinking from being merely reactive and negative. These arguments call for the teaching of thinking 'holistically'; that is, we should keep a balance in dealing with critical and creative thinking, for focusing too much on one will make us an unbalanced person. So, the most appropriate model is a holistic model approach, which incorporates the principles and strategies of both critical and creating thinking.

A Holistic Model for Problem Solving

Such a holistic model, if carefully and properly designed, offers at least two important advantages: (1) A holistic model embraces both the production and the evaluation of ideas and presents students with one coherent, sequential approach to productive thinking. (2) A holistic thinking model fits a broader range of thinking processes (e.g., decision-making, problem-solving, etc.) than does a creative model or a critical model, as all the processes of the former will require the thinker to be open-minded, reflective, and resourceful in obtaining information; careful in formulating interpretation; and logical in performing reasoning tasks (Ruggiero, 1988).

   An example of a holistic model approach can be found in Robert Swartz's conception of what constitutes a skilful thinker (Swartz, 1991; Swartz and Reagan, 1998; Swartz, Fischer and Parks, 1998). According to this model, the skilful thinker is able to produce effective problem solution and sound decision. The most basic assumption in this model is that all our everyday life activities can be reduced to either solving problems and/or making decisions. Thinking skill, according to Swartz, is the mental process that could assist us to consider various factors to find the best solution to problems and make well-founded decisions. Swartz, Fischer and Parks (1998) postulated that these thinking skills

fall into three main categories:

(1) skills at clarifying ideas;
(2) skills at generating ideas — which consists of creative thinking skills; and
(3) skills at assessing the reasonableness of ideas — which consists of critical thinking skills (see Figure 17.1 for details).

These types of skilful thinking form the core important thinking skills that cut across various disciplinary areas. All these thinking skills will then be orchestrated to assist in producing the best solution to problems and making well-founded decisions. Swartz acknowledged that people are thinking all the time but "it is ordinary thinking done well that is our goal when we teach thinking" (Swartz, Fischer and Parks, 1998, p. 2).

For instance, when one encounters a problem, he/she will first of all need to clarify and understand the actual problem situation, taking into consideration the actual context and constraints involved. These activities will call upon thinking skills for clarifying ideas as depicted in Figure 17.1. Next, one will need to put on the creative thinking cap to generate various ideas and alternatives solutions. At the same time, it is also important to suspend judgments so that unusual solutions can be thoroughly explored. Finally, to decide on the best solution, the most likely solutions will need to be evaluated and compared. This is a stage where critical thinking is very crucial. As the process unfolds, it reveals an alternation between the two kinds of thinking, critical and creative. In practice, both kinds of thinking operate together most of the time and are not really independent of each other.

Creative problem-solving as a holistic model

This holistic approach to problem-solving is quite similar to Treffinger's CPS model (Trefingger, Isaken and Dorval, 2000) mentioned earlier. Their CPS model includes three major components and six important stages. The first component involves 'understanding the problem.' There are three stages within this component:

(1) mess-finding — identifying and selecting a broad goal;

(2) data-finding — exploring various expects of the task;
(3) problem-finding — generating many possible problem statements. The second component in CPS involves 'generating ideas' where the idea-finding stage takes place.

Finally, the third CPS component involves 'planning for action.' This component consists of two stages:

(1) solution-finding — examining the most promising option and identifying potential solutions);
(2) acceptance-finding — exploring potential solutions and maximizing chances of successful implementation.

Within each of these six stages, the problem-solver goes through the back-and-forth processes in both divergent (creative thinking) and convergent (critical thinking) types of reasoning. Take the idea-finding stage for instance — the most natural thing to do at this stage is to generate as many unusual ideas as possible, in which case, the creative thinking skills are involved. Upon listed out varied ideas, one need to move back to a more convergent approach whereby all the unusual ideas are critically analysed and evaluated. This obviously calls upon the critical thinking skills. Therefore, the process of reaching a solution, according to the CPS model, depends heavily not only on the creative endeavor of the problem-solver, but also equally determine by the critical thinking activities lavished on it.

We mentioned in the creative thinking section that a creative product must include appropriateness as one of its most important quality. We also mentioned that the other aspect of creativity is to generate varied and unusual ideas. While varieties and newness of ideas can attract attention, it may not be adequate for creating effective solutions to challenging problems. To generate ideas that is truly appropriate and valuable, critical thinking is a crucial element for the refinement of ideas. The qualities of critical thinking such as to suspend judgment, maintain a healthy scepticism and exercise an open-mind, serve an important role in ensuring the quality and appropriateness of an idea, an ultimately the usefulness of the problem solution.

In another model for effective and creative problem-solving, Treffinger, Feldhusen, and Isaken (1990) have proposed a three-level of

thinking skills approach. The foundation skills are fluency, flexibility, originality, elaboration, synthesis, curiosity, openness, risk taking, imagination, and humor. The skills at the intermediate level are critical thinking skills, such as, judging the accuracy of information, identifying assumptions and biases, and reasoning inductively and deductively. At the highest levels are complex methods of problem-solving and decision-making. Treffingerl, Feldhusen and Isaken (1990) posit that their model constitutes the ultimate synthesis of the foundation and tool skills, and that they are the ultimate goals of educational programs. Therefore, the major components of creative thinking processes and creativity should include a knowledge base (both general as well as domain-specific); metacognitive skills in planning, monitoring, and evaluation (critical thinking); personality factors; as well as the environmental stimuli. Again, in this model, the two main cognitive components include the creative and critical thinking.

Torrance (1962) once said that "creative thinking appears to be important, even in jobs which appear to be quite routine." Usually creativity is manifested in one's power to break away from the usual sequence of thought into altogether different pattern of thought. It is only then we can expect our results (problem solution) to be different or new or original. Albert Einstein once said that "there is nothing that is a more certain sign of insanity than to do the same thing over and over and expect the results to be different." How true! It is unrealistic to expect our routine thinking methods to produce creative problem solution. To break away from the routine means to move away from the familiar patterns toward a divergent approach in problem-solving. However, merely breaking away from routine and 'thinking out of the box' alone is not sufficient to produce appropriate and effective solutions. We need critical thinking to analyse and evaluate the potential ideas and solutions. Only then, we can be more certain of the usefulness and appropriateness of out solutions.

In conclusion, we can say that critical and creative thinking are interrelated and complementary aspects of thinking, especially when comes to propelling the complex process of problem-solving. Almost all of the thinking, which we undertake contains some critical and some creative aspects. For example, when we try to solve real life problems we move

back and forth several times between creative and critical reflection as we develop solutions or weigh the consequences of any one solution. It is important, therefore, that any attempts to improve thinking abilities pay attention to both critical and creative aspects of thinking. As aptly put forth by Sternberg (2004), critical thinking is important, but as a complement to, not as a substitute for, creative thinking. He went on further to suggest that people need to not only critique others' ideas, but to generate their own. In doing so, we will be operating in a more conducive psychological and mental state for creative problem-solving.

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The Japanese Creativity Education and Creativity Techniques: A Perspective from the Enterprise

Makoto Takahashi

Introduction

This chapter has two foci. First it reports on the Japanese creativity development and education. Then it describes creativity techniques used frequently in the Japanese enterprises including those invented by the Japanese. Some findings of the investigations on the Japanese businessmen's thinking patterns and creativity education are included. Japanese creativity development received influence from the American creativity development. In the 1930s, the Americans began to engage in the development of creativity techniques and American companies started to provide their employees with creativity education. Japan after the Second World War was in a less favorable state. Thus its creativity development delayed two decades but in time with that of Europe. In the Asian regions, creativity education and research became prevailing in the 1980s.

The first wave of creativity movement arrived in Japan in 1950. At the Sanno College in 1956 the Creative Thinking Course (CTC) was offered. A total of thirty thousand participants have benefited from the program. Ichiro Ueno, the founder of Sanno College, translated "*Applied Imagination*" authored by A.F. Osborn. In 1960s, Japan experienced the peak of creativity growth. During this period, the KJ-Method and the NM-Method were invented. The second wave of creativity movement was featured by the great interest of the enterprises in the KJ-Method.

Japan after the Second World War grew as a country of high productivity. One of the motivating forces for the growth was the movement of quality control (QC). The KJ-method as well as brainstorming were well-received by the enterprises as well as gained its position in the QC techniques. The NM-Method gained the same attention. Between 1960s and 1970s, the KJ-Method was developed as an indigenous, Japanese creative technique. Thereafter, the Japanese indigenous card was used to develop ideas. In the second half of the 1960s, schools began to introduce the above mentioned Japanese creativity techniques to children. Quite a handful of elementary and secondary schools used these indigenous creativity techniques. Some schools published creativity related textbooks. In this manner, creativity became prevailing in the Japanese education. Furthermore, the Japan Creativity Society (JCS) was inaugurated in 1979. The JCS organizes conferences for its member organizations and releases research journals. At the stage of writing, the JCS has a total of 300 members.

Shortly before the turn of the century, in 1990, the concept of new talent development was coined. The Japanese Ministry of Education in 1989 led a curricular reform, in which children's creativity education was discussed. Several years later, in the economic arena, in 1993, the concept of creative collaborative group was proposed. Subsequently, in 1996, the Japan Federation of Economic Organizations suggested creative talent development programs highlighting the importance of creativity. In the twenty-first century, the enthusiasm to recognize the importance of creativity has been enhanced as some Japanese won Noble Prizes.

Creativity Techniques

According to the author, there are four main categories of creativity techniques (see Fig. 18.1). Specifically, in 1983, the author assembled 300 techniques to solve creative problems and identified 100 creativity techniques. Using the vocabulary of the cognitive process developed by J. P. Guilford, the techniques can be divided into two categories: divergent thinking techniques and convergent thinking techniques. The former refers to the thinking for generating ideas and data. The
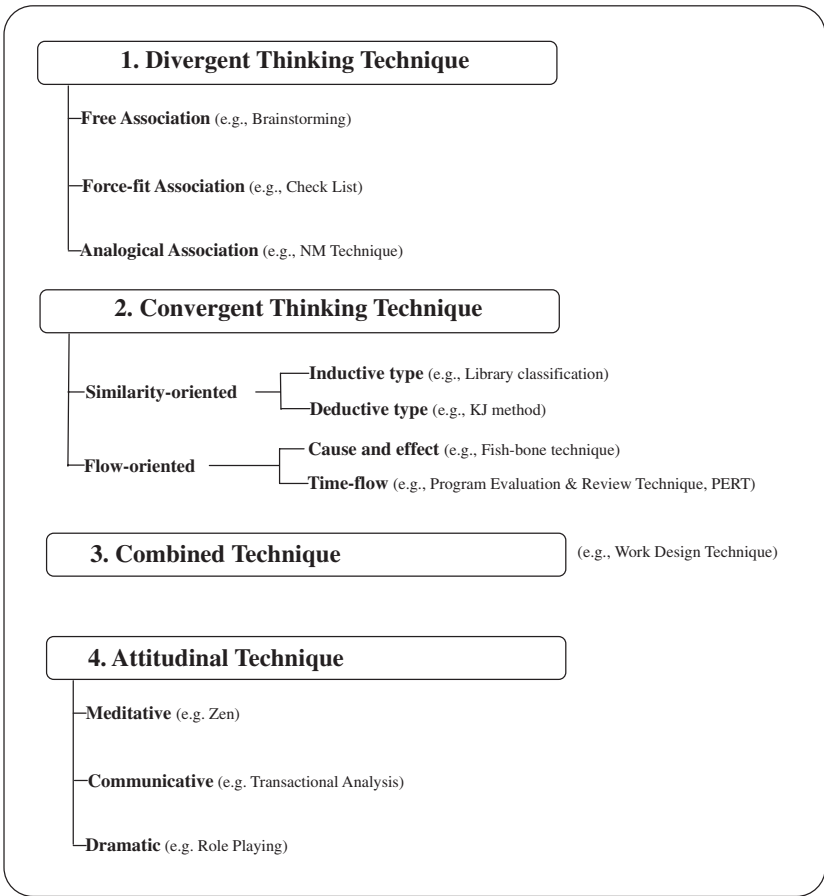
Fig. 18.1.   Four categories of creativity techniques.

latter related to the thinking that organizes and synthesizes ideas and data. Furthermore, the techniques that do not belong to clearly either divergent thinking techniques or convergent ones but involve both of them are grouped under the combined technique. In addition, techniques that do not mean to solve problems but to regulate creative attitudes are termed the attitudinal technique (Takahashi, 2002).

The divergent thinking technique: Aristotle proposed three types of associative thinking. They were contradiction (e.g., the direction "up" is associated with "down"), approximation (e.g., mountain is associated

with river), and analogy (e.g., ball is associated with globe). Referring to the three types of Aristotle's associative thinking, the author came up with three types of divergent thinking techniques: free association, force-fit association, and analogical association. In free association, the person refers to a theme, and thinking without constraints is encouraged. No direction is given in free association. Ideas are freely generated and this is repeated around a given theme. In psychology, thinking from the specific viewpoint of a theme is called limited association. Force-fit association is based on it and refers to thinking according to the direction indicated by the given hint. Analogical association first investigates hints related to an object. From the hints ideas are generated.

The convergent thinking technique: there are two types of convergent thinking techniques, namely similarity-orientation and flow-orientation. The similarity-oriented techniques organize and synthesize data based on their content similarities. The flow-oriented techniques arrange information according to cause and effect and time flow.

The similarity-oriented techniques are further divided into the inductive type and the deductive type. The former is about inferring a specific fact from a principle. The latter is about deducing a principle from facts. In creative problem solving, the deductive type is used often to search for clarity beyond conceptual boundaries.

The combined technique: The balanced use of the divergent thinking techniques and convergent ones is the core of the combined techniques.

The attitudinal technique: There are three types: The meditative, the communicative and the dramatic. The meditative technique originated by the Eastern philosophy includes yoga, Zen, meditation, hypnosis, and self-discipline. The foundation of these techniques is to reach the state of concentration, and then enter into the state of developing concrete products. The communicative technique is an approach used in psychoanalysis and counseling. Transactional analysis is well-received in Japan for healing. The problem solver engages him(her)self in the process of overcoming difficulty, self-transformation, and change. The dramatic technique is adopted from group counseling. In a small group, its members play roles in a scenario, finding out a real problem. The

child is the object of the psychological drama while the adult is the object of the societal drama.

Japanese Divergent Thinking Techniques

Divergent thinking techniques are for idea generation. There are a variety of divergent thinking techniques. One of them is called brainstorming, which was developed A.F. Osborn in US. Brainstorming has been commonly used in Japan, where variations of the technique have also emerged.

Card brainstorming technique

Card Brainstorming (brainstorming with cards) is a technique invented to prevent people who are generating ideas from speaking up what they think. With cards used in generating ideas, each member is required to write down his(her) ideas on the cards in silence. After the individuals generated their ideas, they share them in group verbally. Silence alternates with speaking. In this way, all members- the vocal and the reserved- can contribute their ideas fairly. Also, generating ideas using cards makes the organization of ideas easy.

Procedure of card-brainstorming

Preparation: A theme is recognized. The leader announces the theme to the members (about six of them) of his(her) group. Each of them is given 50 cards (2.5 cm × 7.5 cm sticky notes are the most appropriate) and a piece of A4 size paper. They take seats next to each other around the table. In the middle of the table there are three to four pieces of A3 size paper. The leader undertakes the role of a facilitator, a time-keeper, and an idea-generator. Duration for idea generation is between 30 and 60 minutes.

Idea generation: The first five minutes is allocated for individual idea generation. The leader sets a time-slot for five minutes. Members think silently. When they come up with ideas, they write them down on cards, using one card for one idea. Then, they paste the cards with ideas onto their sheets of A4 size paper at hand. After five minutes, the

members begin to share their ideas in rotation. In this sharing, each member reads the idea written on his(her) card, thereafter pastes it on to one of the A3-size paper prepared on the table. Listening to the ideas presented, the individual members continue writing their ideas on cards. The individual discards his(her) card if the idea on it is the same as what is read by the speaker. During the next five minutes, again, the individuals enter into the individual idea-generation session. Thereafter, the group members share their ideas while their cards are pasted on the A3 paper on the table. The individual idea generation and the team sharing processes repeat until all the cards are pasted on the sheets of A3 paper. The session ends when all the cards of the individuals are read.

The use of the card-brainstorming: Ideas generated and written on the cards can be synthesized with each other. To this end, a combined technique is used (see discussion above). It encourages the individual and group engagement.

Card brainwriting technique

A German researcher refined brainstorming and proposed the brainwriting technique. The procedure for card brainwriting is similar to that of brainstorming. A theme for brainwriting is identified. Participants and tools for brainwriting are organized. Card brainwriting is used frequently in Japan, Korea and China.

Procedure of card brainwriting: It is similar to the basic brainwriting procedure. Each member is given a sheet of A4-size paper and eighteen cards (2.5 cm × 7.5 cm). On each A4 size paper, three cards are pasted horizontally (row) and six vertically (column).

Three minutes are allocated to generate three ideas. During the first three minutes, each participant notes ideas on the cards in the top row of his(her) paper. When the time is up, the paper is passed clockwise to the person sitting next to him. During the second three minutes, three ideas are written down on the cards in the second row. The process repeats until all cards in the six rows of the A4 paper are filled.

Keyword card brainwriting or in short KW card brainwriting uses keywords to generate ideas. For a particular theme, the participants

refer to the given keywords and generate related ideas. In other words, keywords are written at the top of a brainwriting sheet, and accordingly ideas are written below. Suppose that a team is about to generate ideas to promote a restaurant. In this scenario, keywords suitable for KW card brainwriting may include "menu," "advertising," and "facilities" (see Fig. 18.2).

The practical use of brainwriting: Card brainwriting can be employed easily in practice for idea generation. It is easy to manage ideas after a session. To cite an example, the author, using the internet, carried out an idea-generation seminar for 50 organizations and attracted 400 participants. This technique allowed the author to manage time well and the participants to sort out and evaluate their ideas smoothly. The whole process of brainwriting was conducted systematically.

Theme: "How to increase the number of customers for a restaurant?"

BUILDING/ FACILITIES	MENU	ADVERTISING
Spacious parking space	Home-made	Coupons to be distributed at train stations
Good vision from the ceiling	Buffet	Special features in magazines
Wheelchair friendly	Chef cook friendly	Balloons hung on the roof of the ceiling
Comfortable tables and chairs	More than 200 varieties of food	Building and car park painted in red

Fig. 18.2.   KW Card Brainwriting (an example).

The NM-analogical thinking

The NM-image oriented creative associative thinking and problem solving

M. Nakayama invented the NM technique which presents itself as a classical example of the "image" oriented creative thinking. Nakayama believes that the Japanese are good at perceiving and memorizing images. Image-oriented thinking employs human beings' listening and visual capacities to understand non-verbal communication, picture representations, real life experiences, and imagination.

The NM technique uses the principle of analogy to stimulate thinking. Keywords or images are generated from problems. Participants associate functions of selected images with problems. These associations help them to propose solutions.

The procedure of the NM technique includes the following (Takahashi, 1993, 2002, see Fig. 18.3):

- Setting problems
- Deciding keywords
- Finding out question analogy (Stage 1)
- Finding out question background (Stage 2)
- Conceptualizing questions (Stage 3)
- Deciding problem-solving plan

Suppose that a person wishes to invent an "invisible" ashtray (setting problems). S/he will search for a number of keywords that relate to this invention such as: "to throw," "to put," "to store," "not to be seen," and "does not disturb other people" (deciding keywords). On some occasions, s/he is requested to draw pictures using keywords that s/he selected. From here, three stages prevail in the search for the best solution. In the stage one, images are selected to represent keywords (question analogy). For instance, Ninja and a pencil box are employed as analogies or images. Stage two is about "what is happening" to the analogies or images provided in the stage one. Answers are generated in terms of functions, structures, characteristics, and corresponding events of the images (question background). Answers generated in this stage should help describe the images. In this instance, familiar

Theme: "Invisible" ash tray

[Solution]	

Hide and Save ("throw away," "put," "store," "put out," etc.) ← **[KW]**

[Solution]
The product is a pencil holder with an ash tray at its bottom. The ash tray is hidden. It revolves out of the pencil holder when in use; and it revolves back into the pencil holder after use and hence "out of sight"

[QA]
An umbrella stand at the entrance

A pivoted door of a Ninja house

[QB]
A folded umbrella in an umbrella stand can not be seen

A stand with round shape

The door revolves and a person enters the room

The door that revolves is part of a wall keeping only the function of the door but not its shape or feature

[QC]
A deep ash tray (i.e., long in shape)

A pencil holder of which an ash tray is part

A "high" ash tray

A tube-like, vertical ash tray that stands on the floor (the cigarette's fire will go out quickly)

A lid for the top of an ash tray

A device to conceal an ash tray

Changing the shape of the ash tray but keeping its function, at one glance the product does not look like an ash tray

Integrate an ash tray into something else

Fig. 18.3.   The use of the NM technique (an example).

behaviors of Ninja, appearing in front of and disappearing from a door way, and the storing function of a pencil box are selected as sources of ideas for a new invention. In the stage three, using the answers generated during the previous stage, one attempts to generate creative ideas for the theme (in this case "an invisible ashtray") (question conception). It is helpful here to try to force-fit or integrate the theme with the answers generated in stage two. Stage three is followed by the problem-solving stage where a person determines the identified ideas and creates the best solution(s) with them.

The Japanese convergent and divergent thinking techniques

Kawakita Jiro invented the KJ-method taking into account the Japanese's group consensual behavior that attempts to avoid extreme opinions. The KJ-method uses cards to record ideas. It is believed that cards diminish the "openness" of ideas, and hence they minimize the opportunity of ideas being too appealing in a group. The KJ-method focuses on the flow of thoughts using a non-threatening, unconditionally positive attitude to encourage the participants to generate and synthesize ideas. Theoretically, the KJ-method projects two levels of a creative-problem-solving cycle: the thinking level and the experience level. The cycle is represented by a W-shaped model (see Fig. 18.4).

At the thinking level, questions are asked (A) and hypotheses are selected (D), concrete measures are formed (E), and conclusions are derived (H). At the experience level, data observation (B-C) and experiment observation (F-G) are carried out. During the transitional stage between the thinking level and experience level, four processes are discernible. They are investigation (A-B), data collection and summarization (C-D), preparation of experiment (E-F), and evidence searching (G-H). Graphically, it is referred to as a W-shaped model. It is viewed as a classical example of a "card" oriented brainstorming technique. The KJ-method synthesizes extensive data. This method observes the principles of egalitarianism and continuous improvement, and so all data are considered in the synthesizing process with no data abandoned. Cards with similar data are grouped together. Sentences that relate the content of the cards are generated and are recorded on

Theme: "What are the factors of a good working environment?"

Good climate with employee benefits

Positive atmosphere

Study-abroad programs as incentives to encourage employees

Respect for every individual

Employees are encouraged to self-manage their tasks

Leaders who acknowledge their subordinates

Good relations among colleagues. Nomination of leaders according to tasks

Rest well to improve the efficiency of work

Tea at 3 p.m. to rest and refresh the mind

After a sound sleep at night, work better

Good physical environment to improve the efficiency of work

Good BGMs improve work efficiency

Comfortable office enhances work efficiency

Fig. 18.4.   The use of the KJ-method (an example).

prepared labels. The sentences are then synthesized for the best pro-
posal or solution. Participants examine the data repeatedly until they
achieve the best outcome.

The Japan's Creativity Development in the Individual and Organizational Practices

The Japanese thinking patterns

In 2004, the author conducted a survey on the question: "Where busi-
nessmen would gain their ideas or hints?" A total of 201 businessmen

participated in this study. The result of the survey showed that 47% of the participants indicated bookstores as the place for idea finding, followed by 39% with public speaking centers and 38% with streets and shops. The reason for the bookstore to rank first is that it fills with new books as libraries in Japan are not well-equipped. Street and shop ranked third. A daily walk may aid in cultivating consciousness of ourselves and our expressions. The media that induce ideas include websites (46%), general magazines (40%) and TV and radio programs (33%). As for the question "when you seek hints for ideas, whom do you talk to," colleagues at work ranked first (56%), seniors at work (46%) ranked second, contemporaries (36%) ranked third, and spouse and own children (30%) ranked fourth. Ouyang shiu, an eminent Confucian scholar during the North Sung Dynasty once recorded in his writing the places where his writing ideas emerged: they were "on the horse," "in bed" and "in the restroom." Similarly, in our study on the places where the people of this era think, we found the three best places: they were transport or traveling (51%), a bed (40%), and a bathtub (Ofuro, 31%). The Japanese seem to generate ideas at night. According to the same survey, the time in which ideas occurred to people were evening and night (42%), about going to bed (37%) and mid-night (29%).

The use of creativity techniques

The following part briefly introduces three surveys implemented in Japan, respectively, in June 1973, August 1983, and June 1989. A total of 91 organizations took part in the survey in 1973, 70 in 1983, and 394 in 1989. These organizations promoted the use of creativity techniques in enterprise education. The question asked was what creativity techniques were introduced during such education. For all the surveys, brainstorming was listed with the highest percentages: 71.3 (1973), 57.1 (1983), and 87.1 (1989), followed by the KJ-method: 75.4, 48.6, and 63.7; and the NM-Method: 26.3, 20.0, and 23.7. In the 1983 survey, transactional analysis acquired 11.4%, Zen/meditation, 5.7%, and self discipline, 2.9%.

Conclusion

In conclusion, some applications of the creative techniques described above in the enterprises are discussed.

Brainstorming

The research center of Mitsubishi Electric Corporation regularly had brainstorming and idea generation meetings when new electronic products were to be developed. When a new refrigerator was to be invented, the people involved in a brainstorming session included researchers, marketing personnel, line workers as well as those working in the refrigerator department. The person in-charge from the department facilitated the brainstorming session and encouraged the members to suspend their judgment of ideas for the generation of new ideas.

Card-brainstorming and card brainwriting

Advertising firms and planning enterprises have often used both of card-brainstorming and card-brainwriting. They use them during their product-development meetings and generate ideas for names of companies or products. A large number of ideas can be created with these creativity techniques. It is not uncommon that a group of eight persons using the techniques generate 500–1000 options in a two-hour idea meeting. Card brainstorming liberates participants from the stress of presenting their ideas in front of others. Hence, they can freely play with ideas in their minds. In addition, card brainstorming allows ideas to be systematically recorded and so it is not essential to have a secretary in the meeting. Organizing the ideas generated becomes easy.

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Part Three
Creativity of Contexts

Section VI
Disciplinary Perspectives

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Academic and Global Contexts for Creativity: Interdisciplinary Perspectives

Don Ambrose

Introduction

Academic and Global Contexts for Creativity: Interdisciplinary Perspectives

Creative thought and action occurs within various contexts, and we need broad overviews of these contexts for better understanding of the creative process. This chapter provides a brief example of such an overview by surveying several broad aspects of contextual influences on creativity. First, it illustrates some recent analyses of the structure and dynamics of some academic disciplines and considers their possible impact on creative scholarship. These analyses include examination of some implicit, metaphorical influences on scholarly thought. Second, departing somewhat from the influences of academic disciplines, it considers some examples of cultural and historical influences on creative work. Third, it goes into somewhat more depth probing some dimensions of socioeconomic and ideological contexts in our increasingly intertwined, globalized world. From these analyses I recommend capitalizing on the global networking phenomenon of motley coalitions to expand the influence of altruists on the world stage while increasing their numbers and making them exemplars of ethical thought and action.

Diverse Academic Influences on Creativity

Historians Bender and Schorske (1997) initiated analyses of the structure and dynamics of four disciplines from the humanities and social

sciences. Drawing on the long-range perspectives of leading scholars, the analyses contrasted the evolving epistemological structures of two pluralized, fragmented-porous disciplines (English studies and political science) with two tightly unified-insular disciplines (analytic philosophy and economics). The pluralized disciplines are fraught with internal conflict, include a wide variety of competing theories, and are revising their fundamental conceptual frameworks. For example, in the past several decades English Studies entertained a proliferation of very diverse constructs and theoretical perspectives (Abrams, 1997). Much of this dynamic flux was catalyzed by the moral claims of ethnic and gender minorities in society, thus revealing the context sensitivity of the discipline. Outside the scope of the Bender and Schorske analyses, cultural anthropologist Geertz (2000) saw similar dynamics in his discipline. Cultural anthropology reveals the local particularities of diverse cultures so it has a centrifugal impulse, spinning the knowledge-base of the discipline outward away from consensual unity.

In contrast, the unified-insular disciplines are firmly bounded, well-policed, and reflect confidence in their conceptual foundations. Unlike English studies and political science, the disciplines of economics and analytic philosophy are much less context sensitive and tenaciously preserve their core assumptions and methods against post-modern challenges from feminist and multicultural perspectives.

All disciplines evolve over time and the fractured-porous ones are the most prone to change. Nevertheless, even the unified-insular disciplines can discover cracks in their epistemological fortress walls. The currently unified field of economics, for instance, is showing some signs of contestation and fragmentation because its core assumptions about economic systems in full-equilibrium states and economic actors making fully rational decisions are being challenged by theories emphasizing non-equilibrium states (Kreps, 1997; Beckert, 2002; McCloskey, 2002; Fullbrook, 2004). These dissenting pressures are emerging partially from interdisciplinary borrowing from biology, sociology, and psychology.

Root-Metaphorical World Views Tacitly Influencing Disciplinary Structures and Dynamics Disagreements over epistemology in academic disciplines tend to arise from strong adherence to one of

several root-metaphorical world views that implicitly shape scholars' beliefs about the appropriateness of various investigative methodologies, (Pepper, 1942; Overton, 1984; Gillespie, 1992; Ambrose, 1996, 1998a, b). A world view is a root-metaphorical conceptual lens providing a filter through which we view phenomena. Each world view establishes a unique perspective for investigation and interpretation, magnifying some attributes of a phenomenon while hiding others. In academic disciplines, scholars often go to war with one another over these deep-level philosophical perspectives (Ambrose, 1996, 1998a; Gillespie, 1992).

The four world views include mechanism, organicism, contextualism, and formism. The mechanistic view is based on a machine metaphor portraying the world as an enormous mechanism with stable, fixed components conducive to reductive analyses and the search for the simplest cause-effect explanations. The organicist view, based on the metaphor of a living thing, highlights intricately integrated, dynamically evolving systems, encouraging a researcher to look for long-term developmental processes in a system, and for the mutually shaping interactions among its subsystems. The contextualist view, based on the root metaphor of an ongoing event within its context, encourages investigators to discover the unpredictable emergence of novelty in events, and the contextual influences that catalyze such novelty. The formist view, based on the root metaphor of similarity, encourages investigators to look for patterns of similarity in very diverse phenomena.

The world views provide helpful lenses for interpretation of the perspectives provided by the disciplinary analyses of Bender and Schorske (1997) and Geertz (2000). For example, the unified-insular disciplines appear to be strongly rooted in the mechanistic world view because they tend to reject the context-sensitivities of post-modern thought while relying heavily on logic and quantitative model building in search of reductive precision (Ambrose, 2006). In contrast, the fractured-porous disciplines seem rooted in contextualism because they encourage the unpredictable emergence of novelty from the mixing of diverse theories and borrowing from inter-disciplinary contexts. The disciplines also allow some room for formism, because borrowing of concepts

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through porous disciplinary borders can reveal some remarkable similarities. In an interesting example, McMurtry (1999) drew compelling parallels between the dominance of neoliberal ideology in political and economic globalization and the characteristics of a cancer attack on the human body, suggesting that the world now suffers from the cancer stage of runaway capitalism. Finally, organicism may influence fractured-porous disciplines to the extent that interdisciplinary borrowing ties together integrative networks of scholars from different disciplines.

The Effects of World Views on Creative Scholarship

The most obvious implication for creative scholarship to be drawn from insights about the structure of disciplines, and their shaping by root-metaphorical world views, is awareness of the possibilities for tacit thought entrapment and dogmatic insularity. Those who are unaware of tacit influences on their thinking can become dogmatic and insular in their approaches to investigation (Pepper, 1942; Gillespie, 1992; Ambrose, 1996, 1998a, b, 2000, 2003b) and cannot perceive the value in alternative theories that may make them more creative. For example, economists who are tightly wedded to rational choice theory, which portrays humans as coolly rational atomistic individuals making decisions driven by self-regard, tend to reject theories that emphasize cooperation or sociocultural influences on behavior (Beckert, 2002). In an example from another field, many cognitive scientists have argued about the relative merits of symbolism, the view that cognition arises from very rapid computer-like computation in the brain's hardware, and connectionism, the view that cognition emerges from parallel processing in the elaborate neural networks of the brain (Baumgartner and Payr, 1995). A few others have lamented the neglect of sociocontextual influences on cognition, arguing that the mind is largely immanent in the world and not trapped within the cranium (Weizenbaum, 1995; Descombes, 2001).

In view of the tendency of disciplines to follow unified-insular or fractured-porous patterns (Bender and Schorske, 1997), these arguments in cognitive science imply that this vibrant field tends toward

fractured porosity because there appears to be a lack of consensus about core conceptual frameworks. While the lack of consensus and certainty can be frustrating, fractured-porous disciplines can provide rich opportunities for scholars to benefit from the thought-provoking awareness of incompleteness and disharmony that Torrance (1995) argued is important for creativity (Ambrose, 2006). The warring camps constantly battling for theoretical dominance within these disciplines inject a considerable amount of divisive flux. So do the diverse, destabilizing ideas that often are imported through their porous disciplinary borders from other fields.

Through the lenses of the world views, the symbolists appear to be highly mechanistic because their portrayal of rapid computer-like symbol processing reduces the mind to a machine-like process conducive to eventual prediction and control. The advocates of parallel processing seem to be mechanistic to the extent that they rely on another computer metaphor of mind, but their notion of mind integration through neural networking reveals some organicist thought. However, the contextual mind theorists demonstrate contextualist thought because they highlight the importance of sociocontextual influences while criticizing the entrapment of both symbolists and connectionists within mechanistic computer metaphors. Finally, the tendency of cognitive scientists to rely on computer metaphors of mind reveals some formist influence, because metaphor is a primary method for drawing creative insights from patterns of similarity.

While mechanistic thinking may be the most prevalent world-view influence on cognitive science, the field seems to draw from all four root metaphors. This strengthens the field creatively because multiple world-view perspectives provide structural corroboration (Pepper, 1942). But as individuals, many scholars in the field seem trapped within a single world view, often to the point of dogmatic insularity. While scholars can generate creative theories and investigative trajectories from within the confines of a single world view, they would expand their potential for creative work by remaining open-minded about constructs from other world-view perspectives (Gillespie, 1992; Ambrose, 1998a, 2006). Those who react to opposing theories by becoming more entrenched, prematurely rejecting new theories without sufficient

scrutiny, are the most prone to dogmatic insularity and the least likely to foment creative work within their disciplines.

Diverse Socioeconomic, Political, and Cultural Influences on Creativity

While disciplinary influences on creative scholarship are important and often hidden from view, the impact of large-scale socioeconomic, political, and cultural contexts on the population as a whole is of even greater magnitude. The following are some examples of large-scale contextual phenomena and their possible influences on creativity (drawn from Ambrose, in press):

1. Purpose, glory, and warlike Romanticism. In contrast with rational, Enlightenment thought, the periodic resurgence of Romanticism in America brings emotional, highly patriotic, and courageous elements to the fore, making it easier to engage in wars while forgetting the horrors of past conflagrations (Fletcher, 2002). In such times, creative action in the socio-political realm can suffer from polarized, black and white thinking and a lack of intellectual humility.
2. Intellectual vitalization in the midst of oppression. Between the two world wars, African American intellectuals generated the highly innovative Harlem Renaissance, which produced high-impact literature, poetry, theatre, music, and painting (Watson, 2001). That the movement occurred at all in an era of racial oppression highlights the resiliency of some creative people, and their possible use of injustice as inspiration for their creative work.
3. Post-materialist values and worldwide cultural transitions. According to studies based on the world values surveys, which collected opinions about values from a large number of societies representing the majority of the world's population, the fundamental ideals of entire nations and international regions seem to be changing from modern-materialist to post-modern-postmaterialist values (Inglehart, 1997). Once a society has established itself as sufficiently affluent for the population to accept survival as a given, the people tend to shift their focus from material acquisition and adherence

to external, traditional authority to quality of life concerns, and self-expression, because further material gain brings diminishing returns. Modern-materialist nations press creativity more in the direction of materialistic product and service innovations while post-modern-postmaterialist nations likely encourage more creative work in the areas of artistic, literary, and personal development.

These contextual phenomena, and many others, need more investigation by scholars in the field of creative studies. The next section illustrates some aspects of one other set of broad-scope contextual influences on creativity. The pervasive phenomenon of globalization has many socio-economic, political, and cultural strands, each of which exerts considerable and widely varying influences on creative people. A few of these aspects of globalization are briefly considered here to further illustrate the need for more attention to large-scale contexts for creativity.

Globalization: Its Effects on Creative Thought and Action

Globalization is the increasingly vibrant, fluid, dynamic interconnection of the world's economies, sociopolitical systems, and cultures (Singer, 2002). While international integration has been evident for centuries, it accelerated considerably in the last half of the 20th century, driven by the expanding power of information technology. Like any widespread socio-contextual influence, it brings forth both beneficial and harmful effects.

One key element in its evolution, selected for special emphasis here, is its dominance by neoliberal ideology, which is based largely on the ideas of neoclassical economists such as Hayek (1944) and Friedman (1962, 1975) as well as other, more recent thinkers (e.g., Lal, 1996; Gwartney, Lawson and Holcombe, 1999). The neoclassical perspective strongly promotes the freedom of the individual to maximize self-interest in a laissez-faire economic system. Governments are to refrain from significant intervention in, and regulation of, the economy, limiting their contributions to the provision of law and order, especially for

the protection of individual property rights. Under these conditions, rational self-interest on the part of many individuals interacting in a free marketplace should increase savings, investments, and productivity, thereby maximizing per capita income and well-being for everyone.

The 18th-century Scottish economist-philosopher Smith (1937) provided much of the propulsion for this ideology, especially with his metaphor of the *invisible hand* in the marketplace, which represents the efficient, spontaneous organization of the economy through the interactions of many individuals who are guided by self interest.

Runaway Globalized Capitalism?

In spite of this optimism, there are insightful dissenters. Going back to the roots of neoclassical theory, Fleischacker (2004) and Muller (1995) both reminded us of the ethical-philosophical dimensions of Adam Smith's thought. Contrary to the popular impression that Smith was a champion of unfettered market-based selfishness, they showed that he mollified his promotion of free-market dynamics with advocacy of government intervention when necessary to protect citizens, especially the underprivileged, from the excesses of individual greed. In short, with some irony, Adam Smith himself, the historical icon of laissez-faire economics saw enough potential flaws in that system to embrace a larger "civilizing project" designed to create a more decent society.

Consistent with Adam Smith's own warnings about the excesses of unfettered markets, which now strongly shape modern globalization, other scholars have been highlighting some ethical flaws in the globalized socioeconomic system. For example, Howe (2002) worried that the United States and its interests, which include transnational companies, financial and media institutions, and other forces of globalization, constitute a new imperial system. The eminent political theorist Wolin (2004) agreed, arguing that the United States has created a new form of political authority based largely on corporate influence throughout the globalized world. Calling this system *inverted totalitarianism*, he claimed that economic rather than political power has become dominant to the serious detriment of democratic and ethical considerations.

Some other dissenting scholars claim that the neoclassical commandeering of global markets has been failing in its attempts to develop the third world. For example, Chang (2002) claimed that developed nations are forcing third-world nations to adopt extreme versions of laissez-faire policies and institutions, making foreign aid, and debt relief contingent on obedience to neoliberal ideology. Ironically, these policies and institutions are incongruent with those employed by the developed nations themselves when they were emerging from third-world status, and they are showing poor results today, Metaphorically speaking, Chang argued that developed nations' enforcement of neoliberal ideology is kicking away the ladder they used themselves to climb toward prosperity. In a more specific example of such economic hegemony, Babb (2001) reported that American-trained neoclassical economists strongly influenced and largely overrode democratic processes in Mexico by embarking on an ambitious program of privatization, deregulation, budget-cutting, and the advancement of free trade. Woodward and Simms (2006) also argued that globalization driven by mainstream economic thought is failing the world's poor because they share little in any benefits from growth Accordingly, dominant economic thought should change to shift power somewhat from elites in developed nations toward the suffering majority of the world's population.

Still others have connected globalization to problems in the environment. For example, Speth (2004) argued that population growth, climate change, destruction of habitat, and many other factors largely driven by economic globalization and changes in technology are working together to push us toward devastating environmental deterioration. This destruction, along with looming water, food, land, and energy scarcities, portend growing poverty, epidemics, and chaotic, large-scale economic instability and conflict.

An array of other problems emerges in discussions of globalization and its impact. The outsourcing of employment is undermining the opportunities, aspirations, and well-being of working class people in developed nations (Barlett and Steele, 1997). The globalized media and market forces are driving the loss of linguistic diversity (Dalby, 2003). Orlie (2001) argued that late-modern capitalist societies

promote democracy as a supreme value while paradoxically undermining it. Powerful, media-based marketing portrays virtually everything worthwhile in our lives as purchasable commodities thereby seducing citizens to make shallow materialism their primary focal point in life, and undermining their ability to think critically about important policy issues. Others who warn against the dominance of neoclassical, neoliberal ideology on the world stage include Fullbrook (2004) and Saul (2005).

All of these complaints can fit within McMurtry's (1999) notion that globalized capitalism has extended beyond its role as a valued driving force for creative economic development, morphing into a runaway cancerous invasion that is undermining the well-being of most people in the world. To the extent that these criticisms are valid, globalization requires new forms of creative intelligence on the part of policy makers and citizens worldwide.

Globalization Magnifying the Importance of Moral Creativity

Whatever the proportion of positive to ill effects generated by globalization and other large-scale contextual influences, the ever-evolving socio-economic, political, and cultural landscape demands much of our creative capacities. We should attempt to preserve the positive, creative benefits of the globalized world while mollifying its harmful effects to the extent possible. Of course, creatively shifting the effects of massive, intricately complex, and ever-evolving global contexts in positive directions is a daunting, seemingly quixotic endeavor. Nevertheless, scholars of creativity and giftedness have thought such attempts worthy of effort and have emphasized the importance of moral creativity in today's uncertain world (Ambrose, 2000; McLaren, 1993, 2003; Runco and Nemiro, 2003; Csikszentmihalyi, 1993; Gruber, 1989, 1993; Richards, 1993; Silverman, 1993; Stein, 1993; Tannenbaum, 2000).

If we take positive adaptation to globalization as a goal, we need strategies for creative thought and action guided by conceptual frameworks that can highlight the dangers and opportunities posed by the environment in order to strengthen our contextual intelligence

(Sternberg, 1988, 2005) on the large scale. Creative strategies might include using moral creators as exemplars of positive life trajectories that young people can follow. Another possible strategy is encouraging the global networking of our youth, using the example of innovative, motley coalitions described by Tsing (2004). Yet another is the development and employment of new myths and metaphors capable of attracting large numbers of people away from the superficialities of egoistic individualism toward relational altruistic self-fulfillment.

Creative Aspiration and Talent Development Toward Ethical Self-Fulfillment

One conceptual framework that connects the problems of creative adaptation to globalization is a recently developed model of aspiration development and self-fulfillment (Ambrose, 2003a). Based on integration of research and theory from the fields of sociology, economics, and ethical philosophy, the model reveals some ways in which socioeconomic privilege or deprivation encourage or suppress the long-range development of aspirations and capacities (i.e., talents) toward self-fulfillment (Figure 19.1). Aspiration growth generates strong long-term desires for accomplishment, which catalyze the capacity development necessary for pursuit of the aspiration. Emerging and strengthening capacities guided by strong, clarifying, long-range aspirations produce successful, gratifying life experiences, and these in turn generate self-fulfillment over the life span. According to Gewirth (1998), self-fulfillment is the discovery of one's deepest desires and worthiest capacities, and the subsequent development of these capacities. Optimal self-fulfillment becomes evident from looking back over one's life near the end of the journey and feeling that it was a life well lived. It stands in contrast with limited self-fulfillment, which comes from periodic, momentary gratifications dependent on material gain or public recognition, and negligible self-fulfillment, which entails a concatenation of failures, or sleepwalking through life.

The model also shows two life-trajectory (dotted lines on Figure 19.1) destinations representing self-fulfillment. One destination

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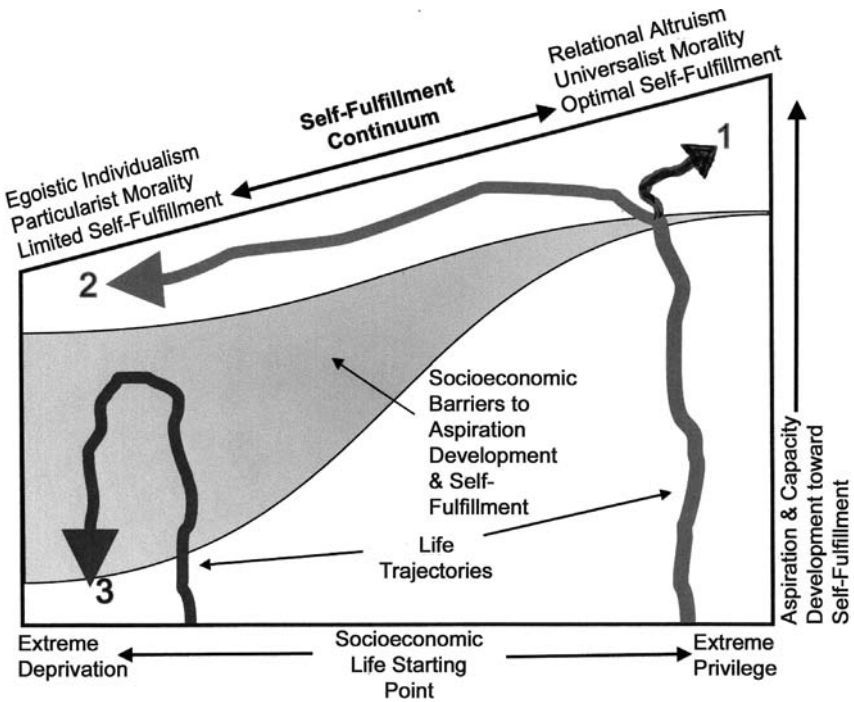
Fig. 19.1.   Creative aspiration development model. Adapted from "Barriers to aspiration development and self-fulfillment: Interdisciplinary insights for talent discovery," by D. Ambrose, 2003, *Gifted Child Quarterly*, 47, pp. 282–294. Copyright 2003 by the National Association for Gifted Children (Adapted with permission).

is the upper-left corner of the model: the region of egoistic individualism, particularist morality, and limited self-fulfillment. The other is the upper-right corner of the model: the region of relational altruism, universalist morality, and optimal self-fulfillment. Egoistic individuals approximate the self-loving rational actors portrayed in neoclassical economic theory. Their aspirations and talents aim at goals of materialistic gain and self-aggrandizement. If they engage in any altruistic acts, these usually are particularist in nature, confined to helping those close to them (i.e., relatives, members of their own ethnic, religious, or national groups), as opposed to helping others in the world in general. In contrast, relational altruists develop outreaching aspirations and talents that lead toward universalist morality, which encourages moral-altruistic connections with all of humanity, not just with one's own

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particular group. According to ethical philosophers (Monroe, 1996; Martin, 1997; Gewirth, 1998), relational altruists can reach the highest levels of self-fulfillment. Egoistic individuals can achieve only limited forms of self-fulfillment entailing somewhat hollow, ephemeral self-glorification or materialistic gratification. These developmental end points are designated on the model by a low self-fulfillment ceiling in the upper-left corner over the end point of egoistic-individualistic life trajectories and a lofty ceiling in the upper-right corner over relational-altruistic life trajectory end points.

The sloping curve on the model represents socioeconomic barriers that can stunt or warp aspiration and talent development, keeping individuals' life trajectories from ascending toward self-fulfillment. Children born into poverty face immediate, oppressive barriers to their development, which include stigmatization, segregation, and deprivation (e.g., poor nutrition, barren and dangerous neighborhood environments, lack of educational and career opportunity). In contrast, children from affluent backgrounds typically face minimal barriers and can develop aspirational momentum based on early success experiences and enriching life contexts.

Three hypothetical life trajectories related to globalization show up on the model. Trajectory 1 represents the path of privileged relational altruism in which an affluent individual achieves the highest levels of self-fulfillment by developing strong altruistic aspirations and capacities, avoids the enticement of egoistic individualism, and becomes a relational altruist. Many of the Doctors Without Borders (Leyton, 1998) follow this path because they come from affluence yet they are willing to sacrifice their own comfort and safety to serve the downtrodden in dangerous, warn-torn regions. Trajectory 2 represents privileged depravity in which the affluent individual develops strong capacities but uses them to reach the limited self-aggrandizing and excessively materialistic forms of self-fulfillment characterized by extreme egoistic individualism. Many of the key players in corporate corruption scandals have followed this path. Life trajectory 3 is the path of deprived passive escapism, which represents the failure to develop productive aspirations and capacities in the face of oppressive deprivation, stigmatization, and segregation. For example, some homeless individuals and exploited

sweatshop laborers are trapped in this abject region of the model. Another six life trajectories appear in the original model (Ambrose, 2003a).

The domination of globalization by neoliberal ideology promotes the largely unfettered actions of self-interested, affluent rational actors, thus drawing them toward the egoistic-individualistic region of the aspiration development model where limited self-fulfillment prevails. The exploitation of the deprived in our highly stratified Darwinian world forces the vast majority of third-world populations and many working class people in developed nations down into the wretched lower-left region of the model because they cannot break through the oppressive barriers to develop promising aspirations. The few people who become relational altruists do it by somehow resisting the compelling magnetism of materialism and vainglory highlighted by neoliberal ideology.

Some Possible Strategies for Creatively Shifting Aspirations and Modifying Globalization

If larger numbers of people from developed nations could move toward relational altruism on the model, by their work and example they might ameliorate the ideology of selfish materialism thereby elevating and thinning the barriers to aspiration development and self-fulfillment. This could enable larger numbers of the underprivileged to develop stronger aspirations and capacities and move toward self-fulfillment. Overall, it could reduce the pull of egoistic individualism on many global actors.

But how can such an improbable shift take place? First, it will take the creation of energetic global networks for encouragement and support of potential relational altruists. According to Ringmar (2005) there is room for creative, grass-roots solutions to power imbalances even in a completely globalized world economy. Individuals and social groups have been very clever in protecting themselves against the excesses of market forces. Tsing (2004), showed how this could occur on the global level. While the current form of globalization most often helps affluent individual creators achieve material gain and

suppresses the aspirations of many deprived people, global communication networks also are supporting the creation of *motley coalitions*, which unite enemies around a common cause to solve problems arising from the excesses of market dynamics. For example, in the late 20th century, Indonesian rainforests were being depleted by the largely unregulated operations of legal and illegal entrepreneurs. In response, unlikely coalitions of local and foreign environmentalists, foreign scientists, North American investors, village elders, urban students, and others came together to defend the rainforests and the communities within them (Tsing). The messy, somewhat conflict-ridden interactions of such unusual, widespread, electronically networked activist groups represent interesting opportunities for the emergence of unique forms of the creative association described by Mednick (1976) and Koestler (1964) as well as the collaborative, creative problem-solving articulated by Treffinger, Isaksen and Dorval (1994).

Such motley coalitions could provide a venue for magnifying the work of talented relational altruists who collaboratively generate and implement creative win-win solutions on the world stage. If so, some of these individuals could become the heroes of new societal mythologies, which could influence the global culture. While this again sounds unrealistic, Wuthnow (2006) pointed out that America was built on stories and myths based on heroic Horatio Alger transformations and self-made men. These American myths dovetail with, and likely contribute to, the characteristics of the archetypal self-interested, self-reliant rational actor of neoliberal ideology. If motley coalitions proliferate on the world stage, strengthening and highlighting the actions of ethical, relational-altruistic leaders, the emerging new hero myths could fortify the aspirational archetype of relational altruists vis-à-vis the competing image of vainglorious, materialistic rational actors while taking important steps toward the thinning of the aspiration-development barriers that hamper the creative self-fulfillment of the deprived worldwide.

Two other bodies of scholarship support this idealistic notion. Mythology has been revealed as a powerful influence on the consciousness of peoples around the world (Campbell, 1988; May, 1990) so employing new, relational-altruistic hero myths may not be as strange as it appears at first glance. Moreover, revelations about the fluidity of

culture make additional room for the proactive shifting of ideology. Benhabib (2002) demonstrated that conservatives and progressives share the misconception that cultures are static, internally homogenous, and coherent. But cultures really are fluid, evolving systems that transform over time. For example, today's American conservatism is quite different from the conservatism of 1875 or 1930. If cultures are not reified and evolve over time, shifting global ideology through motley coalitions and new mythologies seems somewhat more feasible.

Conclusion

The intellectual terrain covered in this analysis is exceptionally broad and complex and it reveals the daunting challenges large-scale contexts pose to our creative intelligence. If we do not take panoramic snapshots of the interdisciplinary and ideological contexts for creative action we are condemned to reactionary mindsets, adjusting too little, too late, or inappropriately to influences seemingly beyond our control.

Any perspective taking on large-scale contexts for creativity has to employ interdisciplinary work, especially when it entails the structure and dynamics of diverse academic disciplines as well as nettlesome, multi-dimensional, moral-ethical issues such as the influences of globalization. Encouragement of interdisciplinary networking around large-scale contextual influences on creativity would be a helpful next step. So would attention to the work of the few Renaissance scholars in our midst. For example, anthropologist Geertz (2000) and political theorist Sheldon Wolin (2004) both have created interdisciplinary, panoptic works with direct relevance to large-scale contexts for creativity. Extending attention to these works beyond their home disciplines, and encouraging the creation of other works like them may generate more widespread awareness of our creative work in academia and in the world.

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Technology-Enhanced Creativity

Effie Lai-Chong Law

Introduction

In recent decades, we have witnessed the rapid development of information and communication technologies (ICT), the ubiquity of the Internet, and the sophistication of distributed as well as embedded computer technologies (e.g. ambient computing). These technological advancements have extended into almost every sector of life such as home, education, commerce, health, and government. Researchers and practitioners thrive to improve the performance of the new technologies and to identify their potential applications for enhancing or even transforming the way people learn, work, think, interact, and communicate with each other. Not only the academic community but also the general public has demonstrated the heightened awareness about the critical role of creativity in personal as well as professional development. Besides, it is encouraging to observe the increasing recognition that creativity is not an endowment of privileged geniuses but, as a cluster of teachable and learnable skills, is acquirable by average persons (IJHCS, 2005; von Hippel, 2005). We see the need as well as the urgency to assume the challenge to identify effective strategies and tools for fostering creative potential in every human being. This challenge can *not* be tackled within a single research area—psychology in which the subject of creativity is well established. Instead, it shall be addressed as an interdisciplinary endeavor, involving not only psychologists but also educationalists, software engineers, computer scientists, human factors experts, ergonomicists, sociologists, anthropologists, and so on. Such a mix of specialists can typically be found in collaborative projects in the field of Human–computer Interaction (HCI). The overarching

mission of this field is to understand and develop software and other technologies with which their users are enabled to attain their goals effectively, efficiently and with pleasure as well as satisfaction. Presumably, enhanced interfaces with high usability can empower their users to be more productive and more creative (Shneiderman *et al.*, 2005).

The objective of this chapter is to examine the relationship between creativity and ICT. Specifically, we aim to discuss, how creative thinking can be promoted by the use of ICT and how ICT can be used creatively so that their potential can be exploited to serve the needs of individuals and the wider society. We attempt to furnish a meta- review on the recent research findings in this area. Loveless (2002) of Futurelab published a highly comprehensive literature review on creativity and learning technologies. In addition, Shneiderman (2002a), a guru of user interface design, developed an alternative framework for understanding creative processes. He further specified how these processes could be supported by ICT. He coined the term "mega-creativity" to convey the idea that millions of people could benefit from software designed for enabling people to be more creative (i.e. creativity support tools). We have also identified a number of interesting scientific works exploring the relationship between creativity and cognition (Candy and Hori, 2003; Vass, Carroll and Shaffer, 2002; IJHCS, 2005; Shneiderman *et al.*, 2005). This specific research community sets its focus on examining the role of HCI research and development in shaping the design of user interface of creativity support software. Our meta-review aims to integrate these divergent but complementary resources to present an overview of the evolving relationship between creativity and ICT and then draw some implications for the future development of such a relationship.

Research on Creativity and HCI: Status Quo

Creativity, like other types of so-called *user experience* attributes (Hassenzahl and Tractinsky, 2006), is gradually gaining its place in the HCI community. The trend of work on the relationship between creativity and technology evolves from being programmatic in the 1990s, conceptual in early 2000 to empirical in mid-2000. Apparently, the

HCI community, to a large extent, has been convinced about the utility and necessity of looking into the problem how technologies can best support creativity. The surge of interest in this special area can be exemplified by a recent workshop on "Creativity Support Tools" (CST) in which 25 leading researchers share experiences, identify opportunities, and formulate research challenges on this significant topic. Accordingly, a number of ways are enumerated to explicate how enhanced interfaces can support creativity:

- enable more effective search for a variety of knowledge resources (cf. federated learning object repositories and digital libraries);
- foster deeper understanding of concepts in question through sophisticated information visualization techniques;
- improve collaboration among geographically distributed knowledge workers;
- more rapid discovery processes with concept-mapping tools;
- provide potent support in hypothesis formation;
- facilitate exploration as well as evaluation of alternatives;
- support error prevention and ease error recovery with undo and backtracking mechanisms;

In particular, it is envisaged that creativity can be accelerated through advanced science collaboratories (e.g., online experimentation with remote labs), design environments for digital arts (e.g. Edmonds *et al.*, 2005), open source communities,[1] and knowledge management tools. These infrastructures can promote idea generation. Furthermore, a variety of brainstorming tools have been developed to facilitate divergent thinking. To enable convergent processing, knowledge organization and concept mapping software are available as well. In fact, there exist a wide range of CST whose quality, however, is not controlled or formally validated. This addresses another significant but under-researched question: How CST can systematically be evaluated? (Hewett *et al.*, 2005).

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[1]Open Knowledge Initiative (OKI) founded by MIT, USA (http://okicommunity.mit.edu/).

Collaborative projects between technologists and artists (including new media artists, musicians and writers) and innovative educational contexts for young as well as adult learners serve as sources of inspiration for developing powerful and usable software. Specifically, Edmonds *et al.* (2005) remark that the cutting edge in the digital arts is a highly fertile ground for investigating creativity and the role of new technologies, which enable innovative combinations of vision, sound and text-based media. Such creative practice can often reveal the limitations of existing technologies. Consequently, such revelation opens up windows for creativity researchers to acquire a better understanding about the multi-dimensional characteristics of the creative process and for inventors of technological solutions to learn what is really needed for digital technologies to be truly creativity enhancing.

Traditionally, creativity has been associated with artistic works. However, due recognition has increasingly been granted to creativity as a key to economic growth and social transformation, as documented in Florida's meticulous analyses (2002, 2005). Specifically, Florida posits a global future shaped by communities that bring creative people together by emphasizing the 3 T's: Technology, Talent, and Tolerance. Assuming the validity of Florida's conjecture, technologies that support and augment creative talents can have tremendous impacts on our lives. Just as magnetic resonance imaging (MRI) has found many novel applications in medicine, biology and beyond, future CST will lure the most innovative minds and enable them to accelerate the pace of discovery and innovation.

In addition, users are increasingly able to innovate for themselves, as exemplified by the recent movement known as 'end-user development' (CACM, 2005). In other words, users are empowered to create their software solutions. The impact of improved software tools is also clearly visible in filmmaking, digital photography, video editing, and music composition. The next generation of these tools will have an even stronger impact as the number as well as the heterogeneity of users grows dramatically.

The challenge for the 21st century is to "work smarter, not harder" (NAS, 2003). The impact of CST on global competitiveness, successful civic infrastructures, scientific leadership, and educated citizenry is

anticipated to be tremendous. Research on CST is still at its infancy (Shneiderman *et al.*, 2005). In particular, rigorous research methods in creativity research will have to be developed because insight, discovery, and innovation are so difficult to assess. Researchers will benefit from development of appropriate benchmark tasks and replicable evaluation methods. Definitely, creativity researchers and inventors of technological solutions will face a number of challenges.

Theoretical Frameworks

Overview of Major Theoretical Models of Creativity

The definition of creativity is often debated. There exist several recent literature reviews which help to describe and theorise understandings of the nature of creativity (Beattie, 2000; Boden, 1991; Craft, 2000; Cropley, 2001; Edwards, 2000–2001; NACCCE,[2] 1999; Partridge and Rowe, 1994; Rhyammar and Brolin, 1999; Santanen, Briggs and de Vreede, 2002a, b; Sternberg, 1999, 2005). Despite the discrepant views of these scholars, some consensus among them is that creativity deals with a process leading to a novel and useful product. Moreover, another unifying element in the related literature is that motivation is a key contribution to creativity (Burleson, 2005; Selker, 2005).Two interpretations of creativity, which are widely recognized by the creativity research community, have been presented by Amabile (1982) and Csikszentmihalyi (1996). Specifically, Amabile developed the componential model of creativity, stating that individuals possess domain-relevant knowledge, creative skills and intrinsic motivation, which interacts with a fourth element, the external social environment, to form a confluence that contributes to creativity. Csikszentmihalyi, in his systems approach, describes an individual operating within a domain, presenting work to the gatekeepers of the domain, who in turn judge the work for acceptance to the domain as a creative

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[2]National Advisory Committee on Creative and Cultural Framework (NACCCE) (UK)—Creative Education (http://www.dfes.gov.uk/naccce/ 028_043.pdf).

contribution. These two definitions are particularly influential in shaping lines of inquiries addressed in the recent creativity research (Shneiderman *et al.*), for instance, identifying design principles and evaluation methods for creativity support tools, investigating the impact of the use of emerging technologies on idea generation, integrating theoretical frameworks of creativity and HCI, and so on. In summary, creativity is understood as a multi-dimensional model such as process vs. product, individual vs. social, and domain-specific vs. domain independent.

Espousing a democratic conception of creativity that recognizes the potential for creative achievements in all fields of human activity and the capacity of such achievements is possessed by many average and not a few elite individuals, NACCCE (1999) has developed an indicative definition: Imaginative activity fashioned so as to produce outcomes that are both original and of value (p. 30). Loveless (2002) extracts five elements from this definition, which presumably can be fostered with the appropriate use of ICT. They are elaborated as follows:

- using imagination—the process of supporting and generating original ideas, providing an alternative to the expected, the conventional, or the routine;
- fashioning process—the active and deliberate focus of attention and skills in order to shape, refine and manage an idea;
- pursuing purpose—the use of imagination to produce tangible outcomes from purposeful goals, motivation and sustained engagement are important to problem solving;
- being original—individual originality in relation to one's previous work; relative originality in relation to a peer group; and historic originality in relation to works which are completely new and unique;
- judging value—the evaluative mode of thought is reciprocal to the generative mode of imaginative activity and provides critical, reflective review from individuals and peers;

These processes can be matched to the characteristics of ICT to be described below.

Shneiderman (2000, 2002a,b) understands creativity in terms of three different models—inspirational, structural and situated. Put briefly, the inspirational model emphasizes the remarkable "Aha"

moments in which dramatic breakthroughs magically appear; the structural model stresses the importance of studying previous work and using methodical techniques to explore the possible solutions exhaustively; the situated model emphasizes intellectual, social, and emotional contexts as key parts of the creative process and regards creativity as embedded in a community of practice with changing standards, requiring a social process for discussion and approval. Embracing the situational approach of which Csikszentmihalyi (1996) is a proponent, Shneiderman develops the so-called *genex framework* in which there are four activities generating excellence (2002a, p. 214):

- Collect—learn from previous works stored in libraries, the Web and other sources;
- Relate—consult with peers and mentors at early, middle and late stages;
- Create—explore, compose and evaluate possible solutions;
- Donate—disseminate the results and contribute to the collection of learning material;

Note that the execution of these four activities is not linear but rather iterative and can be facilitated with different CST.

Overview of Major Theoretical Models in HCI

HCI is a highly diverse and thus an extremely exciting field. Since its inception more than three decades ago, HCI has been metamorphosing through different stages, aligning with the trend of cognitive psychology with which HCI is coupled—from absolutism[3] to relativism,[4]

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[3]**Absolutism**: Two basic assumptions are that knowledge is in principle separable from other human activities and that knowledge is absolutely valid and infallible. Constructivism rejects this notion of absolutism, denying the existence of an objective knowledge because there can be a number of ways to structure the world, and there can be many meanings or perspectives for any event or concept. Consequently, there is not a correct meaning that one strives for.

[4]**Relativism**: It is the view that the meaning and value of human beliefs and behaviors have no absolute reference (in contrast to absolutism). Relativists

from cognitivism[5] to situatedness,[6] and from individualisation to socialization. In particular, several theories have been embraced by the HCI community, including Situated Action (Suchman, 1987), Distributed Cognition (Salomon, 1993), and Activity Theory (Leont'ev, 1974; cited in Nardi, 1994). These conceptual frameworks are essentially rooted in the social constructivism informed by John Dewey's and Lev Vygotsky's philosophical and epistemological views. Each of these conceptual frameworks has implications for the design of CST (Table 20.1). In the realm of creativity research, Fischer *et al.* (2005) have advocated the notion of "Social Creativity". Their conviction is that much human creativity is social (in contrast to the conventional assumption that creativity is an unaided individual endeavor), arising from activities that take place in a context where interactions with other people and the artefacts that embody collective knowledge are essential components. This stance echoes the tenets of social constructivist theories. As reflective thinking and other meta-cognitive skills are integral parts of creative processes, means to foster these high-order cognitive competencies should be addressed in the development of CST.

Researchers endeavor to clarify the role of computers in enhancing creativity. In this regard Lubart (2005) has identified four categories of

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claim that humans understand and evaluate beliefs and behaviors only in terms of, for example, their historical and cultural context. Philosophers identify many different kinds of relativism depending upon which classes of beliefs allegedly depend upon what.

[5]**Cognitivism**: In psychology cognitivism is a theoretical approach to understanding the mind, which argues that mental function can be understood by quantitative, positivist and scientific methods, and that such functions can be described as information processing models.

[6]**Situatedness**: A tenet of the situated approaches to cognition is a shift in the way the person/environment relationship is conceived. Rather than a person being "in" an environment, the activities of person and environment are viewed as parts of a mutually-constructed whole (cf. constructivism). Put simply, the inside/outside relationship between person and environment (cf. cognitivism) is replaced by a part/whole relationship.

Table 20.1. Cognitive theories and their implications for the design of CST.

Basic tenets of cognitive theories endorsed in HCI	Implications to design of Creativity Support Tools (CST)
Theory of Reflective Practitioner (Schön, 1983) Reflection-*on*-action and reflection-*in*-action are essential for the development of 'professional artistry'. The effectiveness of training depends on social interaction, especially reciprocally reflective dialogues between coach and student, and on an individual's reflective conversation with the situation.	— A conversation space where dialogues can efficiently be exchanged and moderated by a more knowledgeable user; — A facility for documenting floating questions and their *multi-perspective* answers from different members of online community of interest to facilitate reflective thinking; — High bandwidth is required to enable creation of 3D-worlds for visualization and demonstration of complex ideas and concepts.
Situated Action (SA) models (Suchman, 1987) According to SA, the structuring of activity is not something precedes it, but can only grow directly out of the immediacy of the situation. The inquiry takes place at a very fine-grained level of minutely observed activities. The unit of analysis is a relation between the individual and the environment. In focusing on improvization and response to contingency, SA de-emphasizes study of more durable, stable phenomena that persist across situations.	Information architecture is so — designed that users can best orient themselves to sources of information required for tasks at hand and get instant access to such resources (e.g., access to help messages); — Effective search engine enables users to locate resources efficiently to address situational demands; — User interfaces are engineered to ease recovery from errors (e.g., backtracking and undo); — Support archives of threaded discussions (e.g., email; forum) for reflection and provide different channels for verbal communication (e.g. asynchronous weblog, synchronous chat).

(Continued)

Table 20.1. *(Continued)*

Basic tenets of cognitive theories endorsed in HCI	Implications to design of Creativity Support Tools (CST)
Distributed Cognition (DC) (Salomon, 1993) DC is concerned with structure—representations inside and outside the head—and the transformations these structures undergo. DC tends to provide finely detailed analyses of particular artefacts and aims to identify stable design principles that are widely applicable across problems. DC strives to understand how individual agents align and coordinate within a distributed process. Shared goals and plans as well as specific features of the artefact in use are important determinants of the quality of collaboration.	— Facilitate externalization of thoughts with media of high affordances (in the Gibsonian sense; see Hartson, 2003; Greeno, 1994) for writing notes, sketching diagrams, etc. (i.e., WYSIWYW (what you see is what you want) editing feature) — Enable analogical thinking to compare and contrast existing and emerging ideas (i.e. juxtaposition of related ideas). — Sustain information flow, e.g. buffering (i.e. holding up new information until a suitable time to avoid loss or confusion), and ensure representation-goal parity and effective coordination of resources (i.e. plans, goals, affordance, history, etc.) (Blandford and Furniss, 2005).
Activity Theory (AT) (Leont'ev, 1974) A key idea of AT is the notion of *mediation* by artefacts such as "computer-mediated activity". Another key notion is to equate activity with context, which is constituted through the enactment of an activity involving people and artefacts. In AT, one's ability to organize and use resources is the result of specific historical and developmental processes in which a person is changed.	— Enable smooth flow of *activities* by ensuring reliability of data transfer, compatibility of different software modules imported in an integrated environment, and consistency in interaction style between these modules; — Provide a shared workspace to facilitate co-creation of artefacts and peer review, and a private workplace to allow individuals to marshal personal resources. — Engineer tools with high tailorability, enabling users to customize applications and to develop sense of control.

HCI, which, interestingly, somewhat align with Sheniderman's genex framework (see above):

- "Computer as nanny" where computers serve as a time-management tool (cf. Collect)
- "Computer as pen-pal" where computers serve as a networker or facilitator for a group of like-minded people (cf. Donate)
- "Computer as coach" where computers serve as an expert system, offering help for applying creativity-relevant techniques (cf. Relate)
- "Computer as colleague" where computers serve as an intelligent partner, integrating fully with human creative activity and stimulating ideas wherever and whenever appropriate (cf. Create)

It is reasonable to assume that computers play all the four roles in users' work; the relative saliency of individual role depends on the problem type and on the cognitive as well as affective status of individual user.

From General ICT to Specific CST

Translating Concepts into Practice

ICT is an umbrella term that includes any communication device or application, including radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning. ICT is often spoken of in a particular context in education, health care or government. Our particular concern is how ICT can serve as CST. Indeed, ICT exhibit the following features which enable users to do things that could not be done as effectively, or at all, using other tools (Loveless, 2002):

- Provisionality—enables users to make changes, try out alternatives and keep track of the development of ideas
- Interactivity—engages users at a number of levels
- Capacity, Range—affords access to vast amounts of information locally and globally in different time zones and geographical places
- Speed, Automation—sallow tasks of sorting, transforming, and displaying information to be carried out by the technologies, enabling
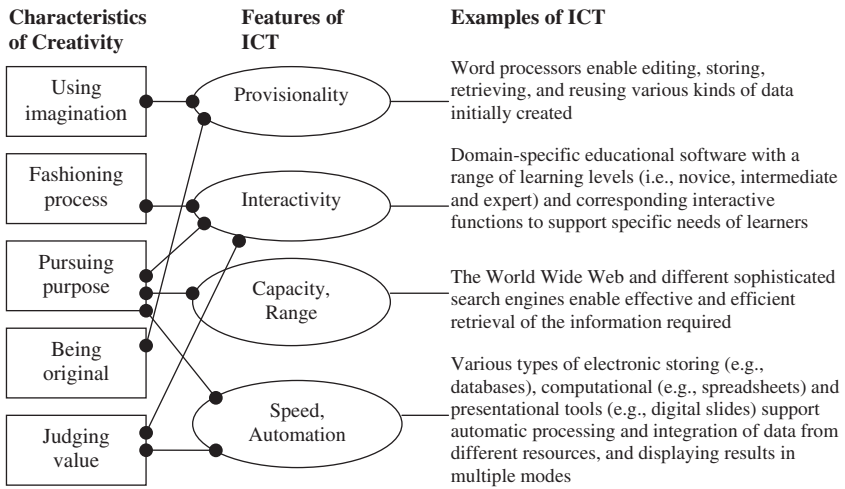
Fig. 20.1. Links between characteristics of creativity and features of ICT.

users to read, observe, interrogate, interpret, analyze, and synthesize information at higher levels

Specifically these features corroborate the realization of the five elements of creativity (Figure 20.1).

Charles Cave[7] reviews 62 diverse CST, such as enhanced thesauri, concept map managers, and guided writing programmes, to name just a few. While these examples are helpful, CST Designers could benefit from a clearer set of requirements (i.e. who the users of CST are and where they use them) to develop the systems in an optimal period of time (Shneiderman, 2002b). Furthermore, Shneiderman's genex framework will become effective only when there is integration of multiple CST, which include commonly used ICT such as Word processors, presentation graphics, emails, databases, spreadsheets, whiteboard, Web browsers, and so on. In addition, Shneiderman proposed eight specific tasks—searching, visualizing, consulting, thinking, exploring, composing, reviewing, and disseminating—and their corresponding tools to support the collect-related-create-donate activities (2002a, p. 119).

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[7]http://members.optusnet.com.au/~charles57/Creative/.

Teaching Creativity: Practical Issues

The foregoing discussions attest the assumptions that creativity is teachable and can be enhanced by technologies. To optimize the effect of ICT in fostering the development of creativity in education, the following questions need to be addressed: Who are the users of CST? Which CST are selected? Where are CST deployed? How are CST used?

Technical Competence of Users

Teaching creativity with ICT and teaching for creativity with ICT are two different matters. Similarly, learning for ICT and learning with ICT are different as well. While each of these tasks entails specific skills and training, the common denominator among them is being ICT-competent. Generally speaking, ICT-competent people are able to understand the rationales why ICT might be suitable for particular tasks and situations, make informed choices in their uses, evaluate their impacts, and be open to new developments and possibilities.

Teacher educators, in-service and pre-service teachers have experienced different levels and types of difficulties in mastering ICT (e.g., understanding technical jargons in user interfaces, troubleshooting skills) on the one hand and in integrating ICT effectively into everyday classroom teaching on the other hand (Ertmer *et al.*, 2003; Snoeyink and Ertmer, 2001–2). Where necessary, policy-makers and administrators at all levels should provide teachers with improved access to equipment, skills development and freedom to innovate curriculum in the classroom. However, the personal philosophical beliefs of teachers are less easily changed and deserve consideration as a critical influence on the successful integration of technology (Albion and Ertmer, 2002). Besides, teachers may have computer anxiety or even phobia for technology. As shown by a number of studies, failure at operating the technologies may hamper teachers' self-esteem and self-confidence (Davies, 2000) and consequently aggravate their resistance to, and fear of, deploying them. In addition, effective and efficient professional help

should be accessible to teachers when they are confronted with technical problems.

Environment Conducive to Creativity

Craft, Jeffreys and Leibling (2001) have conducted a meticulous review on the criteria of learning environments conducive to the development of creative thinking:

- Offer opportunities for exploration and play with materials, information and ideas (Craft, 2000).
- Allow learners to take risks and make mistakes in a non-threatening atmosphere (Davies, 1999).
- Increase the flexibility in time and space for the different stages of creative activity (Claxton, 1999).
- Heighten the awareness of the ways in which creativity is related to knowledge across the curriculum and of the fact that the rules and structures underpinning 'conceptual spaces' in different knowledge domains can be combined and transformed (Boden, 2001).

With the advent of ubiquitous computing, the boundaries of learning space and time have been further expanded. Learning anywhere at anytime has become a goal for a number of researchers, who envisage the exploitation of this emerging technology in education. Nevertheless, there are a host of issues to be solved such as usability (e.g., how to design a quality user interface that enables users to achieve tasks with high effectiveness, efficiency, and satisfaction), security and privacy (e.g., how to identify strategies and techniques to prevent loss, theft, and abuse of personal data), accessibility (e.g., how to meet special needs of users with disabilities), learning assessment methods (e.g., how to ensure the reliability of digital portfolio), trust (e.g., how to establish credibility among members of a virtual community), changing roles of teachers and students (e.g., how to foster teachers' acceptance of technologies and to enhance students' self-directed learning skills), to name just a few. Thus, it may take some years or even decades before this vision can be realized.

ICT Resources for Teaching Creativity

As mentioned earlier, there exist various types of ICT applications, be they proprietary or open-source, which provide environments for creative activities. Amongst others, three are relatively popular:

- Storyboard software for understanding complex texts,
- Virtual reality environments for simulating a wide spectrum of human perceptions and experiences,
- Knowledge forums for collaborative knowledge building within groups of peers and experts; these digital learning spaces afford learners to reflect beliefs, values, and theories of how they themselves and others learn.

Furthermore, results of some interesting projects provide further evidence about the desirable effects of ICT applications in fostering creativity. For instance, EXPO'92 Guest Services Systems and Explore Modern Art (Greene, 2002) share the following characteristics that foster creativity: Support pain-free exploration and experimentation; support engagement with content to promote active learning and discovery; support search, retrieval and classification; support collaboration and iteration; support and encourage instructive mistakes; support the domain-specific actions. In fact, these features well reflect the qualities addressed in Shneiderman's genex framework (see above).

ICT resources can basically foster the creation and development of innovative concepts when they afford an approach to open-ended exploration in design and use (Candy and Edmonds, 2002). The use of ICT to make connections is a mighty and consummate use of the technology, which allows access to cross-cultural experiences and multiple perspectives across time zones and geographical barriers. Nonetheless, mere access cannot guarantee any learning gain or cognitive development. The most critical factor for the successful exploitation of ICT resources is the nature and design of genuinely interactive learning experiences with these resources. Thinking, exploring, composing and reviewing (i.e., Shneiderman's specific tasks leading to 'create') with ICT tools enables users to capture and manipulate information and receive instantaneous feedback. In spite of these promising features,

it is necessary to bear in mind that ICT tools have their limitations, which are yet to be identified through persistent research efforts.

Evaluation of ICT for Enhancing Creativity

Two complex issues need to be considered: First, evidence of creative performance exhibited by learners as a result of receiving creativity training afforded by ICT resources; Second, cost-effectiveness of deploying ICT resources as compared with traditional classroom approaches to training creativity.

Measuring soft skills such as creativity, which involve interpersonal interactions, is much more difficult than hard sills, which, by definition, are those technical skills producing immediate visible results (De Jager, 2003). According to Beattie (1997), more than 200 instruments have been developed for assessing creativity. However, based on Sternberg's (1999) view, none of them have been able to measure the construct adequately. As pointed out by McFarlane (2001), assessment of ICT capability should be contextualized in the sense that the context in which and the purpose for which ICT resources are consumed must be addressed. Besides, Jonassen (2000) proposed "multiple application and multiple skills" approach in a way that a range of ICT applications are employed within subject domains to demonstrate knowledge construction, self-regulation, collaboration, critical thinking, and creative thinking. While the usefulness of this encompassing approach seems acceptable, its usability, considering the complexity involved, is questionable.

Alternatively, the recently developed instrument known as electronic portfolio (or ePortfolio) has been adopted by some researchers and is claimed to be effective (Morris, 2003). ePortfolio consists of a personal digital record containing information such as a collection of artifacts or evidence demonstrating what one knows and can do. For instance, students use a variety of media within a web-based environment to represent their knowledge and organize their evidence to illustrate mastery of some or all pre-defined success criteria for a specific learning programme. Nonetheless, the utility and usability of this approach, similar to Jonassen's, need to be investigated in future

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research. Generally speaking, a progressive approach that focuses on both processes and products of training is more appropriate, i.e., formative as well as summative evaluations need to be performed.

The issue of cost-effectiveness or return on investment (ROI) in deploying ICT resources for training soft skills is catchy. In fact, it is a long-term rather than a short-term issue. Although some models have been developed in the commercial world to compute ROI (see e.g., Danziger, Jennings and Parks, 1999), the transferability of these models to the educational sector is rather uncertain. Furthermore, there is a limited number of empirical studies that systematically compare the effects of deploying ICT resources in training creativity with those of adopting the traditional approaches (i.e. using paper-and-pencil in a brick-and-mortar setting). This gap needs to be bridged.

Conclusion

The characteristics of the new technologies map certain basic qualities of contexts conducive to creativity, namely, exploration, play, taking risks, reflection, flexibility, focus, commitment, and sensitivity to the development of individuals and communities. However, a caveat is that mere exposure to technologies will not enhance creative thinking. Of particular importance is the informed choice of learning and teaching strategies with regard to the context in which such strategies are applied. The implementation of such strategies can be enriched through the appropriate use of ICT. Noteworthy is that it is not the access to digital resources which delivers creativity, but the opportunity of such access affords for interaction, participation and the active demonstration of imagination, purpose, originality and value (Loveless, 2002). Creative activities with new technologies include developing ideas, making connections, creating and making, collaboration, communication and evaluation (Edmonds and Candy, 2002). These activities are not always discrete or sequential and there can be synchronicity in their expression and overlap of applications for purposes.

The aforementioned conceptual frameworks in creativity and human-computer interaction (HCI) help us better understand the phenomena of interest and provide us with heuristics for designing

creativity support tools. Nevertheless, the diversity of these frameworks reflects well the diversity of issues that we have to cope with, because resolution of different issues calls forth multiple perspectives. Clearly, there is no single HCI solution for enhancing creativity, given the tremendous heterogeneity of human users whose needs and goals vary with situational demands and whose intellectual abilities, personality traits, cognitive styles and domain-specific expertise span a wide spectrum. Research on computer-enhanced creativity is just beginning. We, as creativity researchers, will deal with a number of theoretical, methodological and practical challenges:

- Does our current understanding about the nature of creativity and the nature of human-computer interaction enable us to design truly *useful* as well as *usable* creativity-enhancing systems? Such systems should not have a steep learning curve. Otherwise, they would hinder rather than foster users' creative processes that might be thwarted if users have to struggle hard with usability problems.
- To what extent creativity-enhancing technologies enable users to be more creative? Can the quality of such technologies be systematically validated with the existing evaluation methodologies from software engineering and HCI? Is a new evaluation paradigm called forth?

Last but not the least challenging tasks is that, given the inconsistent findings about the impact of ICT applications on creative thinking (i.e. whether and how the use of ICT can enable idea generation, see e.g., Massetti, White and Spitler 1999), it is deemed necessary to conduct a meta-analysis when there are sufficient numbers of empirical studies with experimental rigor; analyzing the results from a group of studies can allow more accurate data analysis.

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Programmer Creativity

Gary Greenfield

Introduction

Beardon (2006) speaks to the "tension" between [computer] programming and creativity, and observes that this is largely due to the association of the word *algorithm* with the earliest computer-generated art works. From an art theory point of view, in the short run the *algorithmic art movement* served a useful purpose. But, in the long run it has proved to be a burden. With the rise in prominence of artificial intelligence, artificial life, cognition, and robotics several important questions that the algorithmic art movement raised about programmer creativity have been overshadowed by a new "grand challenge" in artificial intelligence: artificial creativity.

Boden's (1994) notion of creativity as the novel exploration of and creation of mental representations has helped to fuel this grand challenge. Early research efforts were devoted to studying creativity using groups of autonomous agents functioning in a simulated cultural environment (Saunders and Gero, 2001; Whitelaw, 2004). Now, Boden's mechanization approach to creativity has given rise to more ambitious projects. One example is a project funded by the Arts and Humanities Research Council of the United Kingdom. Its three goals are: (1) to *evolve* a robot that can demonstrate creative drawing behavior, (2) to develop a *theory* for such a robot's creativity, and (3) to provide a historical and *critical* context for the creative results of such a robot (Boden *et al.*, 2005). Although the context is somewhat restricted, these three goals serve as clear milestones for achieving artificial creativity.

As evidenced by recent events such as the *Creativity and Cognition Conference* (Candy, 2005) and the *Computational Models of Creativity*

in the Arts Workshop (2006), this surge in interest in artificial creativity has obscured an open and long standing debate about the status of software objects as indirect evidence, or meta-evidence, of programmer creativity. By also considering an equally restricted context, to narrow the gap, below we will establish three criteria for *programmer* creativity that must be satisfied in order that a milestone similar to the first goal listed above for artificial creativity can be achieved, namely *demonstrating* programmer creativity behavior. We will then examine a case study to show how these three criteria are satisfied in practice.

Our basic premise is that creativity in the pursuit of artistic expression is an appropriate test bed for settling questions concerning either artificial creativity or programmer creativity. Therefore we focus our attention on the problem of how to *instruct* a computer to carry out and fulfill the creative intentions of a programmer artist. As a consequence, we will see why certain software objects used in the making of computer generated art manifest programmer creativity.[1]

The Context-Generative Art

The earliest computer-generated art works were produced by computer programs executing algorithms that generated simple geometric shapes and varied them systematically (Spalter, 1999). An early how-to book by Wilson (1985) dwells upon techniques for using a pseudo random number generator to achieve this systematic variation. A recent book by Maeda (2001) extolling the virtues of his special purpose design language continues in this tradition. For this reason, it is unfortunate that the earliest pioneers of computer-generated art such as Hans Dehlinger, Jean Paul Hebert, Manfred Mohr, Vera Molnar, A. Michael Noll, and Roman Verotsko to name just a few have been labeled as "algorithmic artists". Ironically, even though the nature of computer-generated

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[1] The term software object rather than computer program is used because with current practice a software system or suite of software tools is often needed to execute a computer-generated work of art.

imagery has changed, the fundamental concept of using a computer program to systematically vary images to produce computer art has persisted, albeit in a more sophisticated version now commonly referred to as "generative art". The shift away from algorithmic art to generative art traces its roots to the proof-of-concept research in Drawinian evolution concerning the notion of "evolvability" by Dawkins (1989) and its subsequent application to texture synthesis by Sims (1991). In generative art, the word "generative" is understood to refer to a small data structure called a *genome* that assists in directing and controlling image variation. We will present a detailed case study to show how, under certain circumstances, programmer creativity can be seen as the intentional outcome of a software object implementing this generative art paradigm. Before we can present this case study, we must digress to consider the problems of image space exploration and final image selection.

Exploration of Image Space

To oversimplify, in a generative art system, genomes are viewed as the data structures *encoding* the images. Therefore, there is effectively a one-to-one correspondence between genomes and images. *Image space* refers to the [infinite] number of images—thought of as potential computer-generated artworks—that would result from enumerating all the images coded for by the genomes. The image space exploration problem can now be stated formally as: How does an artist effectively examine (i.e., search) through the space of all images to find the ones that will represent his or her personal form of artistic expression? In practice, the set of genomes is rarely enumerable, and typically uncountable, so the task of exploring image space is often combined with the concomitant problem of deciding which images to ignore, which to keep…and when to stop searching![2]

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[2]An unusual exception to this "rule" occurs in the work of Krawczyk (2003, 2004) who is physically able to enumerate all of the images resulting from his parameterized genome encoding of strange attractors.

Image Selection in Image Space

The key to guiding, or steering, a search through image space is intimately connected with the explicit mechanism of encoding images using genomes. Via this connection, genetic operators that represent mutation and recombination are used to shift from a set of "old" images to a set of "new" images in a constructive and coherent way. Therefore, by always considering only a small subset, or *population*, of all the images in image space, the problem of searching is reduced to considering which images to discard from the current population and when to halt the search process. The first "solution" to this problem used the technique of *interactive* evolution which meant a user (the "artist") would manually select which images, hence genomes, to discard and also decide when the search was successfully completed (Greenfield, 2000). A more challenging and demanding "solution" to this problem is try to implement in software an explicit decision making strategy. Greenfield (2005a,b) cites numerous examples of this non-interactive "computational esthetics" approach. These include a decision-making strategy (Greenfield, 2002) based on the geometric data obtained from segmentations of the images generated using a system modeled after that of Sims (1991), and a decision-making strategy (Greenfield, 2004) based upon the statistics of "activity levels" of simulated cells in images visualizing networks of such cells in a generative system that is modeled after Eggenberger (1997). With the notable exceptions of Ramachandran and Hirstein (1999) and Zeki (1999), there are surprisingly few resources in the cognitive sciences literature that are available to help with this task.

The Programmer Creativity Litmus Test

The above explanations regarding the exploration and selection problems for an image space make it possible to ground the discussion of programmer creativity by specifying three well-defined criteria that must be met for demonstrating programmer creativity within the confines of generative art. They establish a best-case scenario for a programmer artist to express his or her artistic intent by developing a

software object. The three criteria are that the software object:

(1) uses a genome to encode an image,
(2) contains a framework to systematically vary that genome thereby providing a means of exploring the associated image space, and
(3) provides an explicit metric for deciding which images should be selected for the final art work(s).

Note the each of the tasks referred to in these criteria is non-trivial. Taken together, they ensure that the creativity does indeed lie with the programmer. Or, to put it more forcefully, when these three criteria are met it is NOT the case that "the computer made the art and the human had nothing to do with it". There is one caveat to all of this however. Each so-called run of such a software system may produce one or more computer-generated works of art that are the end product of programmer creativity. But, it is still up to the programmer artist to select which exemplars are: sent to a gallery, selected for an art show, or chosen to be published in an article. A case study demonstrating programmer creativity that satisfies the three criteria given above follows. Greenfield (2005a, c) covers several additional examples.

A Case Study—Ant-Paintings

In the discipline known as ant colony optimization (Dorigo and Stutzle, 2004), a computer simulation using large numbers of "virtual" ants is used to search for solutions to combinatorial problems. Such problems usually pertain to either logistics or scheduling. Ramos and Almeida (2000) appear to be the first to apply this idea to the field of image processing. They used simulations involving virtual ants for such basic pattern recognition tasks as edge detection and image segmentation. The term "ant-painting" was first coined by Aupetit *et al.* (2003) to describe images they obtained from an interactive generative art system they devised. In their system, genomes were used to control a small number of virtual ants (typically two to six) roaming on a toroidal grid according to the "scent" they detected. Images were made by allowing ants to deposit color providing a record of where

they had been. Because their model is important for what is to follow, further details are necessary. Their virtual ant genome is a vector $(C_R, C_G, C_B, F_R, F_G, F_B, P_L, P_R, P_A, D, P_S)$ which is interpreted as follows: When an ant is placed on an initially all white grid the red, green, and blue components C_R, C_G, C_B of the color C determine the color to deposit after each move. The red, green, and blue components F_R, F_G, F_B of the color F determine the color to ants are attempting to follow. D determines the movement type when turning. Finally, P_L, P_R, P_A represent the probabilities of the ant veering left, veering right, or moving straight ahead subject to the probability P_S of changing direction when scent matching that of the following color F is detected. Detected scent is defined to be the *luminance* of the color of the current grid cell under consideration. As Figure 1 shows, Greenfield (2005d) was able to use the genomic data furnished in the paper of Aupetit et al. (2003) to "reverse engineer" ant paintings with sufficient precision such that his results matched the *style* obtained using their generative method.[3] The objective of Greenfield (2005d), however, was to improve upon this model and to satisfy the three criteria given in the previous section for demonstrating programmer creativity.

Criterion I

To satisfy the first criterion, virtual ant behavior, which affects the image encoded using the genome, but not the genome itself, was modified. One modification allowed the ants to made color (i.e., scent) comparisons based on the tristimulus colors they encountered rather than the luminance of those colors. The other modification involved adding a mechanism to prevent ants from attempting to follow the color they deposited. The artistic vision was to give a more painterly look to ant paintings.

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[3]The author's Fig. 21.1 of this chapter must be compared with Figure 1d of Aupetit *et al.* (p. 1378) to verify that this was indeed accomplished. It is both rare and remarkable that a research team published full genomic data together with sufficiently precise descriptions of their methods to allow an image encoding to be so closely duplicated.

Fig. 21.1.   An ant-painting reversed engineered by the author using genome data obtained from Aupetit *et al.* (2003). Originally the genomes were evolved using the interactive evolutionary method. Scent is color luminance.

Criterion II

The details of how ant genomes were systematically varied within the underlying simulated evolutionary framework in order to facilitate the exploration of the corresponding image space is too technical to be considered here. Complete details and formulae are given in Greenfield (2005d). It suffices to say that for most generative art systems this step is not considered to be the bottleneck. One point does need to be made, however. Systematic variation of the genomes includes varying the components of the colors C and F that the ants deposit and seek. Therefore, depending on the formulation of the image selection criteria, the final color scheme of an ant painting may be construed as unintentional.

Criterion III

The non-interactive method Greenfield used for image selection was determined by imposing a ranking system for the *ants,* not the image, in the [current] fixed size ant population that made the painting. It used

arithmetic expressions involving an exploration term N_v, measuring the number of distinct cells an ant visited, and an exploitation term N_f, measuring the number of times an ant exhibited scent following behavior. The rationale behind this assessment scheme is that the "style" of an ant painting is governed wholly by the interactions between the ants. Therefore, in this instance, a critical element affecting programmer creativity is his or her ability to formulate behavioral criteria for the ants in such a way that they achieve his or her esthetic goals. To reiterate, this step is necessary because in order to make a variation of an ant painting one must evaluate the genomes of the ants that painted it and on that basis make variations in one or more of those genomes. Figure 21.1 shows an ant painting made by twelve ants using the generative art system just described where individual ant genomes were evaluated using the ranking, or *fitness*, expression $N_v + N_f$.

Refinement

Although the generative system for ant paintings described above does meet the three criteria for demonstrating programmer creativity, it has two obvious shortcomings. First, the visual characteristics of the resulting images often seem unrelated to the ant behavioral criteria that were prescribed, or to put it another way, it is difficult to formulate ant behavior rules that give rise to desirable visual outcomes with reference to color, form, or composition. Second, the definition of when a colony of ants has competed an ant painting is fuzzy. The image in Fig. 21.2 was obtained by letting the twelve ants each take turns moving one cell away from its current position on the grid for 2400 simulated time steps. A more subtle objection arises from the criticism that it is unfair to call an image an "ant-painting" if there are only twelve ants and if their scent, or pheromone, is simulated using color trails that, for obvious reasons, do not dissipate.

After studying ant paintings obtained using an invisible pheromone model for controlling ant behavior by Urbano (2005), Greenfield (2006b) conducted a series of experiments to test several new virtual ant models and ant behaviors (i.e., genomes and encodings) in an
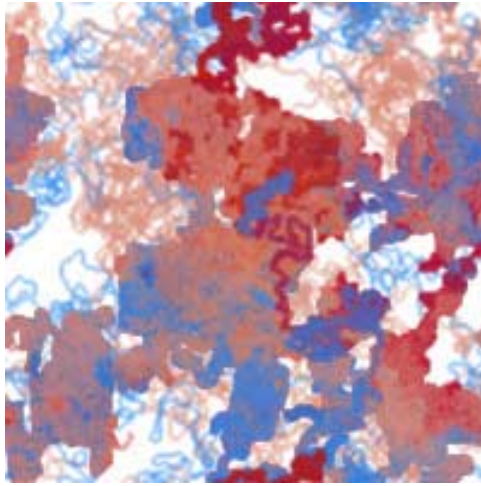
Fig. 21.2. An ant-painting evolved using a model that incorporates scent following and scent avoidance. Scent is tristimulus color. The image selection criterion involves a simple arithmetic formula whose terms are the number of times the various possible ant behavioral choices were adopted.

effort to try and improve both the composition and color palettes of his ant-paintings. A new model for creating an ant painting emerged. Now, each cell of an initially all gray grid exuded an invisible environmental pheromone. The ants exuded an invisible ant pheromone. Both pheromones were able to diffuse and dissipate. Scent following behavior, trail marking behavior, and all other behavioral rules for ants depended wholly on the concentrations of the two invisible pheromones. For esthetic purposes ants belong to either a black or white "caste" even though both castes follow the same behavioral rules. An ant tries first and foremost to follow the environmental pheromone gradient. When an ant is first to reach a grid cell still exuding pheromone, it harvests the cell by marking it as either white or black, according to its caste. If, however, an ant determines that the environmental pheromone gradient is too weak to follow, it re-colors the cell it currently occupies with its caste's trail marking color and then turns away from the ant pheromone gradient in order to have a better chance at picking up the environmental pheromone gradient. The principal advantage of this model is that
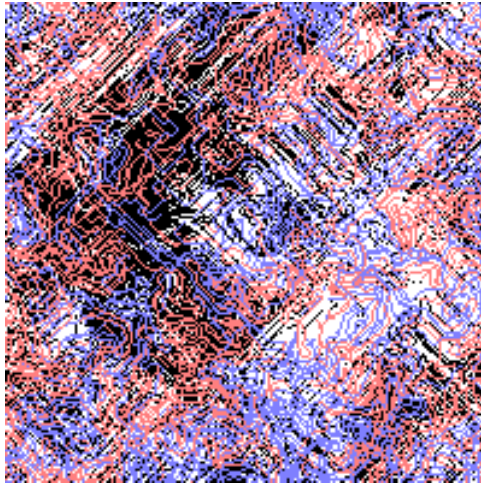
Fig. 21.3. An ant painting "study" using the multiple pheromone scent model. There are two invisible scents. The pixels of an initially all gray background are first re-colored either black or white and *may* subsequently be re-colored red or blue.

an ant painting is "finished" when there is no more environmental pheromone being produced. Figure 21.3 shows an example of an ant painting produced using this model. It was obtained by initially clustering the ants by caste along the horizontal bisector of the painting.

With this new model, ant paintings lose their painterly look and there is no apparent image selection framework to use. In fact, since all ants follow the same behavioral rules, the model does not explicitly support a genome that encodes an image. To address these problems Greenfield (2006c) first corrected the rendering deficiency by blending the trail marking color with the existing grid cell color. An added subtlety is that by varying the shade of the color to be blended, it was possible to make a clearly defined paint "stroke". Next, he designed an image-encoding based on the positions of the *centers* of the two clusters. The details for how to vary such genomes are given in Greenfield (2006c). Using this rather elementary genome meant, on the one hand, that any image variation process could not produce the dramatic results one usually encounters in a generative art system, but on the other hand it offered the possibility that image fitness criteria could

be more easily constructed and interpreted. Now images, not ants, in the [current] population were evaluated by calculating the value of the expression $s \times t$, where s was the number of times color trail marking was invoked, and t was the number of time steps required to complete the painting. Here, the smaller the value of this expression is, the higher the rating of the corresponding image is. The visual aesthetic in force can be expressed in quantitative terms by saying that image selection is based on how fast and how efficiently the ants fan out to reach all the cells in their environment. It can be expressed in qualitative terms by saying that image selection is based on trying to minimize the amount of color trail marking and blending that obscures the black and white under painting. Figure 21.4 shows the ant painting that was the highest rated one that was ever evolved according to this selection criterion. Its color scheme was pseudo randomly generated. However, unlike the previous generative system, in this generative system it is easy to modify the color scheme in post-production. Note that this ant painting was also produced in such a way that it satisfies our three criteria required to demonstrate programmer creativity.
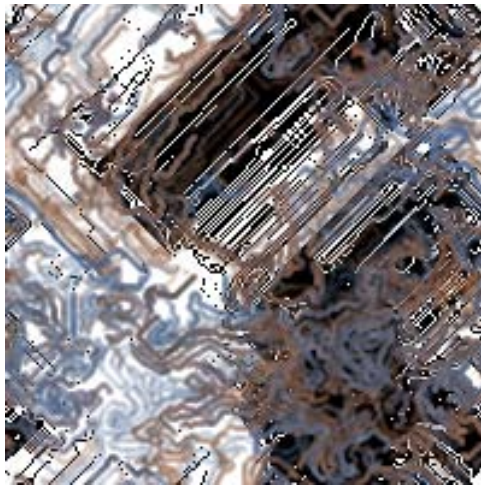
Fig. 21.4. An evolved ant painting using the multiple pheromone scent model but with an improved rendering capability added. Now, subsequent re-painting gives a stroke effect that blends with the black and white background.

Conclusion

This chapter tried to clarify the boundary between artificial and programmer creativity. In the specific context of generative art, it proposed a best-case scenario for demonstrating programmer creativity by introducing three [design] criteria that must be satisfied by the software objects that programmer artists develop to generate their art works. They are: a genome for encoding an image, the implementation of a scheme for varying genomes and hence images, and a metric for evaluating the resulting images. A detailed case study involving ant-paintings was presented. This case study also revealed how closely programmer creativity can mesh with more traditional notions of creativity that are associated with studio artists. This is because it established the origins of the project; described its initial successes; and then showed how they led to further investigation, experimentation, and subsequent refinement. This led to new creative results and documented the effort expended to examine the nuances and complexities of the basic theme. The evaluation of the esthetic results that were the programmer artist's end products can be the next theme of exploration of programmer creativity.

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Automated Assessment of Creative Solutions in Mathematics through Comparative Parsing

Nava L. Livne, Oren E. Livne and Charles A. Wight

Introduction

An important part of student's transition from high school to college is undergoing the transformation from lower-level thinking based on linear relationships and memorization, to higher-level thinking based on *creativity* and *discovery*. To this end, the University of Utah launched a unique new online interactive resource to assist pre-college students to improve their readiness to take entry-level college math courses (Intermediate Algebra and Calculus). In particular, the web site (http://ruready.net) offers free, unlimited assessment tests and electronic learning tools to develop students' creative thinking in mathematics. The core of this software is a mathematical expression parser that has been awarded a provisional U.S. patent and analyzes students' constructed responses to *open-ended* questions in mathematics, (Livne, Livne and Wight, 2006a). Assessment of student creativity is accomplished by presenting questions that have more than one correct solution. Based on the parsing process, the site performs expert analysis and assessment of the level of creativity of students' solutions (e.g., obvious vs. less obvious approaches, or brute force vs. elegant). The software further provides automated analysis and continuous scoring of creative *multiple-choice* questions, in which some distractors represent standard solutions while others represent creative solutions. The focus of the current chapter is on *defining* creative questions in the pre-Calculus curriculum, and presenting a technique for *automated assessment* of

students' responses to such questions. To date, the site's creative question database for Calculus consists of 80 items. The new technique presented here provides a unique automated assessment tool for mathematics teachers to track and measure the level of creativity of their students' responses. Evidence for the content validity of the questions and their creative solutions as a creativity measure in the pre-Calculus curriculum was established through the review of the question items by mathematics teachers.

The Immediate Need for Enhancing Creativity in Mathematics Education

The United States once produced the highest percentage of bachelor's degrees in the world, but now trails behind five other countries including Canada, Japan, and South Korea. Moreover, U.S. performance in mathematics was below the international average at age 15, and U.S. 12th-grade students performed among the lowest of 21 participating nations on tests of general knowledge in science and math (American Institutes for Research, 2005; Mullis *et al.*, 2004). The findings indicated that in mathematics, U.S. students did not score well on questions that emphasized higher-order or creative thinking. Less than 10% gave fully correct answers on physics questions that required multiple steps and relationships, or use of symbolic representation (Bowen, 1998). Data also show that the top three "killer courses" preventing students from advancing in college are pre-college mathematics courses, with failure rates ranging from 35 to 42% (Adelman, 2004). In 2004, ACT found that only 40% of the 1.2 million K-12 graduates *nationwide* had scores indicating they were ready to earn a "C" or higher in their first college Algebra course.

Why has America fallen behind? Scholars suggest that because teachers think that only logic is needed for mathematics, they emphasize algorithms, speed, and accuracy, whereas critical and creative thinking are not important (Pehkonen, 1997; Usiskin, 1999; Bergsten, 2002). According to the view of the conventional instructor, creative students "misread the question", and therefore, should be trained through skills-based remediation tasks (Standler, 1998; Usiskin, 1999).

However, identification of mathematical talent using only speed and accuracy of computation neglects those who are creative and reflective (Köhler, 1997). To this end, creativity in mathematics has defined as a combination of logical thinking and divergent thinking that produces many ideas, some of those seem to be useful in a practical problem solving situation (Pehkonen, 1997). Specifically, creative applications of mathematics in the exploration of problems involves "associative richness" of mathematical rules and procedures, which is manifested in abrupt transitions from one idea to another or non-standard combinations of elements (Piirto, 2004; Simonton, 1999). Furthermore, creativity in mathematics has been also defined as the fluency, flexibility, and novelty to generate different methods of solving one problem (Alvino, 1990; Köhler, 1997; Pehkonen, 1997; Silver, 1997; Arney, 1999;). Nevertheless, these definitions were too broad and did not include specific, measurable mathematical creativity indicators.

Limited Solutions for Assessing Creativity in Mathematics

Instruments developed to identify mathematical creativity have used the notions of flexibility, fluency, and novelty in student responses as a way to quantify student responses. For example, Balka (1974a, b) used problem-posing in mathematics as a measure for creativity in mathematics, where fluency in students' responses referred to the number of problems posed, flexibility to the number of different categories of problems generated, and novelty to how rare the response was in the set of all responses. Problem-posing and problem-solving tasks have also been used by others to identify creative individuals. Getzels and Jackson (1962) used problem-posing to measure creativity in mathematics, in terms of the complexity of the procedures to obtain a solution and the number of ways students suggested to find an answer. Silver (1997) further suggested that creativity in mathematics can be assessed through problem-solving, according to degree of the solution originality, that is, how creative and nonstandard the solution is compared to a standard prosaic solution. Measures of creative problem skills

were also used to measure the level of creativity in mathematics (Selby, Shaw and Houtz, 2005). Nonetheless, these measures were *conceptual descriptions* rather than real-world operational indicators of creative mathematics.

Sternberg (2006) and his associates (Sternberg and the Rainbow Project Collaborators, 2005) have recently developed an *operational* measure of creative Intelligence as a supplement to the SAT, a test for college admission that a widely used in the U.S. (College Board, 2006). Cognitive creative skills were measured by multiple-choice items; each required students to select the correct response of four options. Although multiple-choice solutions are easy to score, their assessment reflects more a trial-and-error or guessing strategy among four options, than a reliable measurement of creative thinking (Paul, 1993; Bowen, 1998; National Assessment Governing Board, 2004). In contrast, general creative performance was measured in this study by responses to open-ended questions, which are considered the most appropriate questions for assessing creativity (Arney, 1999). Nevertheless, the constructed creative responses were manually assessed, thus, were exposed to subjectivity of human scoring that did not provide a complete picture of students' level of creativity (Hashimoto, 1997; Köhler, 1997; Frahm, 2004; Mann, 2005). Moreover, using such measures to identify creative student mathematicians is limited for a small number of grade levels due to the time involved in manual scoring of such instruments (Usiskin, 1999). To address this challenge, in the current study, an automated technique was developed to assess constructed creative solutions dynamically.

Automated Assessment of Creative Solutions in Mathematics

Automated assessment of creative solutions is an innovative component of an adaptive learning strategy facilitated by the *RUReady* interactive Web site, which is designed to improve readiness for college Calculus course. Site features relevant to assessing the level of creativity of students' solutions are described below.

Development of Creative Solutions in Mathematics

The creative pre-Calculus questions were developed on the basis of previous work by Livne (2002) and her associates (Livne, Livne and Milgram, 1999). They used Milgram's 4×4 Structure of Giftedness model (Milgram, 1989; 1991) to develop a psychometric tool, *Multiscale Academic and Creative Abilities in Mathematics—MACAM* (Livne and Livne, 1999a,b), that measured both academic and creative abilities in mathematics. Academic ability was defined as a specific intelligence applied to mathematics, and creative ability referred to a specific original thinking applied to mathematics.

Based on strong evidence of construct validity of the MACAM, standards for creative *solutions* in mathematics were developed in the current study. Four expert mathematics faculty and instructors created a database of 200 *original* questions and their solutions in pre-Calculus. First, the experts divided the questions into two groups according to their type:

- Group 1: 120 academic questions that required standard logical thinking and resulted in one correct solution. These questions have been traditionally used in college and high school courses to get top grades in domain specific subjects, such as mathematics and science (Halmos, 1968; Hart, 1993; Muir, 1988).
- Group 2: 80 *creative* questions that required *original non-standard* thinking for perceiving complex patterns and non-algorithmic relationships (Munro, 2000; Smith & Stein, 1998; Stein *et al.*, 2000) to reach *at least two different correct solutions* (Standler, 1998; Livne, Livne, and Milgram, 1999; Livne and Milgram, 2006).

Creative questions have *not* been commonly used in pre-college courses, because of the unconventional way to solve them (Ramsden, 2004). Therefore, specific strategies were further defined to ensure that the two *distinct* solutions were clearly delineated. Five heuristic strategies were defined for developing creative solutions for a question. Each strategy represents a *category* of questions with at least two different solutions. Most questions contain one strategy; some contain

combinations of several strategies from the list below. In the examples that follow, original solutions are indicated by bold face.

(1) Symmetry: one solution is a *mirror-image* of the other (Figure 22.1).

- Use of $|x|$, x^2 and other symmetric functions, leading to two solutions, e.g. $x = \pm a$.
- Use of a geometrical image/path and its mirror-image with respect to the axes, direction, or reversed time.

(2) Duality: *multiple representations* of the same object (Figure 22.2).

- Exponential representation vs. trigonometric representation of complex numbers.
- Algebraic vs. geometric representation (e.g., complex numbers as *a+bi* or a point in a plane).
- Different trigonometric identities connecting one function to multiple functions. e.g., simplifying "$\sin^2(x)$" to "cos" includes "$\cos^2(x)$"- and "$\cos(2x)$"-based solutions.

Q. A quadratic function has the *form $f(x)=ax^2 + bx + c$* for some real-valued a,b,c.

Find a quadratic function of $|x|$ that satisfies $f(0)=0$, $f(1)=1$, $f(-1)=1$.

A. There are two such functions: $f(x)=|x|^2$ $(a=1,b=0,c=0)$ and **$f(x)=|x|$ $(a=0,b=1,c=0)$.**
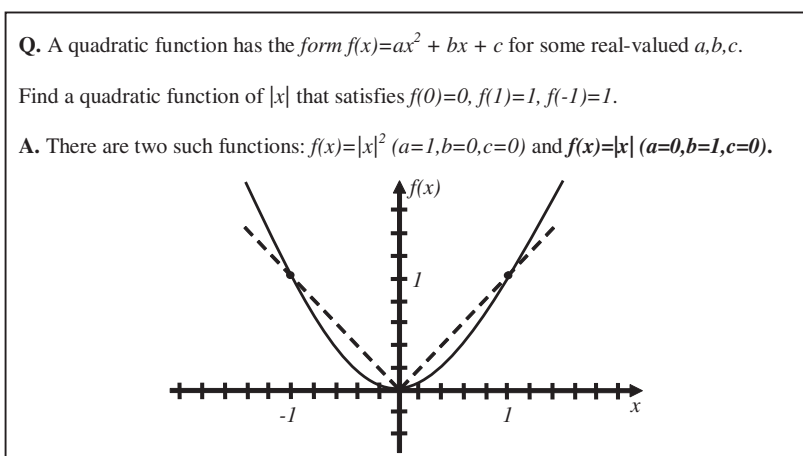
Fig. 22.1.   An example of symmetry in a creative problem.

Q. Simplify the expression $z = (cos(t) + i\ sin(t))^2$.

A. (1) Open the square and use trigonometric identities to get $cos(2t) + i\ sin(2t)$.

 (2) Use polar representation and shift the angle on the unit circle in the complex plane (de Moivre's theorem): e^{2it}
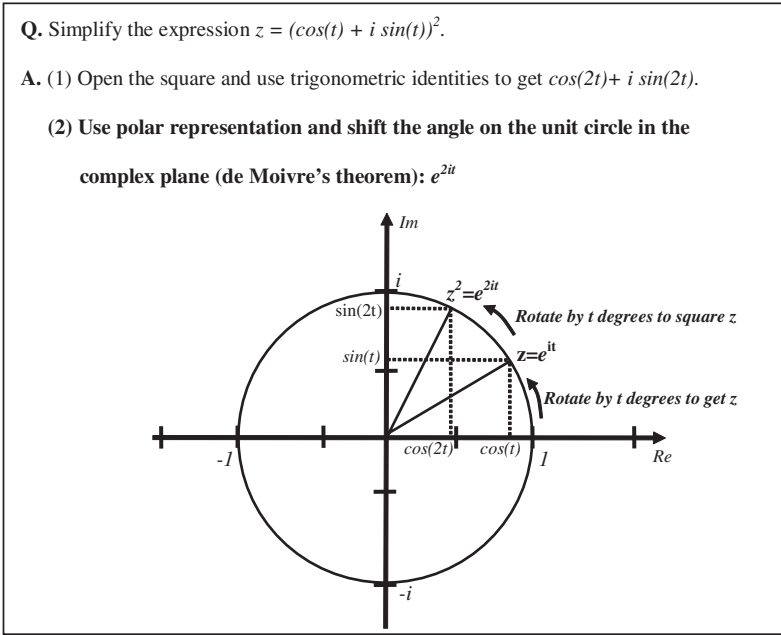
Fig. 22.2.   An example of duality in a creative problem.

(3) Interpolation: *multiple objects* that satisfy the same criteria (Figure 22.3).

- Multiple circles/geometrical shapes that pass through the same points.
- Multiple functions that satisfy the same interpolation criteria (e.g., linear vs. quadratic that pass through the same two points).

(4) Domain: *different solutions* may be found in different *domains* (Figure 22.4).

- Solving a quadratic or higher polynomial equation over the real vs. over the complex.
- Integer vs. fractional solutions.
- Rational vs. irrational solutions.

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Q. Find the center of the circle having radius $r = 1$ that contains the points $(0,1)$ and $(1,0)$.

A. There are two such circles: one centered at the origin $(0,0)$ and **another centered at (1,1).**
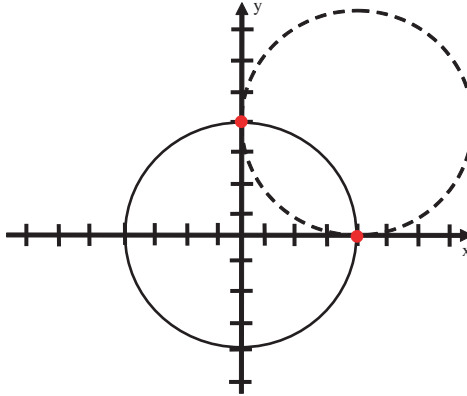
Fig. 22.3. An example of interpolation in a creative problem.

Q. Find the solutions of the equation $x^3 = 1$.

A. There is one real solution ($x = 1$) and **two complex solutions ($x = e^{2\,i/3}$, $x = e^{4\,i/3}$).**
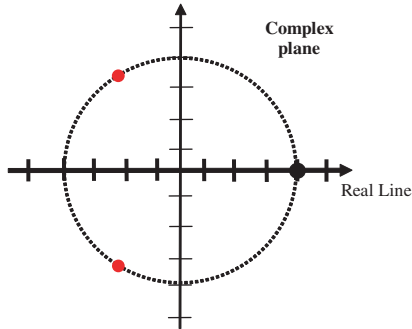
Fig. 22.4. An example of domain in a creative problem.

Q. Find a simple quadratic function that involves the variables x and y.

A. (1) $y = x^2$; **(2)** $x = y^2$. (2) is not a function if y is the independent variable,

but it is a valid solution if x is regarded the independent variable.
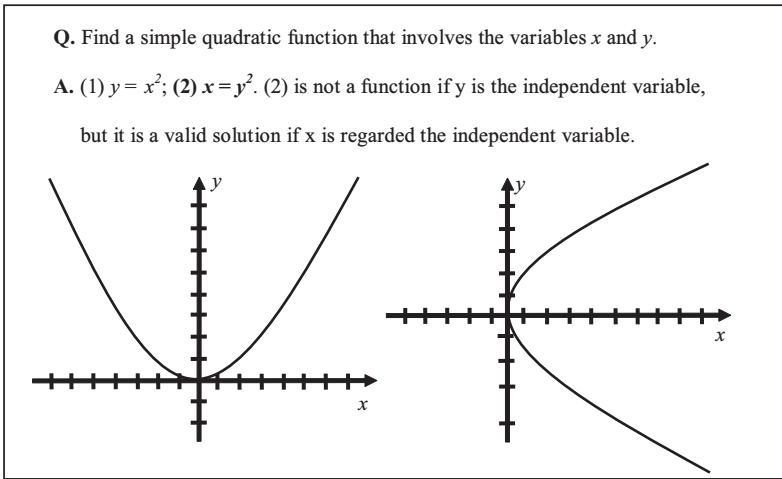
Fig. 22.5. An example of simplification in a creative problem.

- Single-digit vs. two-digit solutions (x=1, x=11).
- Solutions in a discrete set (e.g. Zn) vs. a continuous set (e.g. Z).

(5) Simplification: *transferring the problem to a different form* that allows other solutions (Figure 22.5).

- Coordinate transformation, switching variable roles.
- Cancel out common numerator and denominator functions to make a function defined over a larger domain.
- Simplifying a non-functional relation to a functional form (e.g. simplifying the relation "$x^2 + y^2 = 0$", which apparently is not a function, to "$y = 0$", which is a function).

Technique for Virtually Unlimited Question Generation

The five strategies and their combinations result in a finite number of creative questions, which may lead to memorizing specific solutions and copying answers from other students. To prevent retention and memorization, creative questions should also be *parameterized*. A parametric question contains one or several input parameters that are randomly chosen from a specified domain upon each question "instance". An example of a parametric level 1 academic question

is "Expand the expression $(ax - b)^2$", that has one correct answer $(a^2x^2 - 2abx + b^2x^2)$. An example of a parametric level 4 creative question is "Solve $ln[(a + bx^3)/(a + 1)] = 0$ for x", that has a standard real solution $x = 1/b$, but also original complex solutions $x = e^{2\pi i/3}/b, e^{4\pi i/3}/b$." If a,b are both integers between 1 and 100, there are 10,000 different question instances of a single parametric question.

Developing parametric questions requires extra care than "normal" questions, because the author must ensure that the question is solvable for each set of the parameter values; for creative parametric questions, two distinct solutions must exist in every case. The extra development work is nevertheless easily outweighed by the advantages of such question templates: (1) The number of different creative question instances is *much larger* than the number of questions actually stored in the database; (2) Students may learn to recognize that some question sets share common patterns, which can be applied for other questions of the same set. Thus, they may heuristically identify sets of patterns, and develop higher-order thinking skills and general problem-solving strategies, rather than pure memorization.

To determine whether the parametric form had an impact on the level of difficulty of the academic and creative solutions perceived by mathematics teachers, their judgments were examined. The results showed that there was no significant effect of parameter values (e.g., whether they were single digits or multiple digits) on the degree of difficulty for both academic and creative solutions. The finding indicated that the parameterization schemes were carefully constructed, so that all question instances of the same parametric question shared the same characteristics and difficulty level. This is not always the case; an extreme counterexample is the question "Find how many non-zero integer solutions to $x^n + y^n = z^n$ exist for x, y and z". When $n = 2$, it is relatively easy to prove the existence of an infinite number of solutions (Singh, 1998). For $n > 2$, proving that there are no solutions is known as Fermat's last theorem, which took over 350 years, 800 pages and numerous new techniques in Number Theory to prove, since its statement by Fermat in 1630. However, for practical purposes

of mathematics instruction the parametric form seems to be worth-while.

Content Validation of Creative Solutions in Mathematics:
Teachers' Perspective

Defining creative questions to admit multiple solutions encourages students to generate multiple, creative solutions and to solve a problem however they choose (Pehkonen, 1997; Silver, 1997; Arney, 1999). Bridgeman (1992) and Pandey (1990) asserted that only a valid tool should be used for measuring creative solutions that reflect both the solution stages and the accuracy of the creative solutions on a large scale (Bridgeman, 1992; Pandey, 1990). Accordingly, in the current study the validation of creative solutions in mathematics was examined from the teachers' perspective.

To ensure that the pre-Calculus question items developed in this study indeed represented creative thinking in mathematics, the question items were reviewed by two high school teachers who are also adjunct math instructors at the University of Utah. The judges reviewed each of the 200 items in the database through the *RUReady* Web site. They evaluated each question and its solution as reflecting academic and creative thinking in mathematics. In particular, the judges evaluated whether a creative question has two distinct solutions, whereas an academic question results in one solution only. The teacher judgments were obtained individually, and they completed the task in three to five hours.

The degree of agreement between the teachers in judging the type of solutions for each of the 200 items was investigated by Kendall's coefficient of concordance (Gibbons, 1993; Guilford and Fruchter, 1973; Siegel and Castellan, 1988). The overall Kendall coefficient of concordance for the 200 question-solution category for the two judges was 0.852, $p < 0.0001$. The corresponding Kendall coefficients of concordance for each of the judges were 0.875 and 0.849, $ps < 0.0001$, respectively. Considering the large number of database items, these findings indicated strong agreement between the two judges as to the type of mathematical thinking represented by the 200 mathematical solutions.

Next, the correlation between the solution type assigned by the judges to each of the 200 items and that assigned by the faculty experts that created the database was examined. The Spearman rho Correlation (Spearman, 1910), which is a non-parametric version of the Pearson correlation coefficient, was used because it is considered most appropriate for ordinal data that do not satisfy the normality assumption (Siegel and Castellan, 1988; SPSS, 2006). The correlation coefficients was $\rho = 0.536$, $p < 0.0001$ for the two judges, and 0.611 and 0.463, ps < 0.0001 for each of the judges separately. Considering the large database, these findings indicated that in the opinion of two mathematics teachers, the formulation of the two types of solutions, academic having one solution versus creative having at lest two different solutions, was valid.

Messick (1995) suggested that construct validity be viewed as a single unified concept that integrates six distinguishable aspects of and provides a framework for the empirical testing of hypotheses about the meaning of test scores and their relationship to the theories on which they are based. In this study, the content aspect indicating evidence of the degree to which the test items represent the behavior which they purport to measure (Messick, 1989b), was investigated. There was impressive agreement about the type of solution (academic vs. creative) represented by the 200 database items between two teacher judges in mathematics. There also was a strong relationship between the university expert formulation of the solution types and the teacher judgments of the type of the items. These results constituted good evidence for content validity of the database.

Automated Analysis of Creative Solutions in Mathematics

Research provides evidence that computer environment holds the potential for affording students more opportunities to think critically and present their own creative ideas (Clements, 1995; Krulik and Rudnick, 1999; Roh, 2003). Based on this evidence, we developed an automated system for analyzing and scoring open-ended creative solutions in mathematics via the interactive Web site.

Parsing a Single Response

The *RUReady* site's software contains an advanced mathematical expression *parser* that analyzes student *constructed* responses to *open-ended* math questions and provides detailed error feedback to the student about the correct and erroneous parts in each response. A response can be any string of characters typed on the keyboard that represents a mathematical expression or expressions. The parser first breaks the response into elements, each consisting of a single number, variable or operation. The element array is matched against the parser's mathematical grammar rules (Metsker, 2001). In addition to standard expression matching to determine whether the student's response is mathematically legal, the parser compares the student's response with the correct answer's string provided by instructors, evaluates whether they are mathematically equivalent, and classifies student's response elements as correct, wrong, unrecognized, missing or redundant elements (see Figure 22.6). The parser's algorithm in described in detail in (Livne, Livne and Wight, 2006b). The parsing analysis is applied to scoring open-ended and multiple-choice questions, as described below. A reader who is not interested in the mathematical details of scoring may skip the following two sections and instead observe the examples in Figures 22.7 and 22.8.

Scoring an Open-Ended Academic Question

The score is an average of the last response's correctness score and "error score". Let $A = 1$ if the response is mathematically equivalent to the correct solution, otherwise $A = 0$. Let C be the number of **correct** elements that are parsed in the student's last response, M the number of **missing** elements of the solution, and E the number of **erroneous** elements (number of wrong values plus number of unrecognized elements). The score is defined by

$$S = 0.5A + 0.5S_e. \tag{22.1}$$

The error score $S_e := C/(C + M + E)$, $0 \leq S_e \leq 1$ is a normalized continuous measure of the distance between the response and the solution

Fig. 22.6. An example of an automated parsing analysis and scoring of students' response.

(the *relative* number of correct elements in the student's response; see Figure 23.7).

Scoring an Open- Ended Creative Question

This generalizes the academic scoring formula (1) to two correct solutions. The case the response being [close to] the combined solution,

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Student's response   Correct solution

E   **C**   **M**

 # Erroneous elements   **# Correct**   **# Missing**
(Unrecognized+Wrong)   **elements**   **elements**
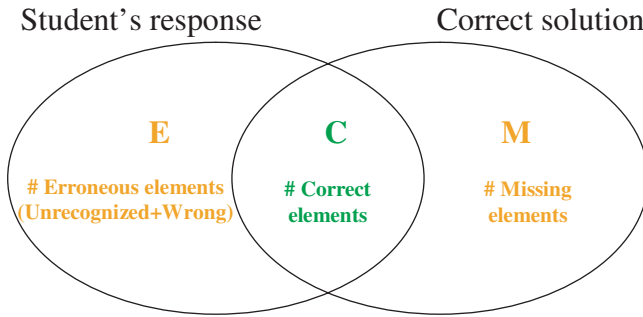
Fig. 22.7.   Student's response contains $C + E$ elements, and the solution contains $C + M$ elements. The distance between them is measured by their intersection size (C) relative to the total number of elements $(C + M + E)$.

(a) Academic question: Score is based on a single solution.

(b) Creative question: score is based on two distinct solutions.

Fig. 22.8.   Examples of automated parsing and scoring solutions.

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namely the concatenation of the two solutions, must also be addressed. Let $A_i = 1$ if the response is equivalent to solution #i, and 0 otherwise, $i = 1,2$; let $A_3 = 1$ if the response is equivalent to the combined solution, and 0 otherwise. We similarly define C_i, M_i, E_i as the number of correct, missing and erroneous elements that are parsed in the student's best responses with respect to solution $i = 1$, solution $i = 2$ and the combined solution ($i = 3$), respectively; let $S_{e,i} = C_i/(C_i + M_i + E_i)$ be the corresponding error scores, $i = 1,2,3$.

The score is again given by (1), where

$$A = \max\{A_1, A_2, A_3\} \tag{22.2a}$$

$$S_e = S_{e,3}, \quad \text{if } S_{e,3} \geq \max\{S_{e,1}, S_{e,2}\}; \tag{22.2b}$$

$$S_e = 0.6 \max\{S_{e,1}, S_{e,2}\} + 0.4 \min\{S_{e,1}, S_{e,2}\}, \quad \text{otherwise} \tag{22.2c}$$

In other words, the response is considered correct (A=1) if and only if one of A_1, A_2, A_3 is 1. If the combined solution's error score is the highest, it is used as the overall response error score; otherwise, the error score is a weighted average of the better solution's error score (60%), and the worst solution's error score (40%). The weights (0.6, 0.4) were adjusted so that a single solution for a creative question admits an overall 80% score, in agreement with (Livne, 2002, Livne and Milgram, 2006). Notwithstanding, the weights appearing in (1),(2) should be regarded preliminary and subject to update as more information on the scoring method is accumulated in future studies.

Scoring Multiple-Choice (MC) questions

The parser analysis and scoring of student's constructed solutions can be also applied to analyze multiple-choice (MC) distractors. MC questions have a discrete set of *n* choices and are traditionally scored by 100%, if the correct answer is chosen and 0% otherwise. The *RUReady* parser enables *continuous* scoring: each choice (#i) is treated as a response to the corresponding open-ended question, thereby assigned a score S_i using (1) for academic questions, and using (1)–(2) for creative questions (Figure 22.9).

Fig. 22.9. An example of previewing a creative multiple-choice question scoring. Choice 5 is solution #1, choice 6 is solution #2, and choice 2 contains both solutions, thus is correct choice. Each choice is assigned a continuous score (red column) and may contain different distractors, manifested by the parser's analysis in correct and erroneous element counts (green and yellow columns).

This scoring strategy can also be effectively used by teachers to develop new questions. The RUReady site contains a question preview tool that allows teachers to experiment with different distractors in MCs, which are automatically scored and displayed. To this end, it is not clear what the optimal distribution of MC scores should be: (1) a uniform distribution seems natural, so that the score expectation is not biased with respect to open-ended questions; or (2) more choices with fewer distractors might be desired, as may be expected from students' error pattern frequencies in the corresponding open-ended question. Also, in creative MC questions, one choice may be a combined option of two correct solutions (score: 100%) and two other choices may contain a single solution each (score: 80%), used to assess the student's ability to generate both solutions (Figure 22.9). This illustrates the inherent flaw of MC format, where even pure guessing succeeds with probability $1/n$. Hence, the proposed continuous MC scoring is a substantial improvement over traditional binary scoring, but should still be referenced with some caution.

Conclusion

A novel system for computerized analysis and scoring of constructed creative responses in math was described. This technique serves several purposes: displaying immediate error feedback to students during

problem-solving; encouraging them to seek multiple and creative solutions, thereby enhancing their high-order skills in an adaptive learning process; automated continuous scoring of both open-ended and multiple-choice questions; and most importantly, providing teachers with tools to measure and track their students' level of creativity, as well as design new creative questions. The *RUReady* project represents a significant advancement in our ability to measure students' levels of creativity in math. As we make further advances in teaching and learning tools, it will be possible to nurture these creative responses and thereby stimulate future advances and discoveries in math, science and engineering.

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Part Three
Creativity in Contexts

Section VII
Self and Other Perspectives

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Fostering Creative Behavior in the Asian Classroom: The Role of Self-Regulatory and Self Processes

Wan-Har Chong

Introduction

In the face of incessant changes to knowledge and technology, the individual has to foster a mindset that calls for greater adjustment in one's actions, behavior and learning, and to construct new ways to adapt flexibly and keep abreast of these changes. Personal attributes of independence, self-direction, initiative, tolerance for ambiguity, and flexibility in adaptation are some of the qualities that would be required in the creation of this innovative and creative spirit. That is, adaptation and adjustment would require substantial creativity. Indeed, contemporary research has shown that it is an important component in problem-solving and other cognitive abilities, and contribute to social and emotional well-being, and academic success (Plucker *et al.*, 2004; Bahr *et al.*, 2006). From this standpoint, creativity is portrayed as a single personal trait, attribute, or ability that individuals possess or lack. There is, however, substantial converging evidence to suggest that creativity could be fostered (Russo, 2004; Hunsaker, 2005; Bahr *et al.*, 2006). Rogers (1961) had proposed that the cultivation of creativity should take into consideration the conditions under which this process of development occur, and the ways in which it may be facilitated. Similarly, Plucker, Beghetto, and Dow (2004) suggested that creativity should attend to "the interaction among aptitude, process, and environment by which the individual or group produces a perceptible product that is both novel and useful as defined within a social context"

(p. 90). From this perspective, constructive creativity can emerge not only just from the person but also the press (environment), product, and through the process.

When creativity is conceptualized as a function of these interactions, it is no longer perceived as a freewheeling endeavor but one in which there is evidence of discipline as one attempts to bring out the essence. This behavior can be promoted through purposive efforts directed at cultivating aptitudes such as a tolerance for ambiguity, flexibility in thinking, perseverance, and sustaining intrinsic motivation. Approaching creativity as a skill to be developed also requires the employment of specific strategies and processes to facilitate the exploration, organization and integration of various thoughts, ideas, and perspectives. The literature on creativity training with student populations is populated with examples of using various cognitive strategies such as brainstorming, creative problem-solving, decision-making, reflective thinking, and problem-finding processes to bring out the creative behavior and thinking. For students, training in creativity would, therefore, benefit not only just their academic experiences but also in other aspects of their lives (Hunsaker, 2005).

Contemporary research however showed that successful engagement in creative undertakings requires considerable self-regulation (Zimmerman, 1986; 1998). Despite the disparate areas of expertise, successful writers, musicians, and athletes revealed that they spend considerable time regulating their efforts to fine-tune their crafts and skills. These experts are proactive in their efforts because they are aware of their strengths and limitations. They are guided by personally set goals and task-related strategies to achieve desired outcomes. They monitor their behavior consistently, and self-reflect on their increasing effectiveness. This, in turn, fosters and enhances feelings of self-satisfaction and motivation to continue with improving their craft. That is, these experts attain self-discipline and self-direction through self-regulatory processes that involves much self-awareness, self-motivation, and self-management to implement their knowledge and skill effectively. From these accounts, there is reason to believe that teaching self-regulation may be particularly relevant for the development of creative thinking and behavior.

Approaching creativity from this person-process-press-product perspective, it becomes evident that considerable attention needs to be paid to an individual's internal and external conditions and the processes under which creativity can be promoted or fostered. The aim of this chapter is to present a socio-cognitive approach to understanding how elements of self-regulatory and self processes could be incorporated in promoting the development of creative behaviors in the Asian classroom. It is proposed that for creativity to be constructively managed, attention should be paid to strengthening metacognitive, cognitive, and affective processes of learning in the individual. When experiences and processes are aimed at strengthening and improving these processes, students are likely to move towards an internal locus of control. A better platform is, therefore, provided for them to draw on personal resources not just to engage creatively, but also to persist in the face of difficulties. The chapter entails a discussion of these strategies.

What Does Self-Regulation Entail?

Self-regulatory processes emphasize the construction of learning experiences that require active involvement and participation from the learners. It is seen as consisting of those "self-generated thoughts, feelings, and actions" (Boekaerts, 1999, p. 446) systematically oriented toward the attainment of desired goals, especially in the face of distractions and obstacles (Ford and Nichols, 1991). Extensive research converges to suggest a strong positive relationship between self-regulated engagement and academic achievement (e.g., Bandura, 1997; Pintrich and Garcia, 1991; Paris and Paris, 2001; Schunk and Zimmerman, 1997; Zimmerman, 1990; 1995). For successful engagement in self-regulation, Zimmerman (1986) underlines the systematic use of three important processes:

(i) Metacognitive processes—self-regulation requires the active planning, organization, self-instruction, self-monitoring, and self-evaluation of the learner at various stages of the learning process,

(ii) Motivational processes—self-regulatory processes are focused on enhancing the learner's perceptions of self-control, including a sense of competence, high efficacy and autonomy, and

(iii) Behavioral processes—successful self-regulation enables the learner to select and/or construct environments that would facilitate learning.

Although all learners use regulatory processes to some degree, self-regulated learners are set apart by their awareness of the strategic relations between their use of regulatory processes and corresponding learning outcomes, and their use of strategies to achieve their goals (Zimmerman, 1995; 1999). These learners actively organize their own learning, and possess the pre-requisite metacognitive, motivational, and behavioral learning strategies to negotiate learning tasks. Their efforts are purposeful, strategic, and persistent, and they accept personal responsibility for the outcomes of their efforts (Zimmerman, 1990). The essence of self-regulation lies in this perception of choice and control, accessibility and adaptability (Boekaerts, 1999), with attention primarily focused on how learners can effectively activate, alter, and sustain their learning practices in specific contexts to achieve the desired outcomes.

Theoretical perspectives on self-regulation abound. One prominent view proposes self-regulation as consisting of strategies that need to be taught, practiced, and applied (Cleary and Zimmerman, 2004). Many classroom applications utilizing this approach assume a highly structured, teacher-directed approach to facilitate student engagement of cognitive and behavioral strategies in self-regulation. Schunk and Zimmerman (1997) believe that most learners will benefit from the direct guidance of a teacher-model who provides guidance, feedback, and social reinforcement to initiate and encourage a student's acquisition of relevant behavioral and cognitive skills.

The second perspective emphasizes "becoming" more regulated as students develop new competencies. In this view, self-regulation is a description of a set of coherent behaviors exhibited by a person in a situation to assist in adaptation to the unique environmental demands, rather than a set of skills to be taught. What behaviors and thoughts

become regulated and to which goals depend on specific experiences (Martin, 2004; Paris and Paris, 2001). This view suggests that self-regulation becomes more meaningful to students when these practices are tied to their strivings to display competence. Both self-regulatory perspectives focus on processes of learning, development, and instruction in differing ways but remain useful in providing a framework to understand parallels between self-initiated and self-sustained learning, and performance across creative disciplines as music, writing, sports, arts, and computing.

Contemporary research has shown that self-regulation involves the selective use of specific processes that must be adapted accordingly to the requirements of the learning task. These key component skills involve:

(a) Self-Monitoring and Self-Evaluation

Individuals need to check over their work systematically by observing and tracking their own performance and the outcomes of their efforts throughout the process of learning. Personal judgment is necessary to ensure that performance does not fall short of pre-determined goal(s), that strategies are implemented accurately, and that one's efforts maximizes the opportunities for effective outcomes. Where shortcomings occur, the individual may need to take the necessary steps to revise or reconsider the feasibility of one's goal or actions (Zimmerman, 1990; Zimmerman, Bonner and Kovach, 1996). Self-monitoring is pivotal to self-regulatory success, as its accuracy determines continuing use of the strategy, subsequent engagement in the task, and one's effectiveness in the specific learning context. Its successful usage therefore underlines the importance of self-awareness in one's ability to regulate performance.

(b) Goal Setting and Strategic Planning

Goal setting is a key component for successful and sustained self-regulation and is primarily concerned with directing attention, and channeling efforts and thoughts towards desired outcomes (Ford and Nichols, 1991). Goal setting provides opportunities for realistic appraisal and evaluation of personal capabilities. When areas of deficiency are identified, students can then revise learning goal(s), and

select the appropriate strategies to control and sustain attention, motivation, emotions, and decisions to attain them (Schunk, 1990).

(c) Environmental Restructuring

To be effective in self-regulation, the strategic learner alters his behavior, select, or create a physical or social environment that facilitates the attainment of his goal(s). Managing one's use of time and effort efficiently, prioritizing goals, self-evaluating one's methods, and enlisting the support of resources to manage and accomplish goals are some adaptive strategies to keep track in the face of competing demands and obstacles.

(d) Self-Consequences

To enhance performance, individuals need to provide themselves with positive or negative consequences when they accomplished their goal(s). Such consequences not only strengthen the desired behaviors, but also serve to inform and motivate learners to continue producing those self-regulatory behaviors that had earlier ensured success. In this regard, self-rewards influence personal evaluation by validating one's perceptions of progress towards the desired goal(s) (Schunk and Zimmerman, 1997).

The Motivation for Creative Thinking

Empirical evidence suggests that there are many routes to enhance the students' creative behavior and thinking. Hunsaker (2005) identified that educational programs in creativity are organized around the four themes of person, processes, products, and press. However, it is observed that many of these interventions were designed to enhance the creativity through generally specific programs and do not necessarily ensure transfer of behavior more than skills training programs that emphasize interpersonal goal setting, planning, and evaluation skills. Research in self-regulation has similarly indicated that developing regulatory skills alone will not contribute much if students do not apply them persistently in the face of difficulties. Indeed, Bandura (1997) highlighted that training can only be effective in so far that underlying issues of student motivation are addressed adequately.

Research indicates that the self-regulated learners depend on underlying beliefs of perceived efficacy and intrinsic interest. Self-efficacy is one set of self-beliefs that has been shown to be influential in regulating one's efforts towards desired goals in the midst of difficulties (Pajares, 1997). Self-efficacy consists of those "beliefs in one's capability to organize and execute the course of action required to manage prospective situations" (Bandura, 1997, p. 2). Efficacious students are known to be better able to regulate their own learning activities, master difficult learning tasks, persevere in the face of difficulties, influence their academic motivation, interest, and achievement performance, manage their emotions in interpersonal relationships, and resist peer pressure. These specific beliefs are influential in shaping general self-conception of competence. Efforts to introduce creativity programs should pay attention to enhancing efficacy beliefs to foster creative initiatives. This is particularly so for beginners in a new discipline who easily lose interest if they are not properly encouraged and guided. Motivation for these individuals can be enhanced if they use high-quality self-regulatory processes, such as close self-monitoring. This capability to detect one's progress in learning can increase one's level of satisfaction and personal efficacy to perform.

In proposing a theory of creativity, Rogers (1961) argued that humans have the tendency to actualize themselves, and to become what they are capable of becoming. This intrinsic motivation provides the primary force in facilitating creativity. To do so, the individual needs to be open to all aspects of his experiences so that he is better positioned to behave and respond constructively and in an integrated manner toward his goals. In particular, experiences aimed at sensitizing and enhancing the self-awareness of one's natural tendencies and impulses, the expectations of one's culture, one's own purposes, beliefs, and perceptions would provide the platform for the emergence of creative thinking and behavior.

The Role of Self in Self-Regulatory Processing

Although self beliefs are important in regulating self-regulatory efforts, it is insufficient just to focus on enhancing these beliefs. It is important

to improve students' calibration in the accuracy of their self-perceptions so that they can better appreciate what they know and not know, and may be more effective and efficient in deploying appropriate strategies as they respond to the demands of a task or situation (Ford and Tisak, 1983; Pajares, 1997). In this respect, the self is seen as the critical link between self-conceptions and motivation, to provide for the development of self-regulation (McCombs, 1986; 1988; McCombs and Marzano, 1990). It assumes a central role in orchestrating the use of metacognitive, cognitive, and affective processes in formulating intentions, making choices, and attaining personal goals.

As such, an important first step in creativity training should involve helping the student develop a sense of personal agency through understanding one's capacity to exercise self-control within the constraints of environmental demands. This is considered a vital phase because the "will" generated from this sense of personal agency becomes primary in initiating self-regulatory and metacognitive processes, and generating positive self-beliefs. The self-regulatory skills developed are then used to further self-determined goals. This ability to exercise personal agency is of particular importance in the high school years, where a growing sense of personal awareness and an emerging self-identity increasingly affect students' developmental trajectory.

Metacognitive Processes

Metacognitive skills contribute to the development of self-regulatory and self-management skills, and are therefore important for developing positive self-control and managing emotions effectively. Essentially, the ability to regulate one's activities also begins with self-awareness and self-appraisal. This is facilitated through various metacognitive activities of goal-setting, planning, self-observation, self-monitoring, self-evaluation, and self-questioning (Zimmerman, Bonner and Kovach, 1996). Skills in self-monitoring are vital in helping the individual develop adaptive behaviors, because deficiencies in this process can make it difficult to correct distorted self-views and corresponding adjustments in other self-regulatory processes. Negative self-views can also cause the individual to focus energy and effort on the avoidance

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of failure instead of maximizing personal competency (Garcia and Pintrich, 1994).

Cognitive Processes

Cognitive processes are generally related to specific intellectual abilities, skills, strategies, and higher order executive control processes like problem-solving and decision-making. These strategies help students to

(a) analyze personal abilities and knowledge,
(b) identify the skills and knowledge they bring to the task,
(c) make judgments about the usefulness and adequacy of specific strategies, and
(d) evaluate their personal ability to apply self-regulated strategies.

There is already considerable evidence from creativity research to indicate the effectiveness of many of these strategies to deliver the required outcomes (Hunsaker, 2005; Russo, 2004).

Affective Processes

Some emotions involving the ability to read one's own and others' emotions are important for effective self-regulation (Boekaerts, 1993; Schultz and Davis, 2000). For adaptive learning to take place, students must be taught not only how to regulate their behavior and master a skill, but also to deal with emotions and intrusive thoughts when confronted with a stressful situation. In particular, students with low self-concepts of ability are most susceptible to repeated failures because their feelings are too vulnerable to protect their sense of personal competency and they do not know how to do it. Affect management would permit the student to make appropriate interpretations of success and failure and adaptive choices, which in turn preserve a sense of self-worth and competence. Therefore, affective strategies need to be oriented toward the role of self in learning, and generally relate to self-knowledge about personality characteristics, emotional and motivational responses and feelings of self-worth. It should also

address motivational influences such as personal and possibly conflicting cultural values and beliefs. A level of personal awareness is necessary for effective management. Metacognitive processes of self-observation, self-evaluation, planning, and goal setting apply well in the control and facilitation of these affects. In a cultural context where there is a need to recognize self and other interests to achieve collectively agreed goals, this ability to self-appraise affectively should constitute a key component of the self-regulation process, providing a "balance" in enhancing both social and self cognitions of the individual (McCombs and Marzano, 1990).

Promoting Self-Regulation in the Classroom

Although there is considerable empirical evidence to suggest the benefit of self-regulatory processes, few teachers effectively prepare their students to engage in learning on their own. In the Asian classroom, students are not often given opportunities to pursue academic tasks of their choice, taught to set goals, self-monitor, self-evaluate or self-appraise their work, or estimate their competence on new assignments. Teachers also provide few opportunities for students to assess their beliefs about learning in order to identify motivational or cognitive difficulties before they present difficulties. Ironically, more student-centred pedagogical approaches, such as Project Work, Problem-based Learning, and Co-operative Learning, are implemented in the classrooms. These learning approaches require substantial student initiatives, and assume and demand students to be self-directing as they venture to identify, work on, and create new learning areas. Such self-directed initiatives require considerable cognitive and metacognitive sophistication, and motivation to work effectively with others.

A first step toward establishing an environment that encourages creative thinking and behavior is to create a classroom atmosphere where there is openness, psychological safety, and flexible boundaries to explore, experiment, experience, and take risk. This allows the individual the ability to receive much conflicting information without forcing closure upon the situation. Furthermore, in designing activities

that promote self-regulation in classrooms, the following principles and suggested activities may offer the teacher useful guidelines.

(1) Self-reflection, self-evaluation, and self-appraisal lead to a deeper understanding of the self as a personal agent of change.

Provide opportunities for the student to (a) review the interrelatedness of personal control, choice, and responsibility and how the applicability of these concepts is constrained by demands of the social context, and (b) analyze how environmental and physical constraints could still afford opportunities to exercise personal choice and control (Chong, 2005, 2006). Subjects such as English, Humanities, and Life Sciences are particularly suited to engage students in reflective discussions on these concepts.

Students can learn how their choice of words come to influence their affect and evaluation of personal competencies, and they can be taught to monitor and reflect on the language used on the self (e.g., "I can't do this"; "I don't know how" as opposed to "I want to"; "I can try"). Challenge them to develop alternate coping vocabulary and positive self-talk that promote feelings of efficacy, adaptive and strategic behavior, and performance.

Paris and Paris (2001) proposed that students could be asked to self-evaluate what they know and what they do not know, to promote efficient resource and effort allocation. They could analyze personal styles and strategies of learning, and compare these with the strategies other students are using. The Motivated Strategies for Learning Questionnaire (MSLQ) secondary (Pintrich and De Groot, 1990) and post-secondary versions (Pintrich *et al.*, 1991) and the Patterns of Adaptive Learning (Midgley *et al.*, 2000) are useful self-report instruments to assess the students' motivational orientations and their use of different learning strategies. Create opportunities for students to clarify personal values and possible conflicting parental and societal expectations to establish personal meaningfulness of the desired goals and to understand the basis for their personal conduct, and against which to self-evaluate performance. This is an important step to help manage thoughts and feelings and maintain self-control. More specific and detailed examples can be found in Chong (2005).

(2) Self-management of one's thinking, effort, and affect through self-observation, self-monitoring, and self-evaluation to promote flexible approaches to problem-solving and decision-making that are adaptive and strategic (Paris and Paris, 2001).

Set personally meaningful and achievable goals and understand the influence of significant others' expectations and goals on one's decision-making. However, the process of goal attainment needs to be managed with priority setting. Allow students to identify obstacles to goal attainment, analyze alternative problem-solving approaches to work through these obstacles, and manage time and resources through effective planning and monitoring.

The 'Thought Cycle' (McCombs and Pope, 1998) offers a useful tool to understand the interrelationships between thinking, feeling, and behavior (Thought → Feeling → Behavior → Result → Thought). Through self-check processes, students can come to learn how their thoughts can to affect their personal motivation, behavior, and learning, and begin to exercise control and make responsible choices.

(3) Promote the skills of self-regulation (Zimmerman, 1986).

Cleary and Zimmerman (2004), Dembo and Eaton (2000), and Zimmerman, Bonner, and Kovach (1996) provided various systematic models of how self-regulation could be taught through explicit direct instruction to influence learning, use of time, control of one's physical and social environment, and performance. Provide persuasive models and participation in practices with experts or mentors so that students can self-reflect on the self-regulatory strategies employed by these models and compare these with the ones they are using.

Facilitate student engagement in natural activities that promote self-regulatory learning. Promoting opportunities to work with others in sustained projects is one powerful example. These initiatives require personal awareness and self-examination of one's self-conceptions, and develop and use various problem-solving strategies. It requires considerable knowledge, effort, persistence, and self-regulation on students as they devise plans, discuss ideas, consider alternatives systematically, monitor their own understanding, compare their point of view with those of others, and challenge with questions.

(4) Promote self-efficacy and regulation of motivation to regulate effort and persistence in the task, particularly in the face of difficulties and distractions.

Bandura (1997) identified four sources of efficacy appraisals through which their personal beliefs about their competency could be enhanced.

 (i) mastery experiences through providing varied opportunities for students to perform and master a variety of skills successfully within and outside the classroom,

 (ii) vicarious experiences by providing teacher modeling of self-regulatory strategies, verbalizing thought processes as (s)he performs tasks, providing and outlining the characteristics and strategies adopted,

(iii) verbal persuasion by encouraging students to perform, and providing contingent constructive feedback, causal attribution of efforts, and efforts that embody a mastery orientation rather than a performance goal, and

(iv) self-monitoring of one's affect and physiological states (of anxiety or fear) in the face of challenges as a means of regulating one's emotions.

Make effort to extend and incorporate self-monitoring and self-evaluation in any academic and social efforts, and provide more choice, feedback, and decision-making opportunities in the classrooms that emphasize the efficaciousness of students' strategies, personal responsibility and control in learning. Raise students' awareness of environmental influence on their learning. Teach them to maintain or alter the physical environment to avoid distractions and maintain focus on the task, and manage their physical and mental readiness to deal with the task (e.g., Do they work better during certain times of the day and/or under certain circumstances?). One other way is to help students develop short-term specific goals out of the long-term self-set goals to manage perceived competence and expectations. Teach them to manage and administer concrete self-provide consequences, and self-reinforcing verbal statements or thoughts ("If I finish this homework, I can buy myself a treat"; "If I don't get this done by dinner time, I

can't watch TV as I had planned") for completing a task or achieving a goal (Wolters, 2003). Teachers can further develop two other types of positive self-talk to sustain interest:

(1) Goal-oriented self-talk that is aimed at increasing motivation and effort in the face of difficulty. The content of these thoughts is different form simple statements that reinforce or punish particular behaviors. Instead, students are asked to think about or provide reason(s) for persisting or completing a difficult task ("I should not disappoint those who believe in me"; "I must push on to see how far I can go").

(2) Efficacy self-talk aimed at influencing one's efficacy for an ongoing task and is linked to effort, persistence, or performance ("I am doing a good job and keeping everything in good time. Just keep going.").

Conclusion

Self-regulatory processes emphasize the construction of learning experiences that require active involvement and participation, greater independence and self-direction from the learners. By providing opportunities for acquiring self-management skills, self-direction and self-initiation, individuals can learn to make their goals personally relevant, and self-manage accomplishments that afford much opportunities for developing choices, effort, persistence, and decision-making ability. Such undertakings help the individual to move toward an internal locus of control, reinstate personal control over learning and life processes, thereby providing a stable platform to meet the many contemporary challenges.

To promote the development of self-regulatory functioning, instructional efforts should focus on an approach that incorporates *skill*, *will*, and *self-regulatory* components (Pintrich and Garcia, 1991). It should be directed at developing the students' *will* through helping them to appraise their role as agents of change and power of choice, and the *skill* aspect involving various metacognitive and cognitive information processing strategies. This approach emphasizes on

the individual student's ownership of learning and provides a focus on how the responsibility for choices, actions, and consequences arising from such actions could be taught and internalized (Zimmerman, 1995). In efforts to apply the processes and skills in naturalistic classroom settings where these various processes operate simultaneously and the behaviors are expected to occur, Pajares (1997) has cautioned against developing "packages" or remedy kit sets without an appreciation and understanding of the contexts and conditions under which these influences work to generalize to differing activities. This applies with creativity programs if they are to be responsive to the needs of those training at which are targeted. Considering that many significant achievements in peoples' lives are long-term in nature, finding alternative ways to support students' creative initiatives is one valuable way to facilitate adaptive learning.

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Promoting Children's Personal Strengths: Positive Psychology Goes to School

Albert Kienfie Liau

Introduction

In recent years, the case for schools to foster individual attributes that go beyond developing children's intellectual ability has become increasingly evident. Researchers including those in the areas of creativity have argued for the importance of non-intellectual strengths for children's development by using terms such as emotional, successful, practical and social intelligence as well as terms such as noncognitive abilities and resilience (Heckman, 1999, 2005). In this chapter, in line with the positive psychology movement and the notion of creativity as a strength (Bacon, 2005), it is proposed that a framework of personal strengths is useful for schools to conceptualize the skills that children need to overcome adversities and succeed in life. The role of creativity as a personal strength is highlighted, and the evidence for the importance of these nonintellectual strengths is reviewed. The components of personal strengths are described in detail. Finally, the chapter ends with a discussion of strategies to promote personal strengths in schools.

Positive Psychology and the Study of Personal Strength

The study of personal strengths is motivated by the rise of the positive psychology movement. Positive psychology is the study of the conditions and processes that contribute to the flourishing or optimal functioning of people, groups, and institutions (Gable and Haidt, 2005). This movement, launched by Martin Seligman during his term as president of the American Psychological Association, represents a shift of

focus for psychology from a pre-occupation with addressing weaknesses to the enhancement of positive qualities (Clonan *et al.*, 2004); there is a focus on strengths rather than weaknesses, competency building rather than pathology (Seligman and Csikszentmihalyi, 2000). A major implication of this movement is "the assumption that environments can be promoted to foster individual strengths such as resiliency, competence, and optimism through attention to prevention and the development of positive institutions" (Clonan *et al.*, 2004, p. 101).

Strengths can be defined as positive traits manifested in thoughts, feelings, and behaviors (Park, Peterson and Seligman, 2004). Strengths are ubiquitous across cultures, and in regards to children, strengths are traits that parents would wish for in their children (Bacon, 2005). Although strengths are valued for their own sake, it has also been argued that people will be happier and live more meaningful lives if they can identify and develop their strengths (Seligman, 2002). In fact, research is beginning to support this link between positive strengths and life satisfaction (Park, Peterson and Seligman, 2004; Lyubomirsky, King and Diener, 2005). Research by psychologists such as Fredrickson (2001) has also contributed to the identification of processes that optimize health and well-being. In her broaden-and-build theory, she argues that "positive emotions broadens an individual's momentary mindset, and by doing so help to build enduring personal resources" (Fredrickson, 2003, p. 332), ranging from physical to intellectual resources to social and psychological resources. For instance, research by Isen and colleagues, indicate that when people feel good, their thinking becomes more creative, integrative, flexible and open to information (Isen, Daubman and Nowicki, 1987). As a result, overtime, this broadening of the possible responses to life events creates and "upward spiral" (Fredrickson, 2003, p. 335) which builds the individual's strengths and resilience, and supports health and well-being.

Creativity as a Personal Strength

Creativity is often seen as an important personal strength (Peterson and Seligman, 2004), and in particular, a focus-oriented strength (Bacon, 2005). Bacon (2005) argues that there are two classes of

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strengths: the focus-oriented, or focus strengths, and the balance-oriented strengths, or balance strengths. Focus strengths are about an emphasis of interest and energy on the development of a particular personal competence without the balancing of other intra-personal or inter-personal interests. Hence, Bacon argues that creativity illustrates several defining characteristics of a focus-oriented strength. For instance, "creative people put a great deal of time, energy, and passion into developing one major target of interest (e.g., their work)" (Bacon, 2005, p. 183), and are not particularly concerned about balancing other interests. On the other hand, balance strengths necessarily involve balancing competing intra-personal and inter-personal interests. Sternberg's (1998) concept of wisdom is an example of such a strength that involves a balance among the self, others, and the community. The framework of personal strengths in this chapter will include both focus and balance strengths, and will be discussed in more detail in a later section of this chapter.

The Case for Promoting Personal Strengths in Schools

In this section, three strands of research are brought together to provide evidence for the case that schools need to move beyond focusing on children's intellectual strengths. First, the research of James Heckman, a Nobel laureate, and his colleagues is presented; their research provides longitudinal evidence for the impact of cognitive and non-cognitive abilities on various outcomes. Second, Sternberg's experimental studies in educational settings strongly support the argument for implementing a more holistic approach to education that goes beyond intellectual abilities. Third, correlational studies using the framework of emotional intelligence are discussed.

Heckman, Stixrud and Urzua (2006) have reported that both cognitive and non-cognitive abilities determine social and economic success. Their analyses were based on the National Longitudinal Survey of Youth (1979) which contained panel data on schooling, wages, and employment of youth, aged 14–21. Heckman's analyses challenged the pervasive view that cognitive ability, as measured by test scores, is the most important predictor of personal achievement. In fact, compared

to cognitive skills, he found that non-cognitive skills, measured in terms of locus of control and self esteem,[1] was equally strong in predicting many outcomes, and was stronger for some outcomes. For instance, for both men and women, cognitive skills have about the same effect on wages as non-cognitive skills. For other outcomes such as engagement in risky behaviors, non-cognitive skills had a larger effect than cognitive factors. In addition, Heckman (1999, 2005) has also found that the success of early intervention programs, such as Headstart and the Perry Pre-school Program, was not attributable to intelligent quotient (IQ) improvements of children, but rather to success in promoting non-cognitive skills and from fostering motivation. While IQ is fairly stable after the first decade of life, non-cognitive factors such as motivation and self-discipline are more malleable at later ages. Hence, Cunha *et al.* (2005) suggest that "social policy should be more active in attempting to alter non-cognitive traits, including values, especially for children from disadvantaged environments who receive poor discipline and little encouragement at home" (p. 22).

In an attempt to move beyond the focus on academic intelligence, Robert Sternberg has proposed a theory of successful intelligence where intelligence comprises of analytical, creative and practical abilities (Sternberg, 1997; Sternberg, 2003a).

"Analytical abilities are used to analyze, evaluate, judge, compare, and contrast. Creative abilities are used to create, invent, discover, explore, and suppose. Practical abilities are used to apply, use, put into practice, and implement." (Sternberg, 2003a, p. 56).

Sternberg (2003b) reports that three separate factor-analytic studies have supported the internal validity of this theory; the three types

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[1] The non-cognitive abilities were measured using the Rosenberg Self-Esteem and the Rotter Locus of Control Scales. The Rosenberg scale contained 10 statements of self-approval and disapproval with which respondents are asked to strongly agree, agree, disagree, or strongly disagree. A high score indicated a high self-approval rating. The Rotter scale was based on four questions about the extent to which respondents believe themselves to have control over the various domains of their lives. A higher score indicated more control over one's life.

of abilities are consistently derived as separate factors in the analyses. The external validity and utility of successful intelligence has also been supported by various studies (Sternberg, 2003a; Sternberg, Torff and Grigorenko, 1998). For instance, Sternberg and colleagues have observed that students who are high in creative and practical intelligences were more diverse in terms of racial, socioeconomic, and educational background compared to students high in analytical intelligence. Hence, the relationship between intelligence and such status variables may be reduced using a broader conception of intelligence.

As most schools tend to focus on analytical intelligence, intervention programmes utilizing successful intelligence as a model of pedagogy have been tested to examine the impact on students' achievement. First, the research indicated there was an aptitude-treatment interaction, where students who were placed in instructional classrooms that better matched their abilities performed better than students who were mismatched (Sternberg, 2003a,b). In other words, when students are taught in a way that fits their abilities, they do better in school. Second, Sternberg's research also found that students who are taught using a successful intelligence approach outperformed students taught in traditional, analytical focused approaches not only in performance assessments, but also in traditional multiple-choice tests (Grigorenko, Sternberg and Jarvin, 2002; Sternberg, Torff and Grigorenko, 1998).

Various researchers have argued that emotional intelligence is essential for the healthy psycho-social development of children (Goleman, 1995). Conversely, the lack of emotional intelligence in children could be associated with a variety of internalizing and externalizing problem behaviors. For example, lower levels of emotional intelligence have been found to be associated with lower levels of empathy and the inability to manage moods (Ciarrochi, Chan and Caputi, 2000), higher levels of alexithymia (Parker, Taylor and Bagby, 2001), as well as higher levels of depression, neuroticism, somatic symptomatology, and stress (Dawda and Hart, 2000; Liau *et al.*, 2003). In regards to externalizing behaviours, lower levels of emotional intelligence are associated with higher levels of tobacco and alcohol use (Trinidad and Johnson, 2002), higher levels of sexual offending (Tidmarsh *et al.*, 2001), and

higher levels of aggression and delinquency (Liau *et al.*, 2003). Lower levels of emotional intelligence are also associated with lower levels of achievement (Bar-On, 1997).

The three strands of research discussed highlights the importance of non-intellectual strengths (Duckworth and Seligman, 2005) in children's development and challenges the pervasive view that intellectual ability, as measured by test scores, plays a dominant role in explaining various academic and social outcomes.. These personal strengths are associated with a wide variety of outcomes including achievement, social behavior, and emotional well-being. More importantly, these strengths are also linked to economic and social success in young adulthood. Sternberg's research suggests that creating classrooms and schools where such non-intellectual strengths are emphasized in addition to academic ability actually has a positive impact on achievement. Hence, there is a strong case to support the notion that schools need to pay attention not only to students' intellectual abilities but also to students' non-intellectual strengths.

Personal Strengths as a Framework for Schools

Despite the strong case for developing students' non-intellectual strengths, there is still uncertainty and debate about terms used to describe these non-intellectual strengths There has been a proliferation of terms that refer to this set of strengths, including emotional (Bar-On, 1997; Goleman, 1995; Mayer, Caruso and Salovey, 1999), social (Zirkel, 2000), successful, creative, practical (Sternberg, 1997), intra, inter-personal (Gardner, 1993) intelligence, as well as non-cognitive abilities (Heckman, 1999) and resilience. Although these terms represent attempts to distinguish non-intellectual strengths from intellectual ability, the result can be very confusing for educators and policy-makers. The variety of terms begs the question of whether these different constructs are distinct or overlapping constructs. For instance, how do emotional, social and practical intelligence differ from one another?

Each of these terms often does not have a common set of definitions. In particular, emotional intelligence (EQ) has been defined differently

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by various researchers. On the one hand, Goleman (1998) has a fairly board definition of EQ that includes a broad set of attributes including emotional awareness, accurate self-assessment, self-confidence, self-control, trustworthiness, conscientiousness, adaptability, innovation, achievement drive, commitment, initiative, optimism, understanding others, influence, communication, cooperation and so on. Hence, such a definition has been criticized for capturing almost everything but IQ (Hedlund and Sternberg, 2000). On the other hand, Mayer and Salovey (1997) have argued for a more restrictive model of EQ that focus on abilities involved in the adaptive processing of emotionally relevant information. Others have even suggested that emotion-related abilities and processes involved in socio-emotional competence may be better represented by the construct of emotional adaptiveness rather than a special form of intelligence (Izard, 2001).

Given the debate and controversy surrounding these terms, it is proposed in this chapter that a framework of personal strengths is useful for educators and policy-makers. First, a framework of personal strengths avoids the unnecessary controversy that is often associated with the term "intelligence". Second, using a language of strengths is consistent with the positive psychology movement in focusing on positive qualities rather than deficits. Third, there is evidence that the development of personal strengths—in particular, those that promote positive emotions—is associated with life satisfaction (Park, Peterson and Seligman, 2004), success (Lyubomirsky, King and Diener, 2005), good health outcomes (Steptoe, Wardle and Marmot, 2005), resilience (Fredrickson *et al.*, 2003) and creativity (Isen, Daubman and Nowicki, 1987).

Csikszentmihalyi (1996), in his conceptualization of creativity, has argued for a systems model in which creativity is seen as an interaction among three elements: the symbolic rules and procedures of a particular domain, the social institutions and culture that make up the field, and finally, the individual person. Similarly, it is important to consider systems model in the framework of personal strengths. Just as the surroundings and social institutions play a vital role in creativity, so does the environment have a crucial influence on personal strengths. Schools represent one of the few social institutions in the community with direct

sustained access to children and families; hence, schools can play a pivotal role in fostering positive development in children. Although certain populations of youth do not attend school (e.g., homeless, chronically truant, or incarcerated youth), most school-aged youth spend about a quarter of their waking hours in school (Miller and Spicer, 1998). Hence, schools may serve as "the nexus between the movement in positive psychology searching to promote positive human development, and the institutions that could serve as the vehicle for positive youth development" (Clonan *et al.*, 2004, p. 101). The framework of strengths helps educators, teachers, and parents to reframe how they see students, to begin to move away from focusing on problem behaviors, and to also seeing the strengths and resilience of children (Benard, 2004).

Personal Strengths and Resilience

The emphasis on focusing on strengths of the individual and of the school setting rather than focusing on deficit-models of the development of children has also been illustrated by decades of research on resilience. The phenomena of resilience grew out of research by psychologists and psychiatrists who examined children at risk for psychopathology due to genetic and experiential circumstances (Garmezy, 1974; Werner and Smith, 1982). The evidence that many of these children thrived despite their high-risk status provided an impetus for empirical work into children's responses to adversity. For instance, Werner and Smith (2001), in their pioneering study, followed nearly 700 children growing up with risk factors from birth to adulthood. By the time they were 18, one-third of this cohort had become more like their peers without risk factors. In follow-ups to adulthood, at ages thirty-two and forty, "most of the high-risk youths who did develop serious coping problems in adolescence had staged a recovery by the time they reached midlife… They were in stable marriages and jobs, were satisfied with their relationships with their spouses and teenage children, and were responsible citizens in their community" (p. 167). In fact, at the end of the longitudinal study, only one out of six of the adult subjects at either age 32 or 40 was doing poorly — "struggling

with chronic financial problems, domestic conflict, violence, substance abuse, serious mental health problems, and/or low self-esteem" (2001, p. 37).

It is important to emphasize that these personal strengths are not fixed personality traits. Instead, resilience refers to "a dynamic process encompassing positive adaptation within the context of significant adversity" (Luthar, Cicchetti and Becker, 2000, p. 543). The amazing finding of resilient research is that most children and youth, even those from highly stressed families or deprived communities, still manage to achieve well-adjusted lives. After decades of research on resilience, researchers have concluded that resilience does not come from rare and special abilities, but from everyday magic of ordinary, normative human resources in the minds, brains, and bodies of children, in their families and relationships, and in their communities (Masten, 2001, p. 235). Hence, the concept of resilience holds great potential in the work with children in schools as it highlights the strengths, the innate self-righting tendencies and the environmental protective factors that help children to face adversities.

Components of Personal Strengths

Research into children living in high-risk environments has indicated that there are three sets of factors that are important in the development of resilience: (1) personal strengths, (2) characteristics of the family, and (3) characteristics of the wider community (e.g. schools) that are related to healthy adjustment in school and society (Masten and Garmezy, 1985; Luthar, Cicchetti and Becker, 2000). In this section, the components of the framework of personal strengths are described in detail.

Personal strengths are the individual characteristics of children associated with healthy development and life success (Benard, 2004). These personal strengths have been synthesized from decades of research on risk and protective factors associated with well-adjusted development. In this framework, personal strengths consists of six components: (1) emotional awareness, (2) self-control, (3) empathy, (4) social

Table 24.1.   List of personal strengths.

Personal strengths	
(1) Emotional Awareness	Intra-personal balance strengths
(2) Self-control	
(3) Empathy	Inter-personal balance strengths
(4) Social competence	
(5) Self-efficacy	Focus strengths
(6) Problem-solving skills	

competence, (5) self-efficacy, and (6) problem-solving skills, and are outlines in Table 21.1.

Emotional Awareness and Self-Control

Just as decades of research on cognitive development (e.g., Piaget) have guided pedagogy in the classroom, so too must our conceptualization of personal strengths be anchored in scientific research on social and emotional development. Research in the area of emotional development has shown that infants have a very limited capacity to regulate their emotional states (Berk, 2000). However, by the second year, gains in representation and language lead to new ways of managing emotion (Thompson, 1990). Rapid gains in emotional self-regulation mirror the rapid cognitive development that occurs after school entry. At school, children have to deal with fears such as poor academic performance and peer rejection. While many children achieve healthy adaptive ways to deal with distress, others may use maladaptive coping strategies such as fighting or defiance (Brenner and Salovey, 1997). One of the primary factors influencing individual differences in children's development of emotional regulation is their social environment (Cummings and Davies, 1994). Hence, it is important for schools to consider how they can play a role in fostering children's emotional development.

   The first step in healthy emotional development is emotional awareness. Emotional awareness includes observing one's thinking, feelings, attributions as well as paying attention one's moods and strenghts, without getting caught up in the emotion (Benard, 2004). This definition is closely related to Gardner's (1983) concept of intra-personal

intelligence: "the core capacity at work here is access to one's feeling life—one's range of affects or emotions: the capacity instantly to effect discriminations among these feelings, and eventually, to label them, to enmesh them in symbolic codes, to draw upon them as a means of understanding and guiding one's behavior" (p. 239).

Emotional awareness also has similarities to other constructs such as mindfulness, and alexithymia. Mindfulness can be seen "a practical way to be more in touch with the fullness of our being through a systematic process of self-observation, self-inquiry, and mindful action" (Kabat-Zinn, 1995, p. 6). Alexithymia is a construct from clinical psychology that has features such as difficulties in identifying and describing subjective feelings, a limited imaginal capacity, and an externally-oriented style of thinking (Taylor and Ragby, 2000). In one study, emotional self-awareness was found to have a strong and negative correlation with alexithymia ($r = -0.71$; Dawda and Hart, 2000).

Self-control or emotional regulation is the capacity for adaptive coping amidst distressing emotions by the use of self-regulatory strategies that reduce the intensity or temporal duration of such emotional states (Saarni, 1997). The development of self-control has been delineated in Mischel's studies utilizing the delay-of-gratification paradigm. In several studies, children were shown two rewards: a highly desirable one that they would have to wait for, and a less desirable one that they could have anytime during the waiting period. The results indicated three points about the development of self-control. First, children developed more strategies for self-control beginning in the elementary school years (Toner and Smith, 1977). But, not until the late elementary years, do children develop more abstract forms of coping involving metacognitive awareness of strategies (Mischel and Mischel, 1983). Second, preschoolers who are taught strategies can improve in their ability to delay gratification. Third, longitudinal research indicated greater ability to delay gratification at age four predicted higher academic functioning and social functioning twelve years later (Mischel, Shoda and Peake, 1988; Shoda, Mischel and Peake, 1990). Recently, Duckworth and Seligman (2005) found that self-discipline accounted for more than twice as much variance than IQ in predicting achievement in eighth-grade students. In addition, they also found that

self-discipline predicted which students would improve their grades over the course of the school year, whereas IQ did not.

Empathy and Social Competence

The components of personal strength discussed so far have focused on characteristics of individuals without reference to relationships with other people. The next two components focus on individuals' relations with others, and are the foundation for Gardner's (1993) inter-personal intelligence—the ability to understand other people: what motivates them, how they work, and how to work co-operatively with them.

Empathy is the ability to understand another's emotional state and feel with that person (Berk, 2000). Based on developmental research, empathy entails the joint operation of both cognitive and affective processes. The cognitive component involves "understanding another's feelings, whether by means of simple associations or more complex perspective-taking processes" whereas the affect component involves a "concordant emotional response stemming from another's affective state" (Cohen and Strayer, 1996, p. 988; see also Feshbach, 1975; Hoffman, 1977;). Hence, empathy is a complex construct that involves both cognitive and emotional processes.

Empathy has been found to be associated with prosocial behavior as well as various indices of inter-personal competence, sociability, and co-operative behavior (Eisenberg and Miller, 1987). Conversely, the lack of empathy has been associated with aggression, externalizing and antisocial behaviors (Miller and Eisenberg, 1988). This lack of empathy is a characteristic of aggressive and antisocial youth (Cohen and Strayer, 1996). Hence, empathy is a personal strength that not only "helps facilitate relationship development, it also helps forms the basis of morality, forgiveness, compassion, and caring for others" (Benard, 2004, p. 15).

Social competence can be defined as the ability to integrate thinking, feeling, and behavior to achieve social tasks and outcomes valued in various contexts and cultures (Topping, Bremner and Holmes, 2000). In a school setting, these outcomes include classroom tasks

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such as relating to a teacher, as well as peer-related tasks such as making friends. Individuals with high levels of social competence tend to be positive, agreeable, animated, outgoing, social oriented, and capable of expressing feelings (Dawda and Hart, 2000).

The lack of social competence is also a characteristic of aggressive and antisocial youth (Gibbs *et al.*, 1996; Simonian, Tarnowski and Gibbs, 1991). Social competence has been identified as an important protective factor for healthy development, and an important quality to help children be resilient in the face of adversity (Werner and Smith, 2001). Rae-Grant *et al.* (1989) found that two particular aspects of social competence—getting along with others and being a good student—were strongly associated with the absence of behavioral and emotional disorders. In fact, getting along with others appeared to be more protective than being a good student. Hence, social competence is an important personal strength that needs to be fostered for children's healthy adjustment. Schools and communities can play a vital role in facilitating opportunities for social interaction and the development of social skills. In particular for at-risk children, such opportunities would allow children to participate in more adult-led activities that would assist them in learning how to relate to both adults and their peers.

Self-Efficacy and Problem-Solving Skills

While the four components discussed above focused on children's emotional skills and balance strengths, the following components of personal strength emphasize two cognitive and focus-oriented constructs — self-efficacy and problem solving skills. Self-efficacy is based on Bandura's (1986, 1997) social-cognitive theory and has become a pivotal construct related to success based on over 20 years of research. On the other hand, problem-solving skills in this framework represent a set of abilities, based on resilience research, that help children at-risk face adversities (Werner and Smith, 1992).

Self-efficacy has been defined as "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performance" (Bandura, 1986, p. 391). In other

words, it is the belief in one's power that determines personal life outcomes. Research on self-efficacy has shown that self-efficacy is an important mediator for all types of achievement behavior as well as many types of behaviors (Bandura, 1997; Stajkovic and Luthans, 1998; Pajares, 2003; Robbins *et al.*, 2004). For instance, Betz and Hackett (1981, 1983) found that self-efficacy is an important mediator of the structural and social influences on career choices, and has a direct bearing on the choices as well. Self-efficacy is strongly related to effort and task persistence. Students with high self-efficacy beliefs are likely to expend effort in the face of adversity and persist at a task when they have the necessary skills (Pintrich and Schunk, 2002). In addition, the motivational impact of self-efficacy is tremendous. When self-efficacy beliefs are high, individuals will engage in tasks that foster the development of their skills and capabilities. When self-efficacy is low, people will not engage in new tasks that might help them learn new skills (Bandura, 1997).

Problem-solving skills include a variety of abilities including planning, flexibility, and resourcefulness (Benard, 2004). Sternberg *et al.* (2000) have referred to these abilities as practical intelligence. Sternberg has defined practical intelligence as "intelligence that serves to find a more optimal fit between the individual and the demands of the individual's environment, by adapting to the environment, changing (or shaping) the environment, or selecting a different environment" (Hedlund and Sternberg, 2000, p. 150).

Planning, as a form of problem-solving, was an integral part of the early intervention project called the Perry Pre-school Program. Teachers in this program emphasized a plan-do-review sequence in their classrooms. In these classes, children made and carried out their own plans, and this planning promoted their sense of control and thus facilitated a variety of positive life outcomes, even into adulthood (Schweinhart and Weinkart, 1997). Flexibility entails the "ability to sell alternatives and attempt alternative solutions to both cognitive and social problems" and resourcefulness involves "identifying external resources and surrogate sources of support" (Benard, 2004, p. 18). For instance, many elementary school aged children have developed strategies such as problem-solving and seeking social support as

strategies for managing emotions (Kliewer, Fearnow and Miller, 1996). Hence, these composite of abilities represents a personal strength that is vital for children's resilience as these skills have been associated with better psychological and social adjustment as well as better coping with adversity (Heppner and Lee, 2002).

Problem-solving skills are the creativity component of this framework of personal strengths. These aspects of problem-solving are often regarded as important capacities in creativity. For instance, Lubart (2003) described that the primary capacities of creativity include "an ability (a) to identify the problem to be solved, define it, and redefine it; (b) to notice information in the environment that is relevant and to selectively encode it; (c) to observe similarities between different fields which clarify the problem (analogy, metaphor, selective comparison); (d) to synthesize diverse informational elements to form a new idea; (e) to generate several alternative ideas (divergent thinking); and (f) to evaluate one's progress toward the solution of the problem" (p. 285). problem-solving ability has been found to be associated with creativity. In particular, correlations between creativity and conventional problem-solving tasks depended on how novel the tasks were; the more novel the items, the higher the correlations of creativity and conventional problem-solving tasks (Sternberg, 2003a,b). Hence, there is a parallel between problem-solving skills as a personal strength and creativity as an ability; both involve the quality of being flexible in applying one's resources to solve novel problems. These skills are similar to the little C or everyday creativity that Simonton (2000) has referred to as ingenuity.

Implementing the Personal Strengths Framework in Schools

In this concluding section, four research-based principles are provided to guide schools in implementing a personal strengths framework. The principles are

(1) using a language of strengths,
(2) promoting a positive school climate,

(3) communicating high expectations, and

(4) creating partnerships with family and community.

Using a Language of Personal Strengths

Having a language of strengths helps educators and teachers to seek out and develop the strengths of their students instead of focusing on the deficits and problem behaviors (Benard, 2004). Unfortunately, schools often provide a "sea of negativity" for their students with minimal opportunities for positive educational experiences and personal relationships (Jenson *et al.*, 2004). Although teachers want to be positive in their daily interactions with students, time demands, over-crowded classrooms, and difficult students, can capture a large portion of teacher's time and attention. Various studies have shown that there tends to be more negative interactions rather than positive ones between teachers and students (Beaman and Wheldall, 2000). For instance, White (1975), in reviewing 16 studies examining the praise rates of teachers, found that rates of disapproval were higher than rates of approval. In addition, the positive teacher interactions in classroom serving students with problem behaviors were also alarmingly low (Shores, Gunter and Jack, 1993). Such coercive interactions between teachers and students not only maintains such negative exchanges but can also result in an escalation of aversive and negative behaviors (Patterson *et al.*, 1992; Maag, 2001).

Hence, there is a need to promote a framework focusing on personal strengths. In fact, research in the area of solution-focused counseling in schools have suggested that in working with difficult students, instead of focusing on their resistance, more progress can be made if school counselors empathize with them and focus on their resilience and strengths (Liau, in press; Metcalf, 1995). In recognizing the strengths in students, these skills can be further developed so that they can mature to become adaptive and fully functioning youth and adults.

Promoting a Positive School Climate

Many educators have long advocated the notion that a school with a positive climate or culture can encourage students to excel

in academics, and be exemplary in conduct (Martin-Reynolds and Reynolds, 1991). In recent research, investigators have shown that a positive school climate or culture—with very structured interventions—can alter the cognitive, social, and emotional competence of elementary school children (Embry *et al.*, 1996; Flannery *et al.*, 2000). Resnick *et al.* (1997) found that perceived school connectedness was protective against risk behaviors such as emotional distress, violence, suicidal thoughts and behaviors, and substance use. This connectedness to school is consistent with Catalano and Hawkins' (1996) Social Development Model which argues that prosocial bonding helps to foster prosocial behaviors and protect against antisocial behaviors such as delinquency.

A characteristic of schools with a positive school climate is that teachers provide caring and supportive relationships. Such relationships with caring adults are essential for children's development. In fact, resilience research has indicated that many children who grew up in adverse environments still had successful life outcomes because they had a relationship with at least one caring adult (Tierney *et al.*, 1995). Teachers and school personnel can provide caring by "paying attention to each student, knowing their names, encouraging class participation, listening, intervening when students are having problems, expressing respect, and having high expectations for student success, and allowing opportunities for relationship building" (Brooks, 2006, p. 71). Recognizing students' personal strengths and rewarding their achievements can also provide support.

Communicating High Expectations

Ever since the classic study by Rosenthal and Jacobson (1968) illustrating the Pygmalion effect, over 30 years of research has indicated that teacher expectations can influence students' achievement and behaviors (Jussim, 1986; Weinstein, 2002). Teachers tend to communicate expectations to their students by their behaviors in four different areas: socio-emotional climate, verbal input, verbal output, and feedback (Rosenthal, 1974). In regards to socio-emotional climate,

teachers tend to provide a warmer climate for students for whom they hold high expectations compared to those for whom expectations are lower (Cooper and Tom, 1984). Verbal input refers to opportunities to learn new material; high-expectation students may have more opportunities to learn new material compared to low-expectation learners. Teachers also engage in more exchanges with high- than with low-expectation students (verbal output). Finally, feedback refers to how teachers tend to praise high-expectation students more and criticize low-expectation students more (Cooper and Tom, 1984). In addition, based on Weinstein's expectancy communications theory (Weinstein, 2002), it has been proposed that expectations—either high or low—can be "communicated to students not only through relationships and messages but also through structure, organization, curriculum, and practices of schools" (Benard, 2004, p. 74). Hence, by incorporating a framework of personal strengths, schools are creating a positive school climate that communicates high expectations in achievement and behaviors for all students—students are told everyone can succeed.

Creating Partnerships with Family and the Community

Resilience research (what about the model, in which component of creativity is there?) has indicated that the family and the community are essential for children's healthy development (Masten and Garmezy, 1985; Luthar *et al.*, 2001). Hence, schools need to develop active partnerships with families and communities to increase the accessibility of resources for their students (Brooks, 2006). Studies have shown that educational interventions are more effective when family members are involved (McDonald and Moberg, 2000). Such efforts to promote school-family partnerships tend to encourage parents to be supportive and involved in their children's education both at home and at school. For instance, schools may include parent participation in programme selection and implementation efforts, publish parent newsletters, organize parent informational meetings, and link classroom and

school based efforts to foster personal strengths to family activities (Graczyk *et al.*, 2000).

Conclusion: Personal Strengths and Creativity

A beneficial outcome from using a personal strengths framework in schools is that creativity can also be encouraged. First, as mentioned earlier, one of the components of personal strengths, problem-solving skills, is directly related to creativity. The attributes of problem-solving skills such as planning, flexibility, and resourcefulness are also cognitive abilities that are important for creativity. Second, recent research in the area of positive psychology has shown that positive affect and subjective well-being are associated with creativity (Lyubomirsky, King and Diener, 2005). Positive affect tends to be related to many of the personal strengths described here including self-efficacy, sociability, and creativity. Positive emotions "produce the tendency to approach rather than to avoid and to prepare the individual to see out and undertake new goals" (Lyubormirsky *et al.*, 2005, p. 804). Hence, these attributes of personal strengths share the tendency to encourage active involvement with goal pursuits and with the environment. However, more research needs to be done with regards to examining the inter-relationships among the various strengths, and in particular the relationship between creativity and the other components of personal strengths (Peterson and Seligman, 2004, p. 122). Third, Sternberg has proposed that a key notion of promoting creativity in schools is that creativity is not just a matter of thinking in a certain way, but rather it is an "attitude toward life" (Sternberg, 2003b, p. 333). Creative people are creative because they have decided to be creative. Similarly, promoting personal strengths is also an attitude toward life. A strengths-based approach requires a change in mindset as schools tend to have a preoccupation with the negative rather than the positive. It is timely that positive psychology has come to schools as empirical research (e.g., Seligman *et al.*, 2005; Tejersen *et al.*, 2004) is now confirming the need for a framework of personal strengths.

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Creativity in Rehabilitation Psychology

Chih-Chin Chou, Julie Chronistor and Fong Chan

Introduction

In the contemporary era of psychology, researchers and practitioners have begun to reach across sub-disciplines in an effort to develop a more comprehensive understanding of human functioning and to provide better interventions. Nonetheless, the expansion and utilization of knowledge developed from cross-discipline alliances remains limited (Seijts and Latham, 2003). According to Seijts and Latham (2003), "researchers and practitioners within subfields frequently appear ignorant of ways they can benefit from cross-subfield research" (p. 232). As a result, researchers and practitioners fail to benefit from the creation of shared knowledge that can expand the breadth and depth of their domain of interest.

Of particular interest is the role of *creativity* in promoting the process of cross-disciplinary convergence (Shneiderman *et al.*, 2006). A creative contribution can be defined as something that is relatively original and high in quality with reference to a specific purpose (Sternberg 1999; Sternberg and Davidson, 1995; Sternberg and Lubart, 1995, 1996). Scholars conceptualize the creative process to occur at three levels: (a) the individual, (b) the field, and (c) the domain level (Csikszentmihalyi, 1996). At the individual level, creativity occurs "when a person . . . has a new idea or sees a new pattern, and when this novelty is selected by the appropriate field for inclusion in the relevant domain" (Csikszentmihalyi, 1996). At the field level, individuals who comprise a specific field such as rehabilitation or social psychology make decisions about whether novel ideas and concepts should be included in the field's body of work (Csikszentmihalyi, 1996). And finally, at the

domain level, a defined set of rules, symbols, and procedures are used to determine what constitutes a formal body of knowledge for broad areas such as psychology, art, or biology (Csikszentmihalyi, 1996; Sternberg, 1999).

Although much emphasis has been placed on creativity at the individual level, today there is general consensus that a critical component of creativity is cross-discipline collaboration (Bennis and Biederman 1997; Sternberg, 1999). In fact, Shneiderman *et al.* (2006) state that accelerating the process of disciplinary convergence by bridging multiple disciplines such as computer science, psychology, human-computer interaction, information systems, information visualization, and software engineering is a central goal for creativity support tools. Indeed, "scientific papers in mature fields such as physics and biology often have teams consisting of dozens of authors from multiple disciplines who contribute to a research result" (Shneiderman *et al.*, 2006, p. 66). According to Seijts and Latham (2003), there are many benefits to sharing concepts and ideas across disciplines. For example, researchers can generalize their work to other areas and offer constructive criticism from the field from which they draw information and of that in which they work. In addition, it promotes interactions among researchers from different domains who are investigating the same phenomena and enabling them to raise questions not previously considered.

While many sub-disciplines of psychology are still considered "islands of unconnected knowledge" (Seijts and Latham, 2003, p. 232), rehabilitation psychology, a thriving sub-discipline in professional psychology, emerged primarily from cross-discipline convergence (Elliott, 2002). And, inter-disciplinary alliances remain central to the field's core philosophy. Specifically, the profession evolved from the contributions of psychology fields such as social psychology and clinical psychology and continues to converge with contemporary fields (e.g., neuropsychology, health psychology) and major disciplines (e.g., medicine, social work, physical, and occupational therapy). Without question, rehabilitation psychology encompasses a wide array of complex and inter-disciplinary services provided in various settings for diverse populations. Thus, while the field has great potential to remain at the forefront of creative innovation and collaboration with

other disciplines, it also faces the challenge of retaining its core identity. Therefore, the purpose of this paper is to provide insight into how the process of creativity through cross-discipline convergence has impacted the field of rehabilitation psychology and ways in which this component of creativity can continue to benefit this field as well as others. In doing this, this paper will (a) provide a historical overview of the field's development, (b) review key concepts and knowledge that was transferred from other psychology fields to define the core features of rehabilitation psychology, and (c) discuss future challenges regarding the identity rehabilitation psychology.

Historical Development

Beginning in the mid-1900s, an increasing number of psychologists worked in rehabilitation settings to serve people with an array of physical, cognitive, developmental, and psychiatric disabilities or chronic illnesses. Initially, 'rehabilitation psychologists' were mental health providers who were part of a rehabilitation team and primarily performed intelligence and personality assessment (Grzesiak, 1979). At this time, the knowledge, skills, and research in the broader discipline of psychology was viewed as irrelevant to the needs of people with chronic illness and disability (CID), mainly because the primary goal for people with CID was vocational rehabilitation (Elliott and Gramling, 1990; Shontz, 2003). As a result, rehabilitation practice within rehabilitation settings was based on three misguided beliefs: (a) people with specific types of CID are more likely to have specific types of personality characteristics or psychological problems; (b) people with CID affecting a particular function would develop special abilities in other areas to compensate for their loss (e.g., people with visual impairments were expected to develop exceptional tactual or auditory sensitivity); and (c) some individuals with CID can not be motivated by nature and therefore change cannot occur (Shontz, 2003).

The application of these or similar principles placed limitations on rehabilitation outcomes and therefore stimulated research and scholarship surrounding the psychosocial needs of persons with CID (Dembo, 1974). Without question, the importance of understanding

the psychosocial functioning of people with CID became critical to providing effective service delivery and establishing appropriate outcomes, and required an inter-disciplinary approach from various areas (e.g., medical, psychological, social, educational, occupational, and physical therapy, etc.) to address the array of personal, social, and environmental issues that affect the lives of persons with CID. Thus, contributions from a number of psychology and allied health fields merged to begin to delineate a central or 'prototypical' definition (Rosch, 1978) of rehabilitation psychology.

According to Sternberg (1999), these creative contributions obtained through discipline convergence propelled the field of rehabilitation psychology to experience *forward incrementation*, or moving the field forward in the direction it is already going. Examples of this creative propulsion included the formation of the National Council of Physical Aspects of Disability in 1949, followed by the American Psychology Association's (APA) establishment of the Division of Rehabilitation Psychology (APA Division 22) in 1958 to organize conference, research, disability advocacy, and other professional activities for researchers, psychologists, and educators concerning psychological, behavioral, and social consequences of CID. Predominant fields participating in this cross-disciplinary collaboration and forward incrementation included social psychology, clinical psychology, and behavioral medicine (Elliott and Gramling, 1990; Elliott, 2002; Wegener, Hagglund and Elliott, 1998). Often considered the roots of rehabilitation psychology, these fields integrated ideas and concepts in order to establish the defining nature of rehabilitation psychology; namely, the research and practice regarding the psychosocial adjustment of persons with CID.

To date, the field of rehabilitation psychology has prospered both in research and practice. Scientific growth in the area of psychosocial interventions has steadily occurred and the role of rehabilitation psychologists within the larger health care system has become widely accepted. Common areas of practice include but are not limited to psychotherapy, psychological assessment, consultation with multidisciplinary staff, patients, and families, research, and supervision (Elliott and Gramling, 1990). These forward developments reflect the integrated

efforts of researchers studying people with and without disabilities from the fields of social psychology, clinical psychology, and behavioral medicine. Specific contributions from these areas are presented in the following sections.

Social Psychology

The disability paradigm that underlies the philosophical and conceptual foundations of rehabilitation psychology was substantially influenced by research in social psychology. Specifically, Kurt Lewin's field theory was fundamental to understanding adjustment to physical disabilities (Elliott, 2002; Elliott and Gramling, 1990; Meyerson, 1955). Lewin (1935) proposed that behavior is a function of person and environment ($B = f(P, E)$: B = behavior; P = person; E = environment). In other word, behaviors are influenced not only by characteristics of the individual but also his or her environment. Thus, an individual's adjustment to CID is determined by the individual's *whole* life situation, including the physical and social environment and the interactions thereof.

Rehabilitation researchers including Dembo, Leviton, and Wright (1956), Barker and Wright (1954), and Meyerson (1955) translated the conceptual framework of field theory within the context of rehabilitation to predict and explain adjustment to CID. This creative merging of social psychology principles with rehabilitation populations resulted in a new theoretical framework referred to as *somatopsychology*. The fundamental principles of somatopsychology revolve primarily around societal values toward disability and include the following: (a) Disability is a social psychological phenomenon; thus, people with CID encounter a variety of problems caused by both individual and social environmental factors that people without CID do not experience; and (b) changing societal attitudes toward people with CID and making social and physical environments accessible for people with CID are important for enhancing rehabilitation outcomes (Meyerson, 1955; Shontz, 2003). Contemporary initiatives and service provision that reflect this philosophy include the passage of the Americans with Disability Act (1990) and efforts by rehabilitation professional to identify personal, social, and environmental factors that impact adjustment to

CID as opposed to focusing only on the impairment caused by the disability.

Another social psychological theory translated into the rehabilitation context included Heider's social balance theory (Heider, 1946, 1958). This theory provided a framework for promoting positive attitudes toward people with CID so as to facilitate positive social relationship between people with CID and society at large (Cook, 1992; Chubon, 1992; Yuker, 1988). According to Heider (1958), one's attitude toward another person is determined by his or her attributions of a third person, object, or event perceived to be linked with the person. For example, if student A found a book that he liked very much but thought 'normal' people his age would not like it, yet later determined the book belonged to student B, according to Heider's theory, student A will likely develop a positive attitude toward student B because he attributes student B with a book he prefers. Conversely, if student A has a negative attitude toward the book, he is more likely to develop a negative attitude toward student B as he attributes the student with negative feelings related to the book.

Wright (1989) extended Heider's ideas to explain attitudes toward people with CID, arguing that negative attitudes toward people with CID were caused by negative perceptions of CID attributed to aspects of the person with CID. Wright (1989) indicated that unfamiliarity is likely the primary reason why the public holds negative perceptions toward people with CID. Thus, if society can broaden their understanding of CID, they will learn that CID does not represent the whole person; people with CID have a variety of characteristics. Wright also suggested facilitating attitude change by promoting the use of person-first language that emphasizes assets of people with CID rather than limitations, as well as providing the public with another perspective of having a CID; namely, one that characterizes CID as meaningful and valuable versus limiting and abnormal.

In conclusion, field theory and social balance theory, both originating in social psychology, were extended to the rehabilitation context to advance the research and practice of this burgeoning discipline. Much of this creative propulsion was led by the early work of Wright and her associates and has stimulated innovating research and scholarship

in person-environment interactions and its relationship to adjustment to CID (e.g., Fichten *et al.*, 1996; Livneh and Antonak, 1997; Tate, 2001) and changing negative attitudes toward people with CID (e.g., Cook, 1992; Chubon, 1992; Yuker, 1988). The importance of understanding the role of social phenomena in CID, as well as emphasizing assets rather than limitations and viewing CID as valuable and meaningful to one's identity remain core tenets and unique strengths of rehabilitation psychology (Dunn and Dougherty, 2005), which remain today rehabilitation psychology's "unique and distinctive contribution to psychology" (Elliot and Byrd,1986).

Clinical Psychology

To assist people with CID in coping with the social, environmental and individual stressors of having a CID, theories, techniques, and research in clinical psychology have been unquestionably relevant to the delivery of rehabilitation services (Elliot and Gramling, 1990). From the inception of rehabilitation psychology, the majority of psychologists working in rehabilitation settings were typically trained as clinical or counseling psychologists. As such, these professionals adapted theories, research, and therapeutic strategies of traditional psychotherapy in clinical/counseling psychology for use with clients in rehabilitation settings. The transferring of knowledge, research, and skills in clinical psychology to rehabilitation populations contributed substantially to understanding adjustment to CID and developing appropriate interventions for people with CID.

Although the early work of the clinical psychologists did not include research in the area of adjustment to CID, more contemporary rehabilitation psychologists (e.g., Cook, 1992; Livneh and Sherwood, 1991; Thomas and Siller, 1999) have drawn on the major personality and counseling theories (e.g., psychoanalytic theory, Person-centered theory, Adlerian life-style theory, Maslow's motivation theory) to understand the psychological affects of CID. Two theories, Freud's psychoanalytic theory and Roger's self-concept theory are presented to illustrate the translation of these major theoretical models within the rehabilitation psychology context.

Freud's psychoanalytic theory posits that people use defense mechanisms (e.g., repression, projection, and regression) to cope with traumatic or stressful experiences (Cook, 1992). Thus, in the rehabilitation context, people with CID may, for example, repress their feelings regarding the CID from conscious awareness to cope with the stressful situation as opposed to actively mourning the loss, whereas others may project their negative feelings onto others, such as "My physician hates me and he does not think I deserve his help" rather than "I hate my physician. I hate the situation that I need others' help." Still others may use regression as a way to cope with CID. In this situation, the individual may revert to childlike behaviors. According to Barker *et al.* (1953), poor adjustment and anxiety associated with CID can be reduced by addressing these defenses and bringing them to consciousness. However, while this psychoanalytic theory has provided rehabilitation psychology with a rich and explanatory model for coping with the stress of CID, psychologists applying intervention based on this theory needs years of training. Moreover, psychoanalytic-based interventions lack the level of empirical support needed for today's evidence-based health care system and the interventions period is typically long and expensive—a process that is not considered of great utility for the rehabilitation psychologist (Phemister, 2001, Livneh and Sherwood, 1991).

Another theory that has been applied to understanding adjustment to CID is Carl Rogers's self-concept theory. Cook (1992) applied Rogers's theory to the rehabilitation context proposing that poor adjustment to CID occurs when there is incongruence between the real self (a person with CID) and the ideal self (a person without CID). In this theory, in order to maintain a congruent self concept, people with CID may use two psychological defenses, denial or distortion, to cope with the experience of CID which leads to false reactions to CID. For example, an individual may respond to a relative minor physical impairment followed by an accident as if it was catastrophic (distortion), whereas another person who experiences a severe impairment may seem to be psychologically well adjusted (denial) right after the accident to insure the traumatic experience remains consistent with the person's prior self-concept. Cook (1992) suggested that to facilitate healthy

adjustment to CID, rehabilitation psychologists need to provide core conditions of congruence, warmth, and empathic understanding to facilitate a threat-free therapeutic relationship to allow clients to explore and experience incongruence and assimilate the previously distorted or denied experiences into a reorganized self. Following a successful intervention, rehabilitation psychologists may facilitate greater client insight into his or her conceptualization of a CID and instill hope for change (Phemister, 2001).

In regards to interventions, researchers and practitioners recognized that traditional clinical psychology interventions were not necessarily universally effective for people with CID (Diller, 1966). Therefore, ways to alter existing intervention approaches for people with various CIDs such as head injury (Butler and Satz, 1988; Carberry and Burd, 1986), hearing impairment (e.g., Halgin and McEntee, 1986; Leigh *et al.*, 1996), physical/orthopedic disability (e.g, Livneh and Sherwood, 1991; Livneh, Wilson, and Pullo, 2004), learning disability, and developmental disability (e.g., Lawrence, 2004; Ruberman, 2002) occurred. Among intervention approaches designed specifically for persons with CID, various techniques that fall under the cognitive-behavioral approach (e.g., learning theory, cognitive restructuring, etc.) were found to be the most common and effective techniques practiced by rehabilitation psychologists (Murphy, Young and Reid, 2003).

Finally, basic knowledge and skills in traditional clinical interviewing, psychological testing, and treatment plan development are interventions that have been practiced regularly by rehabilitation psychologists for years. In fact, the practice of clinical interviewing and psychological assessment is widespread among rehabilitation psychologists today, and was heavily influenced by the field. For example, Hickling, Sison, and Holtz (1985) reported that rehabilitation psychologists working in pain clinics spent 30% of their time conducting clinical interviewing and assessment. Over the years, rehabilitation professionals have modified interviewing and assessment approaches to meet the unique needs of people with CID and ensure equal access to psychological assessment (Kewman, 2001; Sullivan and Vernon, 1979). Today, learning strategies for adapting traditional assessment procedures for

people with various CIDs are a required component of rehabilitation psychology training (Elliott and Gramling, 1990. And, research in this area can be found in contemporary issues of journal publications such as *Rehabilitation Psychology, Rehabilitation Counseling Bulletin*, and *Journal of Rehabilitation*.

Behavioral Medicine

Behavioral medicine was founded in 1978 to promote inter-disciplinary communication and integration of behavioral, psychosocial, and biomedical sciences. The primary goals of behavioral medicine are to understand the relationship of behaviors and psychological functioning in physical and psychological well-being, and to identify methods of facilitating healthful behaviors among patients in medical settings (Marwick, 1996; Smith, Kendall, and Keefe, 2002). Research published in the behavioral sciences (e.g., *Annals of Behavioral Medicine, Behavioral Medicine Update, and Behavioral Medicine Abstracts*) has emphasized the importance of having a behavioral framework for understanding the health and illness of hospital patients, and suggests that behavioral medicine can also be effective in promoting physical and psychological health among people with CID (Eisenberg and Jansen, 1987).

By transferring the wealth of behavioral science research into the practice of rehabilitation psychology, rehabilitation psychologists have been able to explore novel, creative rehabilitation approaches to improve the physical and psychological functioning of people with CID. For example, Ince, Brucker and Alba (1978) successfully assisted people with spinal cord injury to reinstate bladder control by using a classical conditioning paradigm. Similarly, rehabilitation psychologists have successfully used operant behavioral principles to control chronic pain and illness (Fordyce, 1976). Other common behavior medicine techniques utilized by rehabilitation psychologists include electromyographic biofeedback, relaxation, eye movement desensitization and reprocessing (EMDR), and Galvanic skin response (Brucker, 1990; Eisenberg and Jansen, 1987). In behavioral medicine, biofeedback has been used to help patients regain physical functioning in such

areas as controlling high blood pressure (Brucker and Ince (1977) pain resulting from fibromyalgia (Thieme, 2004), back pain (Belar and Cohen, 1979), and headaches (Budzynski *et al.*, 1973). Within rehabilitation, McGinnis *et al.* (2005) found that the bio-feedback along with relaxation techniques decreased depression and anxiety levels among people with type II diabetes. Similarly, Saxby and Peniston (1995) used this method with people with substance-related disorders to reduce depression.

In sum, behavioral medicine has offered the field of rehabilitation psychology a number of interventions and theories that can be effectively applied to rehabilitation populations. For example, the application of behavioral-based interventions such as symptom reduction, management of stress, acquisition of self-management skills, and emotional regulation (Friedman *et al.*, 1995; Elliot and Klapow, 1997) are common techniques used by rehabilitation psychologists working in multidisciplinary teams today. In addition, behavioral medicine is based on a biopsychosocial approach—an approach consistent with the philosophical underpinnings of rehabilitation. As such, these two fields have parallel theoretical underpinnings affording rehabilitation psychologists and behavior medicine professionals an opportunity to access a broader scope of theories and interventions for both hospital-based populations with medical conditions and those with CID. Of particular importance is the emphasis that both fields have on psychosocial interventions, health promotion, and quality of life and the role of these factors in health care outcomes.

Challenges in Rehabilitation Psychology

Although rehabilitation psychology has benefited from cross-disciplinary convergence, the merging of ideas, theories, interventions, and populations served has also threatened the field's identity. In fact, for the past decade the identity, training and direction of the field has been controversial among rehabilitation researchers, practitioners, and educators (Elliot and Gramling 1990; Wegener, Hagglund, and Elliot, 1998; Thomas and Chan, 2000). Historically, rehabilitation psychologists working in the health care arena were working with

individuals with CID. As opportunities grew for psychologists in health care, several specialties emerged (e.g., health psychology and neuropsychology) making it increasingly difficult to differentiate between domains of knowledge, practice skills, and training requirements. While attempts have been made to distinguish rehabilitation psychology from other subspecialties (Elliot and Gramling, 1990; Johnstone *et al.*, 1995; Shontz and Wright, 1980; Thomas and Chan, 2000; Wright, 1983), Frank (1999) suggested that the field may have "zigged when we should have zagged"; specifically, rehabilitation psychology's attempts to define their area of specialty and differentiate from other fields may have narrowed the practice domains and reduced the level of cross-disciplinary convergence and inter-disciplinary treatment planning—an approach that does not reflect the field's original scope of service provision. In response, Frank (1999) offered a broad definition of rehabilitation psychology: "Rehabilitation psychology should be viewed as the application of psychological constructs and principles to the care of individuals with chronic health conditions that are often, but not necessarily, disabling" (p. 36). Given the importance of inter-disciplinary treatment and the sharing of patient populations among different sub-fields today, delineating the role of rehabilitation psychologists while maintaining a cross-disciplinary approach to research and intervention is necessary to refine and re-formulate a unique professional identity.

Another controversial issue facing the field today surrounds the training guidelines for rehabilitation psychologists. It has been suggested that rehabilitation psychologists should be trained in APA accredited clinical or counseling psychology programs and then gain expertise in rehabilitation during their post-doctoral training (Wegener *et al.*, 1998). In contrast, Thomas and Chan (2000) suggested that rehabilitation psychology training should begin at the pre-doctoral level with courses specifically designed to address unique rehabilitation areas—in addition to core psychology and research methodology courses. Both agree that rehabilitation psychologists need to be trained in the scientists-practitioner model, but there remains debate regarding the path taken to gain competence. The question of whether one path contributes to a higher level of cross-disciplinary collaboration and

thus more effective, creative approaches to rehabilitation intervention has yet to be determined. To date, however, training guidelines for rehabilitation psychologists have been determined to allow for a better distinction among sub-specialties within psychology. The guidelines emphasize exposure to rehabilitation populations with various CIDs, and incorporate specific didactic training specific to rehabilitation such as functional issues and disability resources (Johnstone *et al.*, 1995). These guidelines have also positioned rehabilitation psychology to be recognized by the American Board of Professional Psychology as a specialty.

Conclusion

Rehabilitation psychology is a relatively young sub-discipline in professional psychology that has benefited from cross-disciplinary collaboration. Without question, creative applications of theories and interventions from other fields have advanced the field of rehabilitation psychology to allow for the development of novel intervention approaches for rehabilitation populations. Conversely, rehabilitation psychology offers other fields a growing wealth of knowledge regarding treatment of persons with CID—a population that often accesses an array of health related disciplines. This inter-disciplinary approach is critical to the field's ability to remain innovative and unique in assisting people with CID, their families, and society as a whole to create an optimal environment for people with CID to experience a meaningful, valuable, and enjoyable life.

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Constructive Creativity in Education

Ai-Girl Tan and Shyh-Shin Wong

Introduction

The reception of creativity in education evidently points to some considerations on how to promote creativity in schools and among teachers. In this chapter we discuss a framework of creativity in teacher education that aims to provide teachers with some guidelines to engage in creativity education. "A framework" is used instead of "the framework" to indicate the vast scope of our discussion. An individual's creativity is the interactive result of his/her intelligence, knowledge, thinking pattern, personality, motivation, and environment (Sternberg and Lubart, 1991). It is conceptualized from components such as an individual's dispositions, skills, types of work, and social and cultural resources (e.g., Gardner, 1993). Amabile (1983a, b) proposes three components of an individual's creativity. They are cognitive components, personality components, and task motivation. *Cognitive components* are intelligence, knowledge (general, domain-relevant), and skills (general, domain-relevant). Domain-relevant skills comprise knowledge about the domain, technical skills, and special domain-relevant talent. These skills are supported by innate cognitive abilities, innate perceptual and motor skills, and formal and informal education. Creativity-relevant skills comprise appropriate cognitive styles, implicit and explicit knowledge of heuristics for generating novel ideas, and flexible working styles. They are supported by training, experience in idea generation, and personality characteristics. *Personality components* are composed of focusing and task commitment, motivation or motives, and openness and tolerance of ambiguity. *Task motivation* consists of

attitudes toward the task and perceptions of self-motivation for understanding the task. It depends on the initial level of intrinsic motivation toward the task, presence or absence of salient extrinsic constraints in the social environment, and the individual's competence to cognitively minimize the extrinsic constraints. In the teacher educational contexts, cultivating creativity highlights nurturing of *constructive*, valuable and meaningful behavior, emotion, and cognition of every person. Accordingly, the following assumptions are adopted in the teacher educational contexts:

- Every individual has the potential to be creative (Gardner, 1993).
- Creativity can be nurtured when the pre-requisite components (i.e., motivation, intelligence, knowledge and skills) exist within the individuals (Amabile, 1983a, b), supported by the interpersonal and socio-cultural environments (Csikszentmihalyi, 1996).
- Creative processes can be individualized (Finke *et al.*, 1992), like social cognition involving idea generation and exploration phases. During the idea generation phase, the individual proposes numerous pre-inventive structures that can be ambiguous and novel. These pre-inventive structures can be refined individually or in groups during the exploration phase.
- The pre-inventive structures can be assessed with reference to the consensual technique, namely by engaging experts (Amabile, 1983a, b) and novices (e.g., students or peers) (Finke, 1990) in the processes.
- Teachers must feel that they are competent in the area of specialization (e.g., subject matter) and in pedagogy (e.g., planning lessons, selecting suitable teaching models and managing behaviors). They should possess sufficient knowledge and competencies to teach effectively as well as receive ample support from the community of practice to develop students holistically. In addition, they should be motivated to integrate creative strategies and techniques into teaching, cultivate creativity-fostering behavior, and nurture creativity among their students.

Constructiveness in Education

The adjective *constructive* entails connotations such as being open to all experiences (Rogers, 1961), being useful, being ethical, having self-care and care for others and being humanistic. Constructive creativity in education adopts the following values.

First, the goal of education, teaching, and pedagogy is to develop a person fully. Education should be viewed as a way of exploring and expanding our understanding of future optimistically in relation to humanity's history, accomplishments, and purposes (Sarason, 1993). As such, teaching is an interactive, experiential and creative profession. Pedagogy sees to the social and economic role of an individual (Hinchliffe, 2001). Originated from the Greek word "*paidagogia*", pedagogy means "the leading of a slave or child". The term pedagogy thus seems to be connected with ideas of training and disciplining with the purpose of developing a well-formed person. Pedagogy relates to social, economic, and political requirements that a state requires from its educational system. It addresses the skills that a society needs. The goal of pedagogy is to develop critical powers concerned with "the developing of the learner in a certain direction so as to develop the appropriate qualities of creativity, adaptability, and flexibility" (Hinchliffe, 2001, p. 37). To complement this, an element of education is essential, which focuses on the needs and development of an individual.

Second, education is a process *to become a person who self-cares and cares for others.* Care is a value-guided practice. It emerges as a response to a need. It explicitly acknowledges and equally respects all aspects of a need. Care includes everything that we do to maintain, continue and repair our world (i.e., our bodies, ourselves, and environment) so that we can live in it as well as possible (Tronto, 1993). "Care implies responding to another out of something more than pure interest. Care also implies that this response will lead to an action." (Pantazidou and Nair, 1999, p. 207) There are five phases of care (Tronto, 1993):

(1) Caring about (attentiveness),
(2) Taking care (responsibility),

(3) Care giving (competence),
(4) Care receiving (responsiveness),
(5) Ethic or integrity of care.

The ethic of care is best expressed as an activity. It is about respecting a person's wishes, desires, needs, and wants. It is also about empowering a person with basic needs and ample support for her optimal functioning. It thus means providing a person with opportunities to grow physically, emotionally, cognitively, socio-culturally and spiritually. Also, it refers to ensuring a person's quality of life and wellness as the basis for all human relationships. Care is in a relationship (Smeyers, 1999). Care for a person includes care for those around him/her who support his/her growth. Hence, the unit of care is the person and his/her loved ones, as well as his/her contemporaries, predecessors, and successors. Care involves feelings of acceptance and acts of giving and sharing. Patience, friendliness, trust, forgiveness, respect, love and happiness are examples of qualities that support the growth of caring dispositions and competence. Trust, for instance, reflects the value of respect for persons and the value of care. In a care-giving context, a person's dignity and quality of life is of paramount importance (Saunders, 1990). The caregiver and the care receiver are obliged to self-care. Self-care is about knowing where to get and how to gain access to resources of all kinds that benefit one's growth. Care is thus holistic, encompassing socio-economic, cultural, psychological, and spiritual perspectives. The care of the self concerns a life of receptivity (*Gelassenheit*), or "letting things be" (Edwards, 2000).

Third, education is *experiential*. Continuity in growth is dependent on present experiences that have a fruitful and creative bearing on those of the future, as creativeness in the present experience can become a motivating force for growth in the future (Dewey, 1938/1997). A person who is open to all experiences is constructively creative. Rogers (1961) delineated the importance of unconditional positive regards for supporting ones unfolding and experiencing of all positive, negative, and neutral experiences. A person has to feel safe, fully accepted and warmly supported, to embark on a journey of openness.

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In constructive creativity programs, teachers provide opportunities for a person to experience internal freedom (e.g., thought, desires, purposes, observations, and judgment) and external freedom (e.g., speech and movement) (see e.g., Dewey, 1938/1997; Freire, 2002). Creativity involves individualized cognition (see Finke, Ward and Smith, 1992), emotion and motivation. A person should learn to deal with his/her emotions as they are related to motivation, goal mastery and cognition (Linnenbrink and Pintrich, 2002). Self-discipline is the best management technique. Empowering a person to manage his/her own behavior, task, time, and responsibility enables the person to search for appropriate ways to cope with stress. Positive affects generate transformation of behavior; a person with positive affects perceives difficulties as challenges for self-growth and self-transformation (Meyer and Turner, 2002). People with positive emotions are resourceful and are able to widen their scope of resources (Fredrickson, 1998).

Fourth, education is about *self-transformation*. Innovative pedagogies for self-transformation include dialogue, problem-posing education, and appropriate intervention.

Dialogue thrives in humility, love for commitment towards others, faith in humankind, and hope. It develops critical thinking, and is carried out by the course participant and the instructor, mediated by the contexts of a specific theme related to creativity and cultivating constructive creativity. Each dialogue has two dimensions: action and reflection. During dialogue, persons name the phenomenon, reflect on it, transform it into action, reflect upon the created action and recreate it with love or other positive emotions (Freire, 2002).

Problem-posing education is liberating, humanistic and revolutionary. In problem-posing education, the teacher–student contradiction is to be resolved through dialogical relations. The students are in dialogue with the teacher and with their classmates, and the teacher is in dialogue with the students. The teacher and his/her students are "cognitive actors to cooperate in perceiving the same cognizable object" (Freire, 2002, p. 80), and thus they become jointly responsible for a process in which all grow.

In the framework of constructive creativity we propose to employ the learning and reflective cycle as a means to facilitate humanist, problem-posing education based on authentic reflection and action upon reality, inquiry and creative transformation (Freire, 2002). Within the learning and reflective cycle of problem-posing education, the teacher and the student are cognitive actors to cooperate in perceiving the same cognitive objects (e.g., creativity or education).

Intervention as one of the processes of the learning and reflective cycle is an intrusion into value systems, and is based on a relationship of trust and expectations. The elements that must be specified in an intervention are the agent (who should intervene), the target (whose actions are to be changed in some way), the mechanism (how to intervene), and the time and space (when and where a concrete social intervention takes place) (Weiss, 2000). Accordingly, intervention for fostering creativity has to include efforts to impart creative techniques that engage the wish to identify factors supporting acquisition of a technique or skill. Such interventions should draw upon the strengths of individual participants and existing infrastructures. The teacher and students become jointly responsible for a process in which all grow. Intervention of fostering creativity has to include creative ways to engage a person's interest to identify factors that support him/her to acquire one or more techniques or skills. Dialogue, problem-posing education, and appropriate intervention are some of the tools used to achieve this process.

In sum, we regard creativity of a person as an interactive result of his/her intelligence, knowledge, thinking patterns, personality, motivation, and the environment in which he/she lives (Sternberg and Lubart, 1991). A person's creativity depends on his/her dispositions, skills, type of work, and social and cultural resources (e.g., Gardner, 1993).

Indigenizing Experiences

Indigenization can be a methodological orientation (Kagitcibasi, 1992) which sensitizes human behavior and thinking processes within a cultural context that relies on values, concepts, belief systems, methodologies, and other resources specific to an ethnic or a cultural group (Ho, 1998). Six research strategies for creativity in context are adopted

from Kim and Berry's (1993) analysis. The *first* strategy emphasizes the understanding of creativity within ecological, philosophical, cultural, political, and historical contexts. It examines how individuals and groups perceive and react to creativity education within their context. It highlights the use of natural taxonomies as units of analyzes and attempts to document, organize, and interpret people's understanding of their roles in promoting creativity education, and of the socio-cultural environment that influences creative performances.

Individuals enter a socio-cultural system at a particular historical point with capacities for engaging in relevant social units (Kitayama *et al.*, 1997). The *second* strategy affirms the need of each culture (e.g., developed, developing, underdeveloped, or other) to develop its own indigenous understanding of creativity education. The *third* strategy accepts the existence of multiple perspectives in a society (e.g., Western and Eastern), which are not shared by all groups. The *fourth* strategy affirms the use of multiple methods that are appropriate and could be integrated for a comprehensive and robust understanding of creativity education.

The indigenous approach to creativity education can reduce insufficient consideration of the cultural context (culture blind). It can not eliminate the problem of applicability of theories and findings to other cultures (culture bound). To resolve the problem, the cross-indigenous approach to creativity education is recommended in the case of a number of indigenous settings being considered as sources of knowledge. The *fifth* strategy does not assume the inherent superiority of a local researcher. Regardless if they are local or foreign, an indigenous researcher refers to a person who has tremendous dedication to and insights into universal and special behaviors, and thinking pattern of a target group. The strategy encourages cross-indigenous research or recognizes viewpoints of experts, regardless of whether they are local or foreign. The *sixth* strategy discovers universal facts, principles and laws of creativity education through cross-indigenous and/or cross-cultural investigations (with theoretical and empirical verifications). Individual, social, cultural, and temporal variations are incorporated into the research design, rather than eliminated or controlled.

Two principles are fundamental in the constitution of experience: *continuity and interaction* (Dewey, 1938/1997). The principle of continuity or experiential continuum specifies the direction in which growth (physical, interpersonal and socio-cultural) takes place. Present experiences lead the direction of subsequent ones. The principle of interaction and that of continuity intercept and unite. Without social interactions and interactions with social objects, an individual cannot gain new experiences. The quality of an individual's experience in his/her social and interpersonal environment (with persons, objects), influences the quality of his/her life experiences. The principle of interaction has to be present hand-in-hand with the principle of continuity. Every new experience enriches an individual's repertoire of skills and expertise for future interactions with other individuals or for the manipulation of the existing objects.

The principles of continuity and interaction should be understood within an individual professional's framework and his/her social-psychological framework. In addition to personal growth, as a continuum of experience, the individual professionals socio-cultural achieve growth through interactions with the predecessors and contemporaries. Socio-cultural evolutions befit the principle of continuity, when the predecessors (i.e., experts) selectively pass down habits, knowledge, skills, and behavioral and cognitive elements to the learners. The socio-cultural continuity can take place within a learning context when the experts interact with the individual professionals and also when the latter interact among themselves. The quality of the individual professionals' experiences is determined by the quality of continuity of knowledge, skills, behavior, and cognition transferred to them by the experts (interpersonal), and by the individual professionals' past experiences to their future experiences (intra-individual). Patterns of interaction between the experts and individual professionals, as well as between the individual professionals and a knowledge base also determine the quality of an individual professionals' experience. Indigenous strategies discussed below can be useful means to facilitate experiential education guided by the principles of continuity and interaction.

Creative Problem Solving Cycle

In our framework of constructive creativity, teachers are encouraged to use the creativity problem solving cycle (CPS) to guide their lesson preparation. The CPS holds on to the above assumptions of creativity and values of constructive creativity. In addition, CPS highlights the importance of personal assessment and deliberate intervention through which the teachers are likely to make better use of their creative styles, enhance their level of creative accomplishment, and thus fully realize their creative potentials (Treffinger, 1995). In brief the CPS cycle is dynamic and interactive comprising three processes, namely, understanding the problem, generating idea and planning for action. There are three stages for understanding the problem (mess finding, data finding and problem finding), two for generating idea (idea finding and solution finding) and one for planning for action (acceptance finding). These processes and stages are dynamic and iterative.

According to Treffinger (1995), a *mess* is a broad statement of goal or a direction for problem solving. The problem solver will focus his(her) effort on a broad, brief and beneficial challenge. He/She will take a close look at the challenge, and allow different perspectives to emerge. At the stage of data finding, the problem solver asks these questions: Who? What? Where? When? Why? and How? Using key data, the problem solver attempts to focus on the most challenging aspects and concerns of the situation. At the stage of *problem finding*, problem statements are generated to invite an open or wide-ranging search for many, varied and novel options. Key search options include "in what way might . . ." or "how might . . .". A well-formulated statement of the problem will assist in defining the purpose, scope and required resources, and materials.

During *idea finding*, the problem solver is in search for possible responses or ideas to the question or problem statement selected in problem finding. He/She finds as many ideas or alternatives as possible. He/she uses a wide variety of methods and techniques to help create many, varied and original possibilities. Richard (2003) suggests the use of brainstorming, idea checklist, attribute listing, morphological synthesis, and metaphorical approaches.

Solution finding entails consideration of possible criteria for evaluating ones promising ideas. What are the standards or yardsticks to determine the most promising ideas, or their strengths and weaknesses? After determining the criteria, analyze the promising ideas carefully and systematically. The aim is to decide which idea or ideas offer the greatest potential for solving the problem.

Acceptance-finding brings about consideration of aspects of action that will either assist or resist your efforts to solve the problem—obstacles, objections or difficulties in the way, or sources of support and encouragement. Decide which implementation steps are most important and develop a specific, step-by-step plan of action. Various types of learning activities such as games and quizzes (Baer, 1998) that invite the learners' active participation should be introduced. Teachers who adopt unconventional roles and approaches are likely to be more effective in cultivating the learners' creative abilities than those who follow traditional instructional approaches (Esquivel, 1995).

CPS is recommended for teachers to address meaningful and important issues of concern (Treffinger, 1995). Instead of teaching CPS directly, the teacher uses it to design intervention programs for at-risk students (McCluskey, Baker and McCluskey, 2005), prepare lessons (Tan and Goh, 2007), coach talents (Treffinger and Isaken, 2005) and consultation (Richard, 2003).

The Learning and Reflective Cycle

We claim that learning in the constructive creativity education happens in the context of reflection-in-action (reflection happens in the midst of experiences, Schoen, 1983; Rodgers, 2002) or reflection-on-action (reflection happens outside an experience, Schoen, 1983; Rodgers, 2002) and enhances self- and professional development. Ultimately, reflection must be aimed at improving learning. As such, " . . . (t)he power of (the) teacher should be mediated in some way by a process of reflection in which the teacher is open to learning from others and from viewpoints other than his or her own." (Tubbs, 2003, p. 75) To address this compelling concern, we need to deliberate on a host of questions, ranging from basic conceptual and theoretical analyzes to applied

concrete and practical considerations. We recommend Rodgers' (2002) reflective cycle to be used as a guide: seeing learning—being present in learning experience (whole-hearted involvement in learning), differentiating its parts (describing experience), giving it meaning (analyzing experience—learning to think from multiple perspectives and explanations), and responding intelligently (experimenting). Rodgers (2002) explores the roles of presence, description, analysis, and experimentation in helping teachers reflect and attend to their students' learning in rich and nuanced ways. Rodgers' contention of having a *presence in experience* in teacher professional development work is that "reflection must aim at improved student learning" (Rodgers, 2002, p. 234). To do that, the student must be attentive while on task (creating that presence in their mind). As Rodgers (2002, p. 235) put it, "being present is not the same as having a presence". Being physically present and mentally engaged at the right place and time to collect the data may allow a learner to complete the task successfully. The student has to wait, anticipate, puzzle about or predict what the outcome would be while learning. In a self-designed experiment, for instance, the student is the person best able to describe why things are the way they are, where they are, and what could or would happen during the experiment. Even if the outcome is contracdictory to the expectation, it is the student who is in the best position to describe and explain the reasons. This links the learning process to the next stage of the reflective cycle analysis. The reflective cycle does have some linear features in the sequencing of the phases of learning. Rodgers noted that the descriptive and analysis stages also have a "dialectical relationship".

In a learning and reflective cycle, the mind of the learner develops through guidance, within the context of community of practice and community of interest. The learner engages him/herself in the learning experience, being present physically and mentally, describing the experiences, giving them meaning and responding intelligently to the problem. We propose four dynamic stages of learning and reflection through exploration of implicit theories or mental models of a phenomenon, exposure to scientific theories related to the phenomenon, designing intervention to guide-focused learning and reflection upon

the effectiveness of learning. The presence of community of practice generates new ideas and community of interest values shared understanding, and makes all voices heard (Fischer *et al.*, 2005). Their presence is essential for the learning and reflective cycle, particularly to provide ideas, support and feedback. The learners take part in individualized and social cognition (or scaffolding, see Vygotsky, 1978). The teacher and the learner are agents (Bandura, 2001) who internalize new experiences and monitor them towards a desirable outcome. Within the community of practice, the teacher learns, reflects, generates ideas, and adopts pedagogies which enable the learners to acquire autonomous forms of motivation (e.g., intrinsic motivation) (Amabile, 1983a), feelings of self-determination (Karsenti and Thibert, 1995), high internal locus of control and self-esteem (Sterbin and Rakow, 1996), which in turn has a positive impact on school performance (Fortier *et al.*, 1995). Apparently effective Pedagogies include self-directed learning for enhancing motivation, which in turn encourage cognitive (self-monitoring) and contextual (self-management) processes in meaningful learning (Garrison, 1997), co-teaching to increase professional support (Cook and Friend, 1995), and peer tutoring (e.g., Slavin, 1990; Tournaki and Criscitiello, 2003). Table 26.1 summarizes components of constructive creativity in education that have been discussed so far.

Conclusion

In constructive creativity education, we highlight cultivating positive affect among students. In relation to this, we pay attention to the role of positive psychological states in emotionality and coping (Lazarus and Folkman, 1984; Folkman, 1997; Folkman and Moskowitz, 2000; Seligman and Csikszentmihalyi, 2000). Evidently, the positive psychological state of optimism is positively associated with active coping and is to be predicted by active coping strategies, such as positive reinterpretation (Brissette, Scheier and Carver, 2002; Scheier, Weintraub and Carver, 1986; Segerstrom *et al.*, 1998; Taylor *et al.*, 1992). In his presidential address to the psychologists on creativity some half a century ago, Joy Paul Guilford (1950), among others

Table 26.1. Components of constructive creativity in teacher education.

General framework	Constructive framework	Indigenous strategies	Creative problem solving cycle	The learning and reflective cycle
Every individual has the potential to be creative in one or more domains.	Education is about developing a person fully.	Understands creativity within the ecological, philosophical, cultural, political, and historical contexts.	State the problem: mess finding, Data finding, and Problem finding.	Exploration: Understands people's conceptions or implicit theories of creativity
Creativity can be nurtured given the presence of individual and socio-cultural conditions.	An educated person self-cares and cares for others.	Affirms the need of each culture to develop its own indigenous understanding of creativity education.	Generate options: idea finding	Exposure: introduce scientific theories and findings on creativity
Creativity processes require individualized cognition, involving the generation and exploration phases. Affect and motivation are essential for creative performance	Education is experiential, individualized, and social.	Accepts the existence of multiple perspectives in a society. Affirms the use of multiple methods integrated for a robust understanding of creativity education.	Plan for action: Solution finding	Intervention: Designing activities that can help foster creativity

Table 26.1. *(Conitnued)*

General framework	Constructive framework	Indigenous strategies	Creative problem solving cycle	The learning and reflective cycle
Teachers' professional competence and dispositions are prerequisites: pedagogical, creative and motivational.	Education engages self-transformation. Tools helpful for this process: dialogue, intervention and problem posing.	Encourages cross-indigenous research or recognizes viewpoints of experts, regardless of they are local or foreign. Discovers universal facts, principles and laws of creativity education through cross-indigenous and/or cross-cultural investigations.	Plan for action: acceptance finding	Reflection: Recursive query on learning, development, and teaching that leads to self-awareness, self-evaluation, and self-transformation

Note: The points are listed arbitrary to the columns. They are discussed throughout the book.

highlighted the link between motivation, temperament, and creative performance. To illustrate his view, Guilford mentioned some emotional states that may be inimical to production of ideas: fear, anxiety, envy, negativism, apathy, prejudices, and complacency. With his far-sighted wisdom, Guilford articulated the significance of cognitive and non-cognitive abilities in creative performance. His view is supported by many others. Carl Rogers (1961), for instance, articulated unconditional positive regard, empathy, non-evaluative support for openness of all experiences and hence constructive creativity. Teresa Amabile (1983a, b) included task commitment into the componential model of creativity. Mihaly Csikszentmihalyi's (1996, 1997) three-systems theory of creativity presents the notion of "flow" during creative and productive interactions between an individual and his/her socio-cultural systems. Csikszentmihalyi (1997) posits that the individual's creative flow experience is influenced by the balance of goals, and skills apt for the challenges, as well as the influence of external factors such as the reception of relevant feedback and opportunities for action. In other words, by entering into a state of optimum experience or flow, or that of creative engagement, one is likely to experience a balance of the perspectives of deficit and strengths (Nakamura and Csikszentmihalyi, 2003). The possible links between affect, motivation and creative cognition has been acknowledged by creativity researchers. Exactly, how they are linked to one another is yet to be established. A relevant remark is cited here. "Creativity in the domain of emotion" (Averill, 1999, p. 765) raises several issues about emotional creativity such as whether one should focus on the effects of emotion on creativity or emotions as creative products.

Barbara Fredrickson (1998) postulated the broaden-and-build theory of positive emotions comprising joy, interest, contentment, pride, and love. According to her theory, positive emotions share the ability to broaden people's momentary thought-action repertoires and build their enduring personal resources (physical, intellectual, and socio-psychological). The theory further explains how positive affective experiences not only indicate personal well-being but also enable personal growth, development to flourish (Fredrickson 1998, 2001), cope better and be more resilient during crises (Fredrickson, 2003; Zautra,

Johnson and Davis, 2005). This broadened state of mind and feeling enables people to be more receptive to new ideas and reative than usual (Isen, 2000). Positive moods facilitate the creative problem solving process (Vosburg and Kaufmann, 1999). People in positive affect appreciate the physical and social environment better by having their attention broadened (Derryberry and Tucker, 1994). These positive effects of positive affect tend to prepare a person for better relationships and facilitate higher productivity.

We may agree that people's judgment of their subjective well-being can be predicted by their overall balance of positive and negative emotions (Diener, Sandvik and Pavot, 1991). One role of affect can be to help predict "objective happiness" by tracking and then balancing people's momentary experiences of good and bad experiences (Kahneman, 1999). Affect induction on physiological arousal and the dopaminergic pathways suggested possible processes that link positive affect with behavior and cognition (Isen, 1999). Isen, Daubman, and Nowicki (1986) demonstrated that simple measures such as watching a comedy or eating candy can evoke positive subjective feelings that aid in the process of creative problem solving. They stated that an induced positive affect seems to facilitate drawing on the relevant problem solving cues necessary for a cognitive task in a given context. In fact, such evidence has provided insight into how subjective feeling may be specific to problem solving that is either interesting or is done on the basis of necessity; this is with regard to creative tasks rather than on tasks that are done as a routine (Isen, 1999). Affect and its relatedness to creativity may involve cognitive processes under diverse situations, such as the selection of perspectives sustaining motivation and risk-taking behaviors under different circumstances or contexts (Isen, 1999, 2003).

As a matter of fact, positive, neural and negative feelings are present in everyday life. Positive and negative affect, nonetheless, represent two different psychological processes (Davidson, Jackson and Kalin, 2000; Fredrickson, 1998, 2001, 2003). The positive does not necessary emerge in the absence of the negative (Chang, D'Zurilla and Maydeu-Olivares, 1994; Watson, Clark and Carey, 1988). Negative emotions may serve as a survival value. Fear, for instance, indicates the

presence of danger. Sadness may hint that the loss is impending. Anger may make it evident that someone is doing wrong on us. Negative emotions narrow a person's attention down to the source of a threat and thus likely prepares him/her for actions such as fight or flight (Lim and Tan, 2006; Seligman, 2002).

In order to convince teachers on how creative strategies can be used to enhance the well-being of students, we recommend a positive intervention approach to coping with stress. A group of high school students (age 17–20 years old) was invited to a one-hour workshop for two months before the national examination. Referring to the positive intervention approach, the counselor invited the participants to learn creative self-care strategies: imagery, visualization, imagination, and relaxation exercises. The workshop recommended valuable ways to deal with perceived stressful situations such as positive talks, focusing on problem finding and seeking social supports. The participants whose main stressors were studies and examinations were empowered to use effective coping strategies for regulating their emotions.

Positive Affect (PA) is understood as the feelings that indicate a level of pleasurable engagement with the environment (Clark, Watson and Leeka, 1989). PA is also understood as a dispositional tendency to experience positive emotions across situations and time (Perrewe and Spector, 2002). Using the Positive Affect and Negative Affect Schedule (PANAS) (Watson and Clark, 1984; Watson, Clark and Tellegen, 1988) the change of affect of the students ($n = 47$) before and after the creative workshop on positive coping was measured. The positive affect after the talk increased significantly at the $p < 0.05$ and 0.001 levels, for nearly all items (attentive, determined, interested, inspired, enthusiastic, strong, excited, and proud). A significant correlation between the ratings PA (mean of sum of ten items) after the talk and creativity evaluation (mean of sum of five items) was observed ($r = 0.32$, at the $p < 0.005$) (Lim and Tan, 2006). In conclusion, a pleasant and stimulating environment is likely to increase the interests of the learners in classroom activities, and thus their intrinsic motivation (Hennessey, 1995; Cornelius and Casler, 1991).

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Creativity and the Brain

Włodzisław Duch

Introduction

The mystery of the mind and its relations to the brain is slowly being unraveled. Many low-level cognitive functions involving perception and motor control have reasonable neural models. For example, deficits in quantization of basic speech sounds (phonemes) lead to phonological dyslexia and thus learning problems. Despite great progress in neuroscience higher cognitive functions: language, thinking, reasoning, planning, problem-solving, understanding of visual scenes, are all poorly understood. Creativity seems to be one of the most mysterious aspects of the human mind and any attempt to elucidate brain processes behind creative thinking at present has to be speculative. Nevertheless, despite the limitation of the current knowledge of the neural processes that give rise to the cognitive processes in the brain it is possible to propose a testable, neurocognitive model of higher cognitive functions including creative processes.

Creativity research is still in the domain of philosophers, educators and psychologists, as can be seen from articles in *Creativity Research Journal* and *Journal of Creative Behavior*. The *Encyclopedia of Creativity* (Runco and Pritzker, 1999), with articles written by 167 experts, has a few articles (by Goswami, Pribram, Proctor and Schuldberg) concerning general brain processes, quantum phenomena, chaos and dynamical systems. These articles do not propose testable neurological or computational models of creativity. In theoretical cognitive science the metaphor of "a brain as a computer" is still dominating. The *MIT Encyclopedia of Cognitive Sciences* (Wilson and Keil, 1999) devotes only two pages to creativity, does not mention intuition at all, but has six

articles devoted to logic, mentioning different kinds of logic in the index almost 100 times. This over-emphasis of logic is rather strange because most cognitive functions, such as understanding visual scenes, emotional states of people or creative thinking obviously cannot be reduced to logical operations. There are several reasons for this situation: early models of brain functions have been based on logic; artificial intelligence has focused only on symbol manipulation for problem-solving; computational functionalism in philosophy of mind separated neural and mental processes focusing on conceptual analysis of thinking processes. Once the theory has been established it was much easier to extend it than to develop new approaches that usually require new concepts and ways of thinking.

This situation began to change with the introduction of dynamical systems as a language suitable for description of early motor and cognitive development (Kelso, 1995; Smith and Thelen, 1993; Thelen and Smith, 1994). Symbolic language may provide only an awkward approximation to continuous motor processes (movement of limbs, reaching, crawling, and posture development). Introduction of mathematical language of dynamical systems allowed for more precise approximation and categorization of different stages of development, including concept formation based on sensory motor coordination. Perception, action and cognition are all seen as spatio-temporal (behavioral) pattern formation, self-organization of embodied and situated complex systems. At the level of higher cognitive processes pattern formation in the brain is very rapid, with words and concepts labeling the action-perception subnetworks (Pulvermueller, 2001; Pullermueller, 2003).

A neurocognitive model of brain processes that would bridge the gap between psychological and neural level of description is urgently needed to make progress in creativity research. It should link low-level and high-level cognitive processes, and allow for analysis of relations between mental objects, showing how neurodynamical processes are manifested in inner experience at the psychological level. This seems to be a very difficult venture as the language of neuroscience and the language of psychology are quite different. Some experts believe that the gap between mind and body is so huge that it can never be solved

(Rakover, 1990) and the discussion following this paper). A fruitful way to look at this problem (Duch, 1997) is to start with the neurodynamical description of brain processes and to look for approximations to the evolution of brain states in low-dimensional space where each dimension may be related to inner experience. Similar approach has been quite successful in elucidation of movement patterns, where large brain areas act in a cooperative way to produce simple movements of fingers or limbs (Kelso, 1995); description of brain processes behind movement control can then be done in low-dimensional spaces. This idea has been used to model category learning in experimental psychology, showing why counter-intuitive answers may be given in some situations (Duch, 1996). On the surface many contradictory psychological explanations for such experiments may be invented, but they all are based on wrong understanding of causes that are responsible for brain decisions in such situations.

A brief introduction to the neurocognitive understanding of higher cognitive functions is presented in the next section. This is followed by the description of the use of words and symbols, putative brain processes responsible for creativity, and analysis of experiments on pairwise word associations by creative and less creative people. The neurocognitive approach is applied to one of the simplest domains in which creativity is manifested: invention of new, interesting words. It is suggested that this could be a good area for precise tests of creative processes at the computational, psychological and brain imaging and electrophysiology levels. The chapter ends with a discussion of the results and future directions of the neurocognitive approach to creativity.

Neurocognitive Approach to Higher Cognitive Functions

Human behavior is a result of extremely large-scale neurodynamics, or continuous changes in the activation state of a large number of brain areas. Infants and babies develop intuitive theories about physical world and minds of people (Gopnik and Meltzoff, 1997). A rough approximation to the brain processes involved in formation of knowledge about the world is provided by causal Bayesian networks. Even

young children seem to be able to learn conditional probabilities from observed patterns of their own actions and human interventions that change the situation (Gopnik and Schulz, 2004). This is certainly an interesting direction although systematic approximations to neural processes that will lead to Bayesian networks have not yet been demonstrated. The innate need to understand the world including results of ones own actions, leads to narrative comments on one's own behavior, sometimes to rationalization and confabulation (Gazzaniga, 1998).

Few Facts about the Brain

The brain is not a general purpose computer; it is more a highly specialized device that offers a large number of automatic responses that are used in an adaptive way as a result of learning. A few general statements about the brain are cited below. Some of them established quite well. Some are still rather speculative.

- The overall level of arousal and awareness is determined by the reticular formation in the brain stem.
- Many important neurotransmitters are produced in the brain stem, including serotonin (raphe nuclei) and norepinephrine (locus ceruleus).
- Brain stem may be responsible for selection of the global behavioral state, activating and inhibiting different brain areas (Humphries, Gurney and Prescott, 2005), with more precise selection of actions done by basal ganglia.
- Reward information is used to choose, learn, prepare and execute goal-directed behavior, mediated by dopamine neurotransmitters produced mostly in the midbrain ventral tegmentum area, medial temporal cortex involved in the detection and prediction of rewards, and orbitofrontal cortex and amygdala that evaluate relative reward values and expectations (Schultz, 2000; Gottfried, O'Doherty and Dolan, 2003; Berns, 2005).
- Representation of goals is maintained in parietal, premotor and dorsolateral prefrontal cortex (Berns, 2005).
- Motivation, resulting from anticipation of rewards or conditioned positive emotions, is correlated with activity of ventral striatum.

- Executive functions, such as planning, reasoning, abstraction, initiation and disinhibition of behaviors, are strongly correlated with results of verbal and visual memory tests and with the IQ tests (Duff *et al.*, 2005).
- Working memory (Baddeley, 2002) has a very limited capacity of only 3-4 visual objects (Baddeley, 2002), and about four chunks of information (Cowan, 2005).
- A distinct verbal working memory system is used by the brain to analyze the syntactic structure of a sentence and determining its meaning (Caplan and Waters, 1999).

Working Memory

Current working memory model of Baddeley (2002) includes central executive functions in the frontal lobes, focusing, switching and dividing attention, and providing an interface to the long-term associative memory via episodic memory buffer. In this model, working memory includes also two slave short-term memory buffers, auditory phonological loop and visuospatial sketchpad. Individual differences in the ability to control attention depend on the working memory capacity (Cowan, 2005; Vogel, McCollough and Machizawa, 2005). Redick and Engle (2006) used the Attention Network Test to study the relationship between specific types of attention and working memory capacity. They argue that "individual differences in working memory capacity reflect variation in the ability to control attention." (p. 713). This is also reflected in the ability to solve problems and exhibit intelligent behavior. Electrophysiological and brain imaging studies show the involvement of frontal, temporal and parietal associative cortex in storage of working memory information. However, it is quite likely that working memory is not a separate subsystem, but simply an active part of the long-term memory (LTM) network (see the review of the evidence for this point of view in Ruchkin *et al.*, 2003) due to priming and spreading of neural activation. The same brain regions are involved in perception, storage and re-activation of LTM representations. Some activated LTM subnetworks may be in the focus of attention of the

central executive (presumable this is the part we are conscious of) and some may be activated but outside of this focus.

Sensory systems transform the incoming stimuli extracting from auditory and visual streams basic quantized elements, such as phonemes or edges with high contrast. These elementary building blocks form larger patterns, building discrete representations for words and shapes. Although gross brain structures are identical in all normal infants there is a lot of variability at the microscale that may result in exceptional talents or developmental disorders. Auditory event-related potentials (ERPs) for consonant sounds, recorded from left or right hemisphere less than two days after birth, predicted with over 80% accuracy the level of reading performance of children eight years later (Molfese, 2000; Molfese and Molfese, 2000). Lack of systematic perceptual training of infants leaves the developmental process at mercy of random influences, resulting in frequent speech, hearing and reading problems.

Symbols in the Brain

To understand the higher cognitive processes one should start from representation of symbols in the brain. Cortex has layered modular structure, with columns of about 10^5 densely inter-connected neurons, communicating with other cortical columns in the neighborhood, and sometimes also in quite distant areas across the brain, including the opposite hemisphere. Each column contains many types of neurons communicating with each other using different types of connections, neurotransmitters and neuromodulators, in effect forming thousands of microcircuits with different properties. These circuits act as local resonators, sustaining for a while electrical oscillations (like pipes sustain acoustic vibrations in organs) in response to the sensory signals, effectively converting them into intricate patterns of excitations of cortical tissues. Genetic code does not contain sufficient information to specify the details of all local connections in cortical columns, but their great complexity and randomness may actually help to create unique, individual activity patterns that are relatively easy to recognize by other brain areas. Hearing words activates a strongly linked subnetwork of

microcircuits that bind articulatory and acoustic representation of a spoken word.

Such patterns of activation are localized in most brains in the left temporal cortex, with different word categories coded in anterior and posterior parts (Damasio *et al.*, 1996; Martin *et al.*, 1996). The ability to hear and recognize a word does not imply that it can be properly pronounced. Production of words requires precise motor programs that are linked to phonological representations in temporal cortex, but are stored in frontal motor cortex (Brocka's area), connected to the temporal areas via a bundle of nerve fibers called the *arcuate fasciculus*. Damages (lesions) to this fiber or to the cortex processing auditory and language-related information lead to many forms of aphasia (Lapointe, 2005).

Words are organized in a lexicon, with similar phonological forms activating adjacent resonant microcircuits. Upon hearing a word string of connected resonators is activated, creating representation of a series of phonemes that is categorized as a word (Figure 27.1). Native
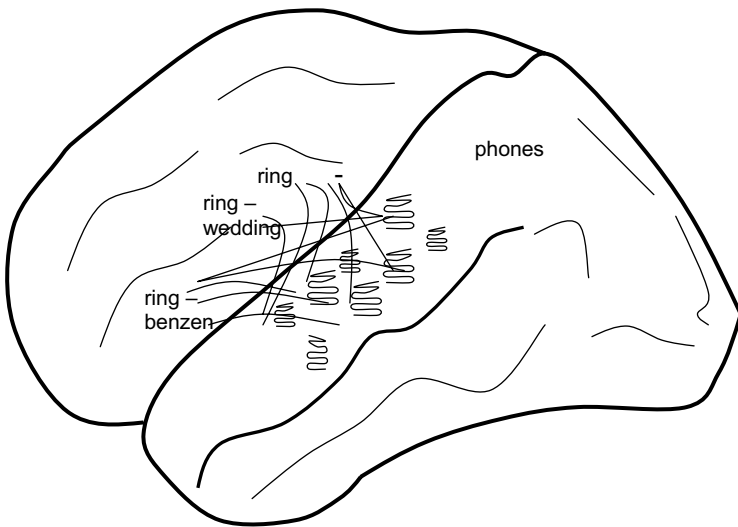
Fig. 27.1. Listing to a word like "r-i-n-g" activates phonological representation (oscillations of cortical columns in response to phonemes are symbolized by little springs here) and primes extended subnetworks that encode semantic representation (for example "wedding ring") in a given context, binding perceptual and motor areas.

language has a number of syllables and longer chunks of sounds (morphemes) that get easily activated when only part of the word is heard. As a result hearing is more robust (in a noisy environment) but frequency effects may sometimes lead to activation of wrong representations. For example, my first name Wlodzislaw is often written down as a much more common name Wlodzimierz by native Polish speakers, because the first half "Wlodzi" is rather unique and almost always followed by "mierz". Foreign speakers do not hear it properly because phonological representations of some sounds, such as "dz" are very weakly connected in their brain, and therefore it frequently gets misspelled in all possible ways.

Psycholinguistic experiments show that acoustic speech input is quickly changed into categorical, phonological representation. A small set of phonemes, quantized building blocks of phonological representations is linked together in an ordered string by a resonant state representing word form, and extended to include other microcircuits defining semantic concept. From the N200 feature of event-related potentials it has been conjectured that phonological processing precedes semantic activations by about 90 ms (Pulvermueller, 2002).

Phonological representation activates an extended network that binds symbols with related perceptions and actions, grounding the meaning of the word in a perception/action network. Various neuroimaging techniques confirm existence of semantically extended phonological networks, giving this model of word representation strong experimental support (Pulvermueller, 2002; Pulvermueller, Shtyrov and Ilmoniemi, 2005). Symbols in the brain are thus composed of several representations: how they sound like, how to say them, what visual and motor associations they have. This encoding automatically assures that many similarity relations, phonological as well as semantic, between words may automatically be retrieved. Meanings are stored as activations of associative subnetworks that may be categorized and processed further by other areas of the brain. Hearing a word activates string of phonemes increasing the activity (priming) of all candidate words and non-word combinations (good computational models of such phenomena in phonetics are described in (Grossberg, 2000,

2003). Polysemic words probably have a single phonological representation that differs only by their semantic extensions. Context priming selects extended subnetwork corresponding to a unique word meaning, while competition and inhibition in the winner-takes-all processes leaves only the most active candidate networks. The subtle meaning of a concept, as stored in dictionaries, can only be approximate, as it is always modified by the context. Overlapping patterns of brain activations for sub-networks coding word representations lead to strong transition probabilities between these words and thus semantic and phonological associations that easily "come to mind".

Perception/action networks allow for associative learning of simple facts and behavioral rules. To recognize a word in a conscious way activity of its sub-network must win a competition for an access to the working memory (Duch, 2005a). In the language of dynamical systems memory traces are coded by attractor states binding activity of microcircuits in many minicolumns that code elementary features derived from sensory inputs. These processes cannot easily be approximated by simple behavioral rules. Analysis of real data shows that only a simple reasoning may be based on logic and justified using comprehensible rules that can be expressed in symbolic language (Duch, Setiono and Zurada, 2004; Duch, 2005b). Intuitive reasoning based on similarity to previously observed cases can sometimes be expressed using fuzzy rules (Duch and Blachnik, 2004). In many cases the brain may take intuitive decisions evaluating complex similarity patterns — activation patterns of cortical networks in posterior sensory and associative cortex will automatically be perceived by the working memory executive frontal lobe areas as similar, because information carried over such long distances in the brain is not too precise. The number of logical rules required to justify some decisions based on intuition may be impractically large. Explanation of intuition is thus rather simple.

Problem-Solving

A model of intuitive problem-solving with concepts defined by probability density distributions over combinations of activations representing feature values in psychological spaces has been presented in

(Duch and Diercksen, 1995). This model has been applied to problem-solving, learning in a qualitative way (from observations) basic laws describing electrical currents (Ohm and Kirchoff laws), and answering questions about the current and voltage changes in a simple electric circuit without solving any equations. General problem solving process involves the following steps:

- Stating the problem by reading, listening or thinking about it puts it into working memory, that is activates (primes) different elements of the long-term memory and indirectly (through attention) binds them together.
- Activation is spread and associated memory elements activated; this may be interpreted as inferences made by specialized processors that can handle bits and pieces of the problem (Baars, 1988).
- New activations are recognized by the central executive as useful steps towards solution, thus changing the problem state; this cycle is repeated until a solution is found or an impasse is reached.
- Final solution is a series of associations that lead from the initial brain state—problem statement—to the final state, representing problem solution.

Several things should contribute to efficient problem-solving. First, the information must really be in the working memory. Thus the ability to pay attention, focus on the problem and inhibit irrelevant brain process is important. The problem is easy if relevant features are extracted and associations are quickly formed, as it happens if similar problems have been solved many times. Understanding of basic concepts is equivalent to placing them in the web of associations, using chunks of knowledge that cannot easily be replaced by elaborate reasoning, learning symbol manipulations, that is forming strong associations between different concept representations that automatically and effortlessly lead from one brain state to the other.

If the problem is hard associations will not be formed quickly; long priming (persistent thinking about the problem), activation of appropriate brain areas by looking at similar problems or by considering subproblems, may be helpful. General arousal of the brain, increasing the oxygen supply (deep breathing, taking a walk), or playing

background instrumental music (hearing words may be disruptive) to increase activation could help. If an impasse is reached some chunk of knowledge may be missing, therefore, intermediate associations should be searched for, or simplified (abstract) version of the problem should be considered.

Skill Learning

When new skills are learned initially they demand full conscious attention and eventually become fully automatic, sub-conscious actions. This is one of the most mysterious processes that may shed some light on the nature of consciousness. Without going into the controversies surrounding consciousness itself, one may assume that in the course of skill learning the focus of attention gradually shifts from elements of the task being learned stored in the working memory that do not need anymore corrections, to other perceptual and internal processes that require attention. This is due to the interplay between the working memory (frontal lobes), intermediate memory storage and value-meaning associations based on the activity of the old memory system in hippocampus and emotional memory in amygdala, long-term memory storage (associative cortex), learning of motor sequences (basal ganglia, caudate and putamen nuclei, pre-motor and supplementary motor cortex), as well as further improvements of initial skills due to cerebellar learning and interaction with the sensory cortices (including proprioception) providing the input. The skill learning process may be divided into three stages:

- In the cognitive stage, initial (usually verbal) characterization of the skill is used to guide the behavior. Understanding instructions requires the use of working memory (frontal cortex), intermediate memory (hippocampus) and spatial imagination (parietal cortex).
- In the associative stage, motor actions are produced (motor cortex) and consequences are evaluated matching results with expectations (sensory and limbic areas), with reinforcement learning tuning the behavior, eliminating errors and the need for verbal mediation and attention to basic movements.

- In the autonomous stage, the skill is gradually improved via cerebellar learning making fine corrections to motor control signals, with little reliance upon working memory.
- Skill learning is obviously a complex activity, still controversial and perhaps too complex to create detailed computational simulations. How is this neurocognitive account of higher cognitive functions related to creativity?

Creativity from the Psychological and Neurocognitive Perspectives

Creativity has been defined by Sternberg and Lubart (1999) as "the capacity to create a solution that is both novel and appropriate" (p.3). Creativity manifests itself not only in creation of novel theories or inventions, but permeates our everyday actions, understanding of language and interactions among people. This becomes clear when simulation of human behavior by chatterbots, avatars, and robots is attempted. Intelligence is strongly correlated with creativity and it is quite likely that both have similar neurobiological basis. The g-factor is highly correlated with working memory capacity, perceptual speed, choice and discrimination reaction times, the structure of EEG event-related potentials (ERP potentials), nerve conduction velocity, and cerebral glucose metabolic rate during cognitive activity (Jensen, 1998). Brains of creative and intelligent people probably differ in the density of synaptic connections, contributing to the richer structure of associations, and more complex waveforms of the ERP potentials.

Creativity and Brain Networks

Problems that require creativity are difficult to solve because neural circuits representing object features and variables that characterize the problem have only weak connections, and the probability of forming appropriate sequence of cortical activities is very small. The preparatory period introduces all relevant information, activating corresponding neural circuits in the language areas of the dominant temporal lobe, and recruiting other circuits in the visual, auditory, somatosensory, and motor areas used in extended representations. These brain

subnetworks are now "primed" and being highly active reinforce mutually their activity, forming many transient configurations and inhibiting at the same time other activations. Difficult problems require long incubation periods that may be followed by an impasse and despair period, when inhibitory activity lowers activity of primed circuits, allowing for recruitment of new circuits that may help to solve the problem. In the incubation period distributed sustained activity among primed circuits leads to various transient associations, most of them short-lived and immediately forgotten. Almost all of these activations do not have much sense and are transient configurations, fleeting thoughts that escape the mind without being noticed. This is usually called imagination. Interesting associations are noticed by the central executive and amplified by emotional filters that provide neurotransmitters increasing the plasticity of the circuits involved and forming new associations, pathways in the conceptual space.

In this view at the neural level creativity requires two components: (1) distributed chaotic spontaneous (fluctuating) neural activity constrained by the strength of associations between subnetworks coding different concepts, responsible for imagination, and (2) filtering of interesting results, amplifying certain associations, discovering partial solutions that may be useful in view of the set goals. Filtering is based on priming expectations, forming associations, arousing emotions, and in case of linguistic competence on phonological and semantic density around words that are spontaneously created (density of similar active configurations representing words). Rapid joint processing of synchronized spontaneous neural activity fluctuations seems to be rather common in the brain, involving gamma frequency (40–70 Hz) oscillations in the visual system (Fries *et al.*, 2001) other sensory systems (Arieli *et al.*, 1996) and associative cortex (Singer, 1999). Although there are many computational studies of such mechanism it is still difficult to apply such models to explanation of higher cognitive functions.

Insight

Some problems can only be solved with insight, a sudden Aha! experience that accompanies solutions of some problems (Sternberg and

Davidson, 1995). Studies using functional MRI and EEG techniques contrasted insight with analytical problem solving that did not required insight (Jung-Beeman *et al.*, 2004). An increased activity in the right hemisphere anterior superior temporal gyrus (RH-aSTG) has been observed during initial solving efforts and during insights. This area is probably involved in higher-level abstractions that can facilitate indirect associations. About 300 meters before insight a burst of gamma activity was observed. This has been interpreted by the authors as "making connections across distantly related information during comprehension ... that allow them to see connections that previously eluded them" (Jung-Beeman *et al.*, 2004, p. 326). Bowden *et al.* (2005) performed a series of fMRI experiments, confirming these results. In their interpretation initial impasse is due to the inability of left hemisphere, focused on the problem, to make progress. This deadlock is removed when less-focused right hemisphere adds relevant information, allowing new associations to be formed. Aha! experience may result from activation by the pre-existing weak solution in the right hemisphere suddenly reaching consciousness when the activation of the left hemisphere is decreased.

An alternative interpretation of the involvement of the right hemisphere is based on the observation that connections between left and right hemisphere require long projections and cannot carry precise information. Therefore right hemisphere has only a global view at a higher level of abstraction, generalizing over similar concepts and their relations. This is also true for the left hemisphere, distributed activations in the right hemisphere form various configurations that activate back larger regions of the left hemisphere. Gamma high-activity burst projected to the left hemisphere will prime subnetworks with sufficient strength to form associative connections linking the problem statement with partial or final solution. Such solutions may initially be difficult to justify, until all intermediate steps will be categorized. The solution may be surprising, based on quite different idea than initially entertained. Gamma burst also activates emotions increasing plasticity of the cortex and facilitating the formation of new associations. One should expect that the same neural processes should also be involved in creative thinking, and that results of such processes will sometimes

be assessed as creative. Although the existence of differences between male and female *corpus callosum* (primary structure connecting left and right hemisphere) has been controversial recently reliable measurements (Mitchell *et al.*, 2003) confirmed that brains of woman are indeed better connected and this can contribute to a different, more intuitive, style of problem-solving. However, gender differences in insight processes have not yet been studied by neuroscientists.

Heilman, Nadeau and Beversdorf (2003) agree that "creative innovation might require the co-activation and communication between regions of the brain that ordinarily are not strongly connected", binding "different forms of knowledge, stored in separate cortical modules that have not been previously associated" (p. 369). However, these authors do not consider lateralization of brain functions. Creativity certainly depends on many other brain mechanisms. Binding the activity of spatially distant columns may be easier in brain states dominated by low-frequency EEG activity (low alfa or theta) for two reasons. First, peaks of traveling EEG waves are 10 times further for 4Hz then for 40Hz, allowing for precise binding of activity across much larger cortical areas. Second, lowering average EEG frequency switches off many unnecessary backgrounds thought processes, resulting in a better energy supply to the cortical areas where they are needed.

Experiments with Word Association

Relationships between creativity and associative memory processes have been discussed already in (Mednick, 1962). In experimental psychology investigation of priming effects is quite popular. The pairwise word association technique is perhaps the most direct way to analyze associations among sub-networks coding different concepts. These associations should differ depending on the type of priming (semantic or phonological), structure of the network coding concepts, the activity arousal due to the priming (the amount of energy pumped into the resonant system). In a series of experiments (Gruszka and Nęcka, 2002) phonological (distorted spelling) and semantic priming was applied, showing for a brief (200 ms) moment the priming cue (word) before the second word of the pair was displayed. Two groups of people, with

high and low scores in creativity tests were participating in this experiment. Two types of associations were presented, close and remote, and two types of priming, positive (either phonological or semantic relation to the second word) and neutral (no relation).

Results of this experiment have puzzled the authors (Gruszka and Nęcka, 2002). Creative people should have greater ability to associate words and should be more susceptible to priming. Less creative people may not be able to make remote associations at all, while creative people should show longer latency times before noticing such associations or claiming their absence. This is indeed observed. In addition neutral priming, based on the nonsensical or unrelated words, increased the number of claims that words are related, in case of less creative people stronger than positive priming, and in case of more creative people in a slightly lower way. Phonological priming with nonsensical sounds partially activates many words, adding intermediate active configurations that facilitate associations. If associations between close concepts are weak neutral priming may activate intermediate neural oscillators (pumping energy to the system, increasing blood supply), and that should help to establish links between paired words, while positive priming activates only the sub-network close to the second word, but not the intermediate configurations. For creative people close associations are easy to notice and thus adding neutral or positive primes has similar small effect. Situation is quite different for remote associations. Adding neutral priming is not sufficient to facilitate connections in less creative brains when distal connection are completely absent, therefore neutral priming may only make them more confused. Adding some neural noise may increase the chance to form resonance state if weak connections exist in more creative brains — in the dynamical systems language this is called the stochastic resonance phenomenon (Wellens, Shatokhin and Buchleitner, 2004). On the other hand adding positive priming based on spelling activates only phonological representations close to that of the second word, therefore there is no influence. Priming on positive (related) meaning leads to much wider activation, facilitating associations.

These results support the idea that creativity relies on the associative memory, and in particular on the ability to link together distant concepts.

Creativity from Computational Perspective

Creativity is a product of ordinary neurocognitive processes and as such should be amenable to computational modeling. However, the lack of understanding what exactly is involved in creative activity is one of the main reasons for the low interest of the computational intelligence community in creative computing. Very few computational models addressing creativity have been implemented so far, the most interesting being Copycat, Metacat, and Magnificat models developed in Hofstadter's group (Mitchell, 1993; Hofstadter, 1995; Rehling, 2001). These models define and explore "fluid concepts", that is concepts that are sufficiently flexible and context-sensitive to lead to automatic creative outcomes in challenging domains. Copycat architecture is based on an interplay between conceptual and perceptual activities. The first is implemented in a *Slipnet* spreading activation network, playing the role of the long-term memory, storing concepts, from simple objects to abstract relations. Links have lengths that reflect the strength of relationships between concepts, and change dynamically under the influence of the *Workspace* network, representing perceptual activity in the short-term or working memory.

Numerous software agents, randomly chosen from a larger population, operate in the Workspace, assembling and destroying structures on various levels. The Copycat architecture estimates "satisfaction" derived from the content of assembled structures and concepts. Relations (and therefore the meaning) of concepts and high-level perceptions emerge in this architecture as a result of a large numbers of parallel, low-level, non-deterministic elementary processes. This indeed may capture some fundamental processes of creative intelligence, although connections with real brain processes have not been explored (Mitchell, 1993; Hofstadter, 1995; Rehling, 2001).

Perhaps the simplest activity in which creativity is frequently manifested is in understanding and creating new words. In languages with rich morphological and phonological compositionality (such as Polish) novel words may appear in normal conversation (and much more frequently in poetry). Although these words are newly invented and cannot be found in any dictionary they may be understandable even without hearing them in a context. The simplest test for creative thinking in linguistic domain may be based on ingenuity of finding new words, names for products, web sites or companies that capture their characteristics. A test for creativity based on ingenuity in creating new words could measure the number of words each person has produced in a given time. Although general intelligence, as measured by the IQ score, is not a good predictor of creativity (because of context dependence and domain-specific effects), test of creativity with words may correlate better with IQ results, as both depend on similar neurological processes.

Suppose that several keywords are given, or a short text containing such keywords, priming the brain at the phonetic and semantic level. The goal is to come up with novel and interesting words that capture associations with the keywords in the best possible way. Large number of transient resonant configurations of neural cell assemblies may be formed in each second, exploring the space of all possibilities that agree with internalized constraints on the phonological structure of words in a given language (phonotactics of the language). Very few of those imagined words are really interesting, but they all should sound correctly if phonological constraints are kept. A phonetically-detailed computational models of spoken word representation has not yet been created but experiments with simple statistical algorithm based on this idea gave quite interesting results (Duch, 2006). Imagination is rather easy to achieve, taking keywords, finding their synonyms to increase the pool of words, breaking words into morphemes, syllables, and combining the fragments in all possible ways.

In the brain words that use larger sub-networks common to many words have higher chance to win competition, as they lead to stronger resonance states, with microcircuits that mutually support activity of each other. This probably explains the tendency to use the same word

in many meanings, and create many variants of words around the same morphemes. Creative brains are probably supported by greater imagination, spreading activation to more words associated with initial keywords, and producing faster many combinations, but also selecting most interesting results through emotional and associative filtering. Emotional filtering is quite difficult to model, but in case of words two good filters may be proposed, based on phonological and semantic plausibility. Phonological filters are quite easy to construct using second and higher-order statistics for combination of phonemes (in practice even combination of letters is acceptable). Construction of phonological neighborhood density measure requires counting the number of words that sound similar to a target word. Semantic neighborhood density measures should evaluate the number of words that have similar meaning to a target word, including similarity to morphemes to which the word may be decomposed.

Starting from the following keywords: "portal, imagination, creativity, journey, discovery, travel, time, space, infinite", large number of interesting words has been generated, with about 3/4 already used as company or domain names. This shows that the algorithm indeed creates new names in a similar way as human brains. For example, *creatival* is used by creatival.com, *creativery* is used by creativery.com. Some words have been used only a few times (at least according to the Google search engine), for example *discoverity* that can be derived from: disc, disco, discover, verity, discovery, creativity, verity, and may mean discovery of something true (*verity*). Another new interesting word is *digventure*, because it is easy to pronounce, and both *dig* and *venture* have many meanings and thus many associations, creating a subnetwork of activity in the brain that resonates for a long time.

Discussion and Conclusions

Neurocognitive approach to higher cognitive functions presented here is obviously quite speculative, but it seems to be able to explain, at least qualitatively, many phenomena, such as creativity or automatization of skill learning, that were quite mysterious not so long time ago. Results discussed above support the idea that creative processes are

based on ordinary cognitive processes and that understanding creativity and developing computational models of creativity may actually be easier to achieve than previously thought.

Creativity requires imagination and filtering. Imagination should be constrained by probabilities of composition of elementary operations, corresponding to activations of specific brain subnetworks. Products of imagination should be ranked and filtered in a domain-specific way. The same principles should apply to creativity in design, mathematics, and other domains, although in visual or abstract domain elementary operations and constraints on their compositions are not so easy to define as in the lexical domain. In arts emotional reactions and human reactions to beauty are rather difficult to formalize. Nevertheless it should be possible to create a network that learns individual preferences evaluating similarity to what has been evaluated as interesting. It is sufficient to observe how long and where a person looks in the art gallery to learn preferences and to create a new painting that would fit this person's taste. In abstract domains various measures of relevance or interestingness may be used for filtering, but to be interesting creative abstract designs (for example in mathematics) will require rich conceptual space, reflecting many neural configurations that may be potentially active.

Brain imaging and electrophysiological studies of brain activity during invention of new words, as well as during analysis of novel words read or heard, would make an interesting test of neurocognitive approach to creativity and may be done with methods already used to study word representations (Pulvermueller, 2001, 2003). Probing associations and transition probabilities between brain states using experimental psychology techniques (Gruszka and Nęcka, 2002; Mednick, 1962) should be easier with detailed models predicting the outcomes and explaining puzzling results that link associative memory and creativity (Gruszka and Nęcka, 2002). Research program on creativity that includes neuroscience, cognitive psychology and theoretical modeling, focused on word representation and creation, could be an entry to a detailed understanding of this fascinating brain processes.

The ability to create new words may be tested quite quickly and it would be interesting to see how these tests correlate with more sophisticated and well established tests, and how words invented by humans compare with software-generated words. Computational models of creativity outlined in this paper may be implemented at a different level of neurobiological approximations, from detailed neural models to simple statistical approaches. Psychological theories are frequently based on conceptualizations that are difficult to justify as approximations to brain processes. Neuro-cognitive approach is well funded in neuroscience and may thus be directly tested using brain imaging, electrophysiological experiments and predictions of computational models. Creativity research is certainly on a good track.

Acknowledgment

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Culture and Creativity in Organizations: An Integration of Commonalities, Divergences, and Levels

Keith James and Jacob Eisenberg

Introduction

International migration and globalization of companies, markets, production and trade have spiked upward in recent years. Following this, studies of cultural influences on organizations have gained attention. Similarly, the last decade has seen resurgence in theories and studies on workplace creativity. Despite these two trends, little work has been done on how culture and creativity relate to each other in organizations. Three themes are discussed in this chapter: *commonalities* of culture and creativity, *divergences* in cultural influences and creative processes across cultures, and the relevance of multiple *levels* of culture and multiple *levels* of creativity and their relations.

Commonalities

Briefly, culture has been defined varyingly as the common cognitive programming transmitted to individuals by collectives of which they are part (Hofstede, 1980), as broad and deep preferences for self and the world that are shared by a group of people (Rokeach, 1973); or as the social and material products shared by members of a group (Moghaddam, Taylor and Wright, 1993). Creativity is defined as the generation of ideas or products that are *novel* and *useful* (Amabile, 1996). We regard culture and creativity as multi-level phenomena. Societies have cultures. Sub-sets of societies (e.g., professions and political parties)

have cultures. Organizations have cultures. Sub-groups within organizations (e.g., functional units) have cultures. Individuals' personalities have sometimes been characterized as equivalent to cultures (e.g., Triandis *et al.*, 1985; Wallace, 1971). Individuals create. Teams create. Organizations create. Societies create. Given that, the study of cultural influences on creativity needs to be — but has largely not been to this point — multilevel. Kozlowski and Klein (2000) pointed out that lack of attention to multilevel characteristics and processes in areas where they clearly exist, leads to disconnected research and micro-theories that only marginally advance true understanding.

Every culture has an observable level of creativity. Creativity is a source of culture as showed in the feedback circle in Fig. 28.1. Tools, techniques, religious systems, political structures, social norms, art, symbols, knowledge, and myths make up the cultures of the world. Many *types* (if not levels) of individual and social creative processes are common across cultures (Chick, 1997; Jung, 1959). Wechsler (2006), for instance reported that the divergence and convergent thinking
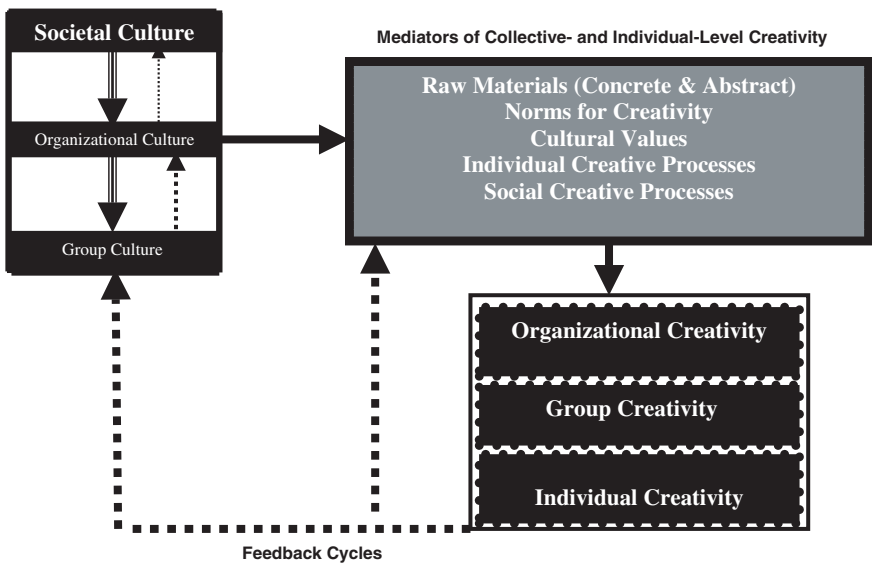
Fig. 28.1. Multilevel culture and multilevel creativity in organizations.

skills assessed by the Torrance Creativity Test show levels of criterion validity in Brazil similar to those seen in the U.S. and Western Europe (see also Madaus, 1967). Another example for this is the groupthink effect which has the cross-cultural relevance of *social* processes for creative performance — linking to low creative production (Janis, 1972; McGrath, 1984; Whyte, 1998). The concept of groupthink originated in the North America. Bovasso (1992) documented its occurrence in Australia. Ko (2005) provided data indicating that it also sometimes influences group creativity in Hong Kong.

Strong cultures have sometimes been argued to impede creativity by imposing conformity to existing ways of viewing the world and operating within it (see, e.g., Hayes and Bond, 1981). This seems antithetical to original thinking and generation of new products (with "product" broadly defined). In fact, a culture-free person would probably be incapable of creativity. In other words, creativity does not develop in a cultural vacuum. Creativity is always rooted in the patterns, priorities, materials, trends, and techniques of collectives. Paradoxically, to be truly creative, creativity must somehow deviate to some extent from the existing collective culture(s) (James, 2005; Mar'i, 1976). Creative individuals and groups take the contents of cultures as they exist, as well as extend, modify or integrate them in novel ways (James, 2005; Ohly, Sonnentag, and Pluntke, 2006).

There is some evidence that *quantity* of available cultural raw materials (i.e., physical, economic, and intellectual resources) affects the level of creativity of individuals and in societies and organizations (Maslow, 1970; Osche, 1990; Pfeffer and Salancik, 1978; Simonton, 1990; Sternberg and Lubart, 2004). We posit, therefore, a meta-cultural law of the relation of cultural resources to creativity. At low levels of cultural inputs, creative outputs tend to be low. Creative outputs increase substantially when available societal-cultural inputs rise to moderate levels. At relatively high levels of such resources, levels of creativity tend to decline somewhat (Osche, 1990; Simonton, 1990). One reason for the eventual downturn in the curve is that the more cultural resources an entity can access the greater the tendency to devote resources *and* creativity toward maintaining the status quo

(James, 2006; Tilly, 2003). This directly promotes stasis, and channels resources away from *productive* novelty even as creativity in service of power and resource maintenance may increase. The latter is another reason for the feedback cycles in Fig. 28.1.

A further reason for the curvilinear relationship of cultural resources to creativity is that deficits in resources (relative to desires, situational demands, or life necessities) *activate* creativity (c.f., Bettleheim, 1960). For instance, the highest levels of innovation seems to occur in organizations that have some resource constraints combined with problems and pressures to adapt (Katila and Shane, 2005).

Another way that resource availability links culture to creativity is through the mechanisms of identity. As the resources of an individual or a group become less dependent on the cultural system of a higher-level entity, the less power the cultural system of higher-level entity has on the identities of constituent members (Triandis, 1989). This has the potentially beneficial effect of releasing members from conformity, but can also divorce them, to some extent from the cultural contents and congruence that potentially provide important starting points (raw materials) for creative production.

Divergences

Cultural creative goals

Cultures differ in the extent to which they encourage creativity among the members, and in the specific types of creativity they promote. That is, cultural contents include specifications of whether, when, and what types of creativity are appropriate in which situations (James, 2005; Mar'i, 1981). Norms are prescriptions of "proper" behavior (Moghaddam, Taylor and Wright, 1994). Relative to creativity, cultures differ in whether they generally view creative behavior, itself, as desirable versus viewing it as undesirable. Cultures range across a continuum from generally encouraging creativity; to generally tolerating it without actively encouraging it; to generally discouraging it (James, 2005; Mar'i, 1976; Triandis, 1995). This is why differences occur across cultures in the overall level of creativity (Hasagawa, 1986; James, 2005; Mar'i, 1976).

Whatever level of creativity a given culture supports, overall, it will channel creativity toward particular culturally acceptable directions, and away from other, unacceptable ends. Some cultures encourage, or at least tolerate, social-political creativity; but most, historically, probably have not. Mar'i (1976; Mar'i and Karayanni, 1983) indicates that traditional culture strictly limits religious and social creativity. Bhawuk (2003) argues that Asian-Indian society encourages religious creativity. Some cultures (or at least components within cultures), such as Renaissance Europe or Industrial Revolution America, have strongly promoted scientific and technical creativity. Others, such as "dark ages" Europe, clearly have strongly opposed creativity in those domains. Much of this seems to occur because of cultural values (James, 2004; Mar'i, 1976; Mar'i and Karayanni, 1983).

Specific contents of cultures

Different cultures are partly defined by their distinctive differences in patterns of information organization, information processing, social exchange, social collaboration, and product construction (Colligan, 1983; James, 2005; Wallace, 1971). Each culture's distinctive patterns guide the creative thinking and action of the groups and individuals within them (Bovasso, 1992; Colligan, 1983; James, 2005; Ohly, Sonnentag and Pluntke, 2006). Since creativity requires a divergence from standard operating procedures, typical associations, common usage, and normal habits, cultural patterns are raw materials for creativity and potential sources of the perceptual sets, the mental sets, the collective mental models (Phillips, 2005), and the groupthink that militate against creativity (Frensch and Sternberg, 1989; James and Eisenberg, 2004; Janis, 1972; Wagoner, 1924; Whyte, 1998).

Cultural values

A value is an enduring belief that a general mode of conduct or state of being is desirable and preferable. Values are standards that guide and determine attitudes toward, and thoughts about, objects and situations; as well as goal and motivation development. Creative performance in any particular domain (e.g., art versus science versus social

problem solving) is value-driven. Many specific cultural values (e.g., Power Distance) and dimensions (e.g., Masculinity-Feminity) can be tentatively linked to creativity (see James, 2005, for a review). There are surprisingly few direct empirical studies of the influence of specific values on creativity. More should be conducted.

Various value taxonomies exist (e.g., Hofstede, 1980, 2001; House *et al.*, 2004; Schwartz, 1992; Trompenaars and Woolliams, 2003). A consideration of the relationship of all major types of values across multiple levels of culture to creativity is beyond the scope of the current chapter. Individualism/collectivism has been the subject of psychological literature more than any other cultural dimension. Therefore, we use individualism-collectivism as an example to show how particular values may influence creativity across cultures.

Individualism/Collectivism (I/C) and creativity

In general, individualists seem mainly motivated to perform by goals (including goals regarding creativity) that are personal and that yield individual outcomes (Triandis, 1995). Collectivists, on the other hand, seem mainly motivated to perform by group-related goals and ones tied to group-focused outcomes. Indeed, some form of individualism and collectivism are essential for societies, organizations, and individuals to function. What differentiates cultures and individuals relative to I/C, then, is *where the balance between individualism and collectivism falls*, not in which cultures and individuals I/C is present and absent.

The personality-and-creativity literatures indicate that relatively high individuality promotes creativity (see Barron and Harrington, 1981; Feist, 1998, for reviews). Some recent research and theoretical work has pointed toward a more complex picture. First, there is correlational evidence that individualism or collectivism dominates an individual's personality, and shapes the *direction* (i.e., target domains) of an individual's creativity, but not overall *levels* of creativity (James, 1995; Pacey, 1983). There is growing evidence that individualism or collectivism may promote certain types of creativity, and may hinder some other types of creativity (Eisenberg, 1999; James, 1995; James and Eisenberg, 2004). For instance, cross-national comparisons indicate

that individualism correlates positively with concrete and abstract creativity in organizations; but that *collectivism* correlates positively with forms of organizational creativity that are directed primarily toward enhancing *social processes or social systems* (James, 2005; Kedia, Keller and Julian, 1992; Pacey, 1983).

Moreover, the personality literature that supports a positive relationship of individualism and creativity focuses overwhelmingly on individual-level creative performance. Creativity is, however, a collective product. Organizations seem to be expanding the use of work teams to perform all types of tasks, including creative tasks (Sundstrom *et al.*, 2000). Critical influences on team-level performance often differ from the key influences on individual-level performance (Gully, Incalcaterra, Joshi and Beaubien, 2002). The relationship of individualism-collectivism (either as an individual-personality factor or as a cultural construct) to *collective* (team, group) creativity has seldom been studied. There *is* some limited evidence, from studies of socio-cultural diversity within the U.S., that groups composed of collectivistic people perform better on shared creative tasks than do groups composed of individualistic people (Cox, Lobel and McLeod, 1991; Paulus, Laurey and Dzindoet, 2001 — see also Eisenberg, 1999; James, 2005; James, Chen and Goldberg, 1992; James, 1994; James and Eisenberg, 2004; and Janssen, Van de Vliert and Veenstra, 1999).

It seems to be the case that either individualism or collectivism can promote creativity *but* only when matched to the appropriate circumstances. An important process that may mediate the interaction of cultural (and internalized-individual) individualism/collectivism and creative task-type (individual versus group) is perceived efficacy.

I/C and Efficacy. Self-efficacy is a significant predictor and mediator of task performance. Collective efficacy is documented to have an important influence on team and organizational task performance (see the meta-analysis by Gully *et al.*, 2002). While the majority of efficacy studies have dealt with non-creative performance, efficacy may differ for creative and for non-creative tasks. Bandura (1998; 2002) argued, for instance, that change efforts are shaped by *change-specific* efficacy beliefs. In addition, a few studies have empirically supported collective efficacy specific to creative or innovation performance tasks

(e.g., Whyte, 1998; James, 2006). It seems to propose that each particular collective has non-creative efficacy beliefs that mediate its performance on non-creative, but not on creative, tasks. A second set of efficacy beliefs for *creativity* mediates its performance on creative tasks. It also seems to suggest that the creative performance of individualists (and of social entities that values individualism) should be influenced by self-efficacy for creativity. Likewise, the creative performance of collectivistic individuals (and social entities that value collectivism) should be influenced by collective creative efficacy beliefs.

Levels

I/C interactions with cultural tightness-looseness

Tightness-Looseness is a *cultural syndrome*. Cultural syndromes are defined as multiple shared elements of a culture (e.g., attitudes, economic patterns, norms, values) that come together to create a theme or an ideological scheme within a culture (Triandis, 1989; Triandis 1996; Triandis and Suh, 2002).[1] "Tight" cultures are those in which elements and ideas are tied together in a closely-knit structure (Chan *et al.*, 1996; Triandis, 1995). Such tight structuring of elements broadly discourages creativity among members (Boldt, 1976; Chan *et al.*, 1996; Mar'i, 1976; Triandis, 1995). "Tight" cultures directly proscribe novelty — and, therefore, creativity — because it necessarily weakens the existing type and pattern of cultural elements. The strong patterns of tight cultures indirectly reduce creativity by promoting rigid thinking among groups and individuals. The more tightly-woven are the contents, the less likely the individuals and groups within a culture will be able to conceive novel ways of employing or combining the contents (James, 2005; Mar'i, 1976; Osche, 1990; Simonton, 1990). Tight cultural systems promote centralized control of goals, decisions, and resources

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[1]Schwartz scheme has a similar component in his Openness to Change/Conservation value dimension. We agree with Triandis' view of a syndrome of Tightness-Looseness that includes elements beyond values. Triandis and Suh regard Individualism-collectivism as a cultural syndrome. They also term it as a cultural dimension.

that tend to broadly suppress creativity. "Loose" cultures, on the other hand, at least tolerate and possibly encourage novelty. In these cultures, heterogeneity of goals is possible; and resources are potentially evenly accessible. "Loose" cultures, therefore, encourage, creativity. At very high levels of looseness, it likely results cultural disorganization or dissolution. As such, likelihood of creativity is to be reduced (James, 2005; Simonton, 1990).

Organizations or groups and individuals within organizations have characteristics that are akin to the tightness-looseness construct (Gelfand, Lim and Raver, 2004; Nemeth and Staw, 1986). The construct is related to those such as conscientiousness, cohesiveness, and conformity (see McCrae, 1996). Group and organizational-level tightness-looseness should affect creativity in ways similar to societal-level tightness-looseness and may substantially underlie the constructs of organizational and group climates for creativity and innovation (*Viz* Amabile *et al.*, 1996; Paulus, Larey and Dzindolet, 2001). Specifically, organizational and group cultural norms for tightness or looseness will prescribe the general appropriateness of creative behavior. In other words, group or organizational tightness will limit creative behavior; looseness will encourage it. Figure 28.2 is an interactive model of Tightness-Looseness and Individualism-Collectivism as influences on creativity. We elaborate on this model from the perspective of mediating processes across multiple levels of culture and creativity.

One cross-level influence of tightness-looseness is on the *degree of sub-group differentiation* in an organization (or society). Differentiation promotes organizational creativity, by providing a broader range of raw materials, goals, guides to thinking, and emotions as inputs. Higher-level collectives attempt to bind subgroups to an overarching culture, to promote unified goals, and to specify the structure of sub-group inter-relationships. To the extent that a higher-level collective succeeds at that process, it reduces social-structural variability resulting, in turn, in reduced creativity.

Tightness/Looseness and Boundary-Spanning. Cultural tightness/looseness shapes the extent to which individuals interact with groups other than their primary one; and the extent to which individuals and groups are able to span an organization's boundary and interact
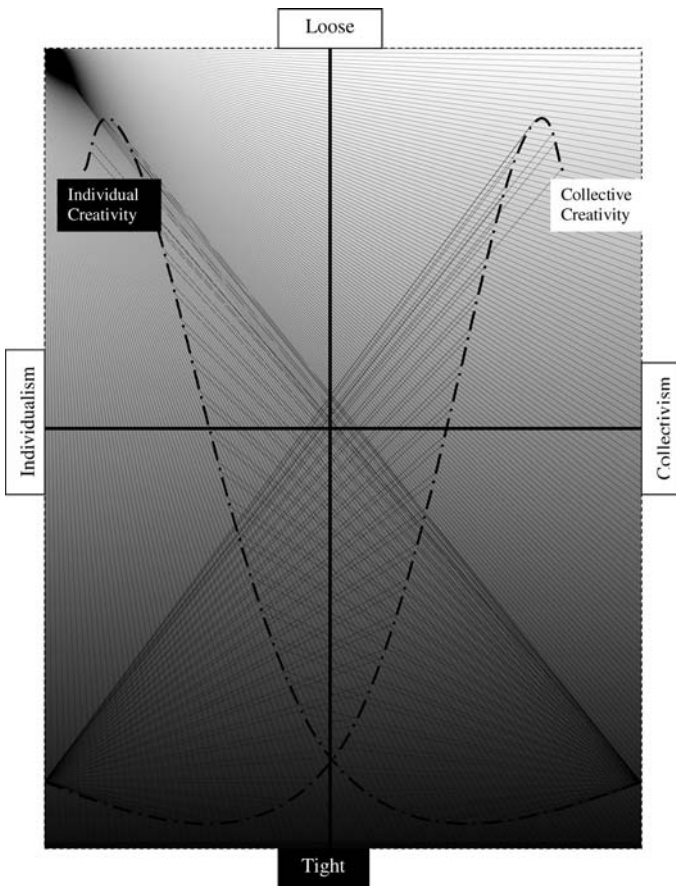
Fig. 28.2. Interactive model of Tightness-Looseness and Individualism-Collectivism.

with other organizations or relevant groups within them. The same concept extends to societies, such as in the case of relatively "tight" anti-monopoly laws in the U.S. and Europe that restrict inter-organizational mergers, collaborations and, to some extent, even inter-organizational communications. In South Korea, intensive and close inter-organizational collaborations are supported by (and closely inter-twined with) the national government.

Innovations are frequently adopted from parties outside of a defined group or organizational boundary (Osche, 1990; Simonton, 1990) or organization (Katz and Tushman, 1983). Kanter (1988) points out

that four-fifths of the 500 industrial innovations rated by experts as most important were adopted from outside sources by the organization that popularized them. Creation of new technologies seems to be facilitated by interdivisional and inter-professional interactions and initiatives (Daft, 1986; Pacey, 1983; Pavitt, 1991; Pelz, 1967; Quinn, 1975, 2000; Stone, 1971).

Cultural boundary spanning by organizations, groups, and organization members seems to promote creativity (Adler and Shenbar, 1990; Daft, 1986; Quinn, 1975). Boundary spanning provides access to information, exposes individuals and groups to ideas and to model solutions to problems, but boundary spanning weakens mental sets. The effects of patterns of perception and problem solving derived from each group are weakened by competing influences from different patterns from the other group. Mental and perceptual sets are, therefore, less likely to restrict problem-solving or idea-generation efforts. In fact, when multiple cultures occur harmoniously in the individual mind or in a collective, the guidelines each provides for perception and thinking should be mutually modified into somewhat novel patterns of cognition. Thus, the odds will increase. Creative ideas and creative productions will result.

Tightness-looseness at the societal and organizational levels should influence levels of inter-organizational boundary spanning. Culture at the organizational- and group-levels should influence intergroup boundary spanning. Boundary-spanning at all levels should partially mediate the effects of tightness-looseness on group- and individual-level creativity. Members of individualistic cultures tend to have more (but weaker) group memberships than do members of collectivistic cultures (Triandis, 1995; Triandis and Suh, 2002). Hence, a tight *and collectivistic* culture will have fewer groups than would a tight but comparatively *individualistic* culture, as the former will discourage boundary-spanning across group lines. Similarly, a loose but somewhat collectivistic culture should be *less* likely than an equally loose but highly individualistic culture to reach the point where looseness becomes (social or individual-cognitive) incoherence. The patterns just outlined account for the downward curves of the lines at the top of Fig. 28.2.

Cultural Zeitgeist: Synergist Influences of Multiple Elements of Culture on Creativity

The discussion of our model (Fig. 28.2) begins to sketch the emergence of a *Cultural Zeitgeist* for creativity. The definition of Zeitgeist is the intellectual, moral, and cultural climate or spirit of an era. Era implicates time[2] as a factor in cultural influences. An era is a distinct period of time that differs from other distinct periods. A Creative Cultural Zeitgeist is the climate or spirit for creativity that pervades and characterizes a cultural group at a distinct time period. It is similar to a cultural syndrome specific to creativity. A cultural Zeitgeist for high creative production should depend on favorable conjunction of cultural values and contents that become magnified across multiple social levels. Relative to the topic of this chapter is that a facilitative *societal cultural Zeitgeist* helps trigger and strengthens a positive *organizational cultural Zeitgeist*. That in turn triggers and strengthens a creativity-promoting *group cultural Zeitgeist* that exaggerates the creative potential and *inspiration* of member individuals. A creative contagion can result that feeds back up the levels of culture and further strengthens the Zeitgeist. Situational factors also play a role such as an abundance of raw material, favorable political and technical trends, fortuitous inputs from different but somewhat compatible cultures, and leadership for creativity. Such situational contexts set the stage for a creative cultural Zeitgeist, and interact with an existing one to channel and strengthen

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[2]Time, as used in the Zeitgeist section, is somewhat different from *time orientation* in Table 28.1. Time orientation refers to either variations across cultures in the primary time focus (i.e., past versus present versus future), or variations in the time *spans* (e.g., short-term versus mid-term versus long-term) that a culture emphasizes. Either version of it may have implications for creativity. For instance, mainstream U.S. culture may incline members toward applying creativity to relatively short-term goals and away from focusing on long-term goals. Some Asian cultures (e.g., Japanese) may incline members more toward applying creativity to long-term goals and less toward short-term focused creativity. For further discussion of the two versions of time orientation as components of culture, see Hofstede (2001), Kluckhohn and Strodbeck (1962), and Russo (2000).

it. Variations in creative cultural Zeitgeist explain the substantial variations in levels and types of creative production seen within societies and single organizations across time. Table 28.1 outlines the list of elements relevant to the creative cultural Zeitgeist (Those bolded and starred are discussed in this chapter).

Table 28.1. Consistency and differences to multi-level culture-creativity relationships.

Cultural creative invariances	Cultural creative differences	Multilevel culture and creativity
Culture* (every collective and human has it)		
Creativity* (found in some form in all cultures)		
Cultural contents→ Creative resource*	**Normative value of creativity***	**National/macro-societal**
Relationship of resource level & creativity*	Specific cultural values	Sub-societal culture
Human genetics Archetypes	Time orientation Power distance Paternalism	
Emotional moderation/mediation of creativity		
Identity mediation of culture & creativity		
Neuro-cognitive processes for creativity	*Value dimensions*	**Organizational culture***
Weak neural networks	Uncertainty avoidance-sensation seeking	**Organizational sub-cultures***
Degree of elaboration of neural connections	**Individualism-collectivism***	**Group/team cultures***
Highly developed sensory areas	Egalitarianism-hierarchy	Role cultures
Synesthesia	Humanitarinism-equity	
Opportunity finding	Masculinity-femininity	**National/societal creativity***

(Continued)

Table 28.1. (Continued)

Cultural creative invariances	Cultural creative differences	Multilevel culture and creativity
Information gathering & processing	Dominance of/accommodation to nature	**Organizational Creativity***
Domain skills and know (e.g., imagery; musical)		Sub-societal
Divergent thinking (option generation)		**Organizational creativity***
Convergent thinking		**Org sub-cultural Crea***
Analogy and metaphor		**Group/team creativity***
Mental rhythms		
Perceptual and mental sets	**Normative Patterns (rhythms)**	Role Creativity
Set breaking	Emotional moderation of creativity	**Individual creativity***
Symbol manipulation	Symbols	
Automatic (Unconscious) processing	Myths	
Preparation ⎫ Incubation ⎪ Insight ⎬ 4-stage model Logical elaboration ⎭		
Problem resolution		
Performance goals*	Goals and Goal Hierarchies	
Creative efficacy*	Behavioral norms	
Mastery goals	Reward systems (for creative goals)	
Goal conflict		
Personality		
Social processes for creativity	Social structures and groups	
Leadership		
Modeling	Role-types & role linkages to creativity	
Inspiration	*Cultural syndromes*	
Support	**Tightness-looseness***=UA/SS+E/H+	

(Continued)

Table 28.1. (Continued)

Cultural creative invariances	Cultural creative differences	Multilevel culture and creativity
Conformity/cohesion/ groupthink*	Cohesion + boundary spanning + normative	
Diversity	Value of creativity + reward systems	
Boundary spanning*		
Knowledge/idea communication		
Knowledge/skill coordination		
Social loafing		
Social conflict		
Task conflict (across individuals)		
Social rewards		
Social blocking		
Collective creative efficacy		
Group boundary spanning		
Creative assessment		
Limited evidence that some *creativity measures* are cross-culturally valid		

Summary and Conclusions

Connections between culture and creativity in organizations have been little considered and deserve substantially more attention than they have received to this point. Moreover, culture and creativity are multi-level phenomena, yet the literature on multi-level culture-to-creativity relations is rare. In an initial effort to redress these gaps in organizational science, we present a taxonomy — along with two heuristic models — with an intention to stimulate theory and research on the multi-level dynamics of culture and creativity.

We focus on only a few cultural constructs and individual and social processes that serve to tie culture to creativity. Many other multi-level

linkages of cultural patterns, creative processes and outcomes could be made. A major difficulty to researching then is, the complexity inherent in assessing, analyzing, and interpreting multiple elements of culture and multiple elements of creativity across multiple social levels. Relevant new analytic techniques have been developed (e.g., Bauer, Preacher and Gil, 2006). It is challenging to gathering such complexity of relevant data. We have faith nonetheless in the creativity of organizational scholars.

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Epilogue: Creativity Research, Ethics and Health

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The chapters compiled in this handbook represent some of our conceptions, theories, models, frameworks, research, and teaching experiences. Teachers who wish to nurture creativity have to adopt new approaches in several ways, undertaking the responsibilities of knowledge innovation, research related to learning, cognition, feeling and development within the contexts of classroom and school. For instance, in engaging learners innovatively for deep learning, Brown (1992) proposes the notion of *intentional learning* as an alternative to drill-and-practice, teacher-centered learning. In an intentional learning environment, students play the roles of researchers, teachers, and monitors of progress. Teachers adopt active role models of learning and responsive guide to students' discovery processes. The content of the curriculum is deep. Technological environment encourages intentional learning, reflection and communication. And methods of assessment focus on the students' ability to discover and use knowledge. Intentional learning encourages students to be partially responsible for creating their own curriculum.

To make informed policies and classroom practices for fostering creativity, we advocate the importance of best evidence-based education. By best evidence, we mean the best available evidence at the time of policy and classroom decision making and implementation. Adopting Harden *et al.* (1999) views on best evidence medical education, evidence for best teaching and learning can be

obtained from meta-analysis of randomized experiments, from at least one randomized controlled experiment, from one well-designed controlled study without randomization, from at least one other type of well designed quasi-experimental study, from well-designed non-experimental descriptive studies (e.g., comparative studies, correlation studies and case studies), and from expert committee reports or opinions and/or classroom experiences of respected authorities. The following dimensions are essential in evaluating educational practices: Quality (how good is the evidence?), utility (to what extent can the method be transferred and adopted without modification?), extent (what is the extent of the evidence), strength (how strong is the evidence?), the target (what is the target? What is being measured?), and the setting of context of the evidence (how valid is the evidence?).

In view of the above, we refer to some insights on the importance of vertical integration of research efforts for better teaching and learning. Buckhardt and Schoenfelt (2003) argued that research and practice foci are different at each level (i.e., student, teacher or system change), but that research and development are deeply intertwined through the entire process, from initial learning studies to large-scale systematic implementation. It goes without saying that much larger teams than currently exist will be necessary to explore at the representative teachers and system change levels. Such studies would provide the real "gold standard" for educational research—detailed documentation of what really happens when a reasonably well-defined instructional "treatment" is implemented in practice, with full descriptions of the impact of typical usage, contexts that are productive and problematic, and "side effects" that can be anticipated.

The processes of "learning *about*" and "learning *to be*" (from Bruner, 1986) are deeply interwined (Hung and Chen, 2002). Learning *about* or learning knowledge is about knowing many things or knowing that, and is about the accumulation of factual knowledge. Learning *to be* is about knowledge how, by application and practice, and happens in and with the community of practice (e.g., the likeminded learners). Learning *to be* is the appropriation of an identity through the process of enculturation. Creativity and talent development programs

thus should incorporate learning strategies and processes of mediation and scaffolding (Vygotsky, 1981), and fit somewhat well into a framework of community-based learning, where learners and experts co-work together, establish shared knowledge, in authentic tasks and through the use of appropriate technologies, and learning resources and tools (Cole and Engestrom, 1991).

In line with this aspiration, we would like to discuss the importance to undertake *use-inspired basic research* proposed by Stokes (1997) illustrated in Tan and Law (2004) in the creativity educational contexts. Stokes (1997) proposed two-dimensional model by conceptualising goals of understanding and goals of use as two distinct continua. Three different perspectives on the relationship between theory and practice arise from that assumption (Fig. E.1).

Pure basic research is represented by the Point [A] of the first quadrant of research matrix in Fig. E.1. Such research sets its focus exclusively on goals of understanding and has minimal concern on the application of knowledge to technological development and production. Pure applied research is represented by the Point [C] of the third quadrant, which only pursues goals of use without exploring theoretical understanding of the phenomena under investigation. The Point [B] of the second quadrant represents *use-inspired basic* research, which combines goals of understanding and use in conducting basic research and aims to resolve important practical problems. Tan and Law (2004)
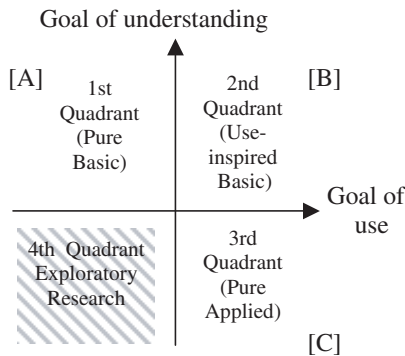
Fig. E.1.   Research matrix. *Source*: Adapted from Stokes (1997) and Tan and Law (2004).

claim that of these three kinds of research, *use-inspired basic research* has its special appeal in that it systematically links insight into learning processes and intervention for change (Fischer *et al.*, 2003). Espousing this assumption, we attempt to enhance teachers' understanding of creativity through the exposition of the related theoretical frameworks and at the same time present them some practical techniques for improving creativity. We emphatically propose that the future research in creativity should be of *use-inspired basic* type.

The scientific and practical discourses presented in individual chapters of this book are not the end by themselves but serve as the means to stimulate teachers to further pursue specific topics of interest in creativity. Specifically, teachers are strongly recommended to peruse the related literature, reflecting upon the ideas, considering counter-arguments, exchanging views with colleagues and experts, refining and reviewing interpretations, constructing alternative perspectives or action plans, implementing such plans and evaluating outcomes. Presumably, consistent practice of these activities will strengthen our creative competence.

One significant issue we have not yet addressed up to this point is ethics of creativity. For any creativity related activities such as innovation, invention, designing, entrepreneurship, and composing, the compelling concern is that ethnics cannot be removed from the equation of creativity (Glor, 2003). Specifically, it is imperative for teachers and professionals to apply their reflective thinking competencies, wisdom and compassion in responding to challenges arising in their fields and the ethics inherent in these responses. Not only should emphasis be placed on ethics pertaining to creativity related activities, but more important, to the applications of creativity. By the same token, not only creative products, but also the processes leading to such products, which normally involve experimental interventions, need to be governed by ethical standards. Creativity and its related activities are meant to improve living conditions of human beings. Hence, it is necessary for educators and researchers to reflect upon what is ethically permissible, ethically impermissible, and ethically obligatory (Clapper, 2003). While creative activities imply breakthroughs from conventional

methods, ideas or approaches, they are still bound by societal values and acceptance. Innovators, inventors, designers, composers, and creators alike need to take the questions *for what* and *for whom* into serious consideration when developing a novel product (Doughty, 2003). It is timely for professionals and scientific communities of creativity to draft out and ensure the proper use of ethical guidelines in any form of creative endeavor.

In line with the above our call for cultivating creativity includes maintaining health or well being and attaining constructive behavior. The World Health Organization (1946) defines health as a "state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity." Accordingly, the World Health Organization (2001) defines mental health as a "state of well-being in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community." This definition stresses that "mental health is not just the absence of mental disorder," but also recognizes the primacy of the positive dimension of mental health. This focus on positive mental health is echoed by Marie Jahoda (1958) in her report to the Joint Commission on Mental Illness and Health and cited by Paul Torrance (1965), one of the pioneers of creativity research. This proposed emphasis on the positive dimension of mental health is in line with the views of researchers in creativity. Simonton (2000), for instance, stated that "creativity is often seen as a sign of mental health and emotional well-being" (p. 151). Maslow (1971) and Rogers (1970) considered creativity to be an essential concomitant of the process of self-actualization. The adjective *constructive* entails connotations such as being open to all experiences (Rogers, 1961), being ethical, being humanistic, and being able to self-care and care for others. Ng *et al.* (2004) argued that "any conception of psychological well-being or wellness is culturally embedded and depends on how the notions of "well and "being" are defined and practiced in different cultural communities" (p. 317). Their review of the literature shows that people in different cultures exhibit different combinations of agency

(e.g., self-care) and communion (e.g., care for others) in order to experience psychological well-being. However, the ideal situation would call for a dialectical synthesis of agency and communion so as to experience well-being to the fullest. Related to the idea of the importance of having both dimensions of agency and communion, Bacon (2005) argued that creativity as a strength needs to be balanced by other strengths, such as wisdom, fairness, citizenship, gratitude, prudence, humility, and kindness. Creative individuals frequently lead focused lives. They hence need to cultivate strengths that assist them in balancing competing intrapersonal or interpersonal interests. To maintain health, creative activities in the form of writing, composing, or drawing can be used as a means to self-understanding, emotional stability and resolution of conflict. Cultural practices such as meditation experience associated with increased cortical thickness (Lazar *et al.*, 2005) shall be encouraged in schools and educational institution to cultivate positivity (e.g., motivation, moral maturity, unique capacities), attention, thought and cognition (elevating strength thoughts), and thus enhance subjective wellbeing (Walsh and Shapiro, 2006) and likely creativity among teachers and students.

Before closing the last chapter of this handbook, the editor would like to remark that the journey of editing this handbook was highly exciting and rewarding. We have engaged ourselves in profound reflection on the issues examined, exchange of views and ideas, open-minded discussion, and painstaking reviews. Consequently, not only the understanding of our roles as researchers and teachers has been deepened but also our creative competence has been strengthened. The editor earnestly hopes that the readers of this handbook will share similar experiences.

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