Creativity for the Gifted or for All? My Reflective Points

Tan Ai Girl, Ph.D.
Associate Professor
National Institute of Education (Psychological Studies)
Nanyang Technological University
Singapore (637616)

Abstract

Creativity since 1950 has become an increasing appealing component of education. This is especially true in many Asian countries including Singapore. Creativity is a necessary but not a sufficient component ofholistic education. Beginning with creativity for the talented, the gifted, and people with high abilities, creativity has gradually become a phenomenon of every society, and a potential competence of every person. This paper presents my views on the evolving trends of creativity in education and challenges my thoughts on who should be given the opportunity to become creative. Is creativity merely meant for the gifted or for all? Some reflective points with regard to answering this question areelicited with reference to the development of Singapore's education.

Introduction

Creativity for the Gifted Education is the conference theme selected by the Korean Society for the Gifted. I congratulate the organizing team for contacting us. I would also like to express my gratitude to the organizer for allowing me to share my reflective points on the theme from the perspectives of the Singapore's education. While I agree to provide my observation on Creativity for the Gifted Education from the context of Singapore's education, I am aware of the fact that each culture, society, and institute has its unique history and thus its paths of development. Some of the considerations to promote creativity to the Gifted and/or to all elicited in my talk can be contextual to the Singapore's society, institute or culture. These considerations might only be feasible at the time when they were introduced to the targeted group.

My talk is organized intothree parts. Part one presents an overview of the current state of art of Singapore's education and particularly on creativity education. Part two elicits some reflective points I observed from Singapore's

creativity education in relation to some theoreticalunderstanding of creativity I came across. The list of reflectivepoints is personal and subjective. It is certainly far from a complete list. Part three concludes my views on the search into who is eligible for creativity, the gifted or all people.

Creativity after 1950s

The American Psychological Association's presidential speech delivered by J. P. Guilford (1950) has been regarded as a significant document that set the momentum for the study oncreativity. Between 1950 and sixties, collectively psychologists and other researchers conceptualized what creativity is and attempted to find out how creativity could possibly work in the human minds. Rhodes' (1961) eclectic framework of creativity which includes aspects of person, product, process and pressor environment (the 4Ps) is one of the commonly received frameworks for further discourses on creativity. For years, researchers, psychologists and educators gathered in numerous occasions to conceptualize what creativity is, and how creativity takes place. For instance, selected papers presented at the first, second and third conferences of the University of Utah were compiled into an edited book (Taylor, 1964). These papers addressed others among issues related to creativity education and/or research in public schools (Jablonski, 1964; Norman, 1964) and creativity in special fields such as architects (MacKinnon, 1964), visual arts (Beittel, 1964), advertising work (Elliott, 1964), and industries (Dalta, 1964; McPherson, 1964). Soon after, the Creative Education Foundation was founded and in 1967 the first issue of the Journal of Creative Behavior was released.

Subsequently,theories of creativity developed in the eighties highlighted the importance of interactions between the person and his(her) social institutions and culture. Representative theories cited frequently by many of us include among others the Teresa Amabile's (1983) componential theory of creativity, the three systems theory (Csikzentmihalyi, 1988; 1996) and creative cognition (Finke, Ward & Smith, 1992). These theories provided us with a clear understanding creativity as a multifaceted construct, comprising general intelligence, domain-specific knowledge and skills, creative-relevant skills, motivation, personality characteristics, as well as supports from social institution and readiness of culture.

The study of creativity was also benefited from the study of giftedness, intelligence, high abilities, talents, and wisdom, and vice versa. The phenomena of high abilities such as giftedness, creativity and talents have their importance in socio-political, economic and educational interests. Hence, they have been of interest of not only the researchers but also the policymakers. Thus, one has to be clear that the understanding of the conceptions of creativity and giftedness for

instance is not the same as the interpretation and implementation of the creativity education and gifted programs and policies. The research on the construct of creativity or giftedness may have provided us with insights into individual differences and the needs for differentiated programs. The use of these findings for delineating creativity education and gifted education policies and programs may call for evaluations and reflections.

Renzulli's (1977, 2005) model of giftedness includes creativity as a component of giftedness. Other components are being task commitment and intelligence. Munich's model of giftedness developed in the eighties is a componential model; it includes personality, intelligence, motivation, talents, and giftedness (Heller 2005; Heller, Perleth & Lim, 2005). Sternberg (1985) studied implicit theories of creativity, intelligence and wisdom, and found that to a certain extent, there seems to be overlaps among these conceptions. Hence, he proposes a synthesized model, the WICS (wisdom, intelligence, creativity, synthesized) and claims its validity for the gifted leaders in the future (Sternberg, 2005). We learn from neuroscience research and findings that there is a biological base of creativity (Reuter et al., 2005 Reuter, Roth, Holve & Hennig, 2005). The argument is that if creativity is a trait then it has a biological base. Hence, creativity is a potential of all persons. If creativity is a component of giftedness, would not it fine to argue that giftedness is for all individuals?

Social psychological discourses on creativity have opened up the frontier of creativity which was once thought of to be exclusive for some people. Under these discourses, the frontiers to defence the arguments that creativity education is meant for those highly intelligent, gifted and talented has become vulnerable.The conceptions of creativity and the creativity programs gradually have included most children, if not all.

From the beginning of being conceptualized within the personal and socio-cultural milieu, the construct of creativity has beenchallenged with the notion of multiple aspects, dimensions, components, and degrees. Diversify in creativity has gradually move the conceptions of creativity and creativity education into an inclusive educational era. In line with the world's movement to provide education for all, regardless of the persons'backgrounds, creativity for all is the contemporary philosophy of creativity education. This conception of creativity fits well into today's most, if not all, policymakers', educators' and even scientists' aspirations. Emerging in the creativity literature are phenomena such as the big "C"and the little "c", multiple intelligences, everyday creativity and the like. All these point us to the fact that underway is a paradigm-shift in the conceptions of creativity and creativity education. Today, we are clear that there exists evidence of the biological base of creativity (Reuter et al, 2005 Reuter, Roth, Holve & Hennig, 2005). This confirms Guilford's (1950) view of creativity

asa trait hence a potential of every person.

The same lines of thought are observed in the literature of giftedness. One of the arguments is that traditionally gifted education is exclusive for a certain group of people, and hence it failed to fit into the educational philosophy of equity. In turn, gifted education should mean having differentiated programs for children with different learning needs and competence (van Tassel-Baska, 2005). The notion of "inclusive schools with heterogeneous classes" (Borland, 2005, p. 14) is likely convincing for educators today. Robinson (2005) prefers the notion of "promising children" or "children with promise" to gifted children. He suggests that the "promising children" should stay with their peers during school days and can be nurtured through mentorship and intensive and the like programs in vacations.

The conceptions of giftedness like those of the intelligence and creativity underwent a series of paradigm shifts. In the early years, the gifted programs were perceived as exclusive for children with special talents, excellent academic or intellectual performances, and faster learning curves that those of the same cohorts or age groups. From years of teaching experiences and research observations the outcomes of the gifted programs might not be too encouraging. Children who attended this programs either superseded their peers with extraordinary performances or ended with socio-emotional struggles such as feeling of missing of childhoodand lost of intrinsic motivation (Winner, 2000). As a matter of fact, researchers in giftedness programs realize that high school grades (a popular criterion of admission to gifted program) does not warrant success in adult life (e.g., Freeman, 2005). The challenges of gifted education likely lie in the policies and implementations of the gifted programs (Reis, 1999).

Singapore's Creativity and Gifted Education

Singapore is a young nation gained its independence in August 1965. As an island country of 699 square kilometers Singapore is situated above the equator, at the Southern tip of the Malay Peninsula. Singapore is strategically located along major air and shipping routes between China, Japan and Australia to the East and the Indian subcontinent on the West. It has a multiethnic population of 4.24 millions comprising Chinese (76.2%), Malays (13.8%), Indians (8.3%), and others (1.7%). Its population is young (median age: 35.7 years); of which 20.1% between 0 and 14 years old, 71.9% between 15 and 64 years old, and 8% 65 years old and above.

As of the year 2004, Singapore's gross enrolment ratio for elementary children (age: 6-11) was 94%, secondary (age: 12-15) 98%, post secondary (age: 16-17) 49%, tertiary (16-20) 87%. Singapore had 347 schools, of which 172 elementary (age: 6 11 years) and 158 secondary schools (age: 1215 years), and one

centralized institution and sixteen junior colleges (age: 1618 years). The school expectancy year for 2004 was 12.6. The public expenditure on education was 4% of the Gross Domestic Product. The total expenditure per student in Singapore dollars varied between $4,100 and $26,800 (Statistics Singapore, 2005). The ratio students-teaching staff was 24.3 for primary schools, 19 for secondary schools, and 10.9 for pre-university, respectively. In total, there are nine elementary schools and seven secondary schools selected for the gifted program.

Singapore's Educational Paradigms

Singapore's creativity education began as early as in 1967 when the country proposed a framework for its reform programs. Creative imagination, educational technology and morality has been three core areas. Education is "a society's method of preserving and passing down to future generations the cultural variations that have had adaptive value in the past history of socio-cultural evolution" (Simonton, 1988, p. 122). "It is also a method of evolving existing cultural variations and creating new cultural variations that have adaptive values for future socio-cultural evolution." (Tan, 1997, p. 77) For the past fourty years, Singapore's creativity education has shifted its paradigm there times. According to Kuhn (1970), a paradigm is also known as a disciplinary matrix (Kuhn, 1977) to most or all of the objects (e.g., a set of beliefs) of a group's (e.g., a scientific community) commitment. We discuss the paradigm shifts of Singapore's creativity education within the four paradigms of Singapore education: The survival-driven (SD) educational paradigm (1965-1978), the efficiency-driven (ED) educational paradigm (1979-1998), and the ability-driven (AD) educational paradigm (1999 present).

The SD Educational Paradigm (1965-1978): Under the SD educational paradigm, the main focus of the country was to provide fundamental education to its residence. Much effort was put into building physical infrastructure to enable all school-age children to learn some basic skills. One of the main contributions of educational reform was to construct comparable standards across diverse educational systems that used different languages of instruction, namely the English, Malay, Chinese, and Tamil languages. A common educational system was created when syllabi and examinations were instituted in elementary, secondary, and pre-university schools. Towards the end of seventies, all government schools adopted a common educational framework featuring bilingual education.Since then, all children learned their mother tongue (Mandarin, Malay or Tamil) as a subject and the English language as the language of instruction for all subjects. Around mid-sixties, nurturing creative imagination was one of the core elements in Singapore's education. There was no specific program for gifted students.

The ED Educational Paradigm (1979-1998): Under the ED educational paradigm,

the participation rate and achievement levels of students increased. In 1980, 20% of the same cohort passed five "O"level subjects. The percentage of passes of the same examination increased nearly threefold to 59% in 1999 and further fourfold to 82% in 2004. In 1984, the gifted education program (GEP) was implemented by the MOE in line with its policy to allow students to learn according to their pace of learning. The GEP program was mainly catered to the needs of the intellectual gifted. Only selected schools were invited to embark on the GEP. In the mid-eighties, some arts program was also introduced to selected secondary schools. Other significant events included the establishment of the Singapore Science Centre (1977) and the Institute of Education (IE). In 1991, the IE joined the NTU and renamed as the National Institute of Education (NIE). The NIE conducts all the pre-service and in-service teacher educational programs at the Diploma, post-graduate diploma, degree and post-graduate levels.

Expanded significantly during this period were opportunities for post-secondary and tertiary education. Before the turn of the century, high academic achievement was regarded as a "norm" in education. Achievement in science education in Singapore was evidently shown in the students' high scores of the Third International Mathematics and Science Study (TIMSS). For instance, Singapore 8^{th}grade science (1995: 580, 1999: 568) and mathematics (1995: 609, 1999: 604) achievements were far above the international average (1999: mathematics = 487, science = 488) in the TIMSS.

Administrative innovations were observed nationwide prior to the twenty-first century. Particularly in 1997, in line with the vision of Singapore 21 (1996) and within the framework of the knowledge-based economy (KBE), the Ministry of Education (MOE) Singapore released three major initiatives. The first initiative released in April 1997, i.e., the National Education (NE) program that intended to implant a strong sense of community among Singaporean residents (Lee, 1997). The second initiative released in May 1997 was the Information Technology (IT) master plan which transformed the infrastructures of educational institutions and skills of educational officers, educators, teachers and students (Teo, 1997). The third initiative, the Thinking School and Learning Nation (TSLN) framework released in June 1997 set thedirections for schools and other educational institutions to engage in cultivating habits of mind and constructing culture of thinking (creativity, problem solving, and critical thinking) among students of all levels (Goh, 1997). A document - the Desire Outcomes of Education (DOE) (MOE, 1998) was released spelling out values and competences of students all educational levels.

The AD Educational Paradigm (1999-present): The Singapore 21 delineates several ideals, among them "every Singaporean matters" and "opportunities for all". Accordingly, the ability-drive (AD) educational paradigm proposed in 1999

was with the intention to develop the full spectrum of talents and abilities in every childthrough *individualize* education.

The AD education paradigm built on the frameworks of the TSLN and other initiatives (e.g., National Education, Lee, 1997; and Information Technology Master Plan, Teo, 1997), and the school-year-wise educational expectations delineated in the official document "Desire Outcomes of Education" (DOE) (MOE, 1998). Within the AD paradigm, compulsory education (nine years) and restructuring of pre-school education were proposed and implemented. The DOE articulated the nation's desire to recognizecuriosity, imagination, creativity, leadership, and citizenship as a continuum effort beginning in the elementary school age. There seemed a move to *pupil-centered*, inquiry, discovery and socio-emotional learning. School textbooks and supplementary readings were revised to incorporate creativity elements.

The MOE introduced an annual work plan seminar to communicate the nation's educational aspirations to the school leaders, teacher educators, and higher educational institutional faculties and administrators. This annual seminar has been scheduled a month or more after the Prime Minister's national day rally, and built on his delineated educational directions. Over years, at the work plan seminar the TSLN framework was referred and principles were developed to educate enterprising and innovative minds (2003), effective pedagogical strategies (2004) and facilitating engaged learning (2005). In total, there were less than 10% of Singapore's elementary and secondary school children enrolled into the gifted educational programs. In sum, creativity in education has shifted from being an implicit component, to being introduced explicitly through some specialized programs, and further to explicitly a component of everyday teaching and learning. Such a series of paradigm shift in conceptions of creativity and in policies and implementations of creativity in education has challenged us to reflect upon the inclusiveness of gifted education.

Reflective Points for Creativity and Gifted Education

Learning Point 1: Social Cultural Innovations

According to Csikzentmihalyi, creativity is never a result of an individual's action; "it is the product of three main shaping forces or systems: a set of socialinstitutions, or field, a stable cultural domain, and the individual (Csikszentmihalyi, 1988, p. 325). That means, the field selects promising variations and incorporates them into the domain (culture). The domain (culture) preserves and transmits the selected new ideas or forms to the next generations. The individual processes variations and changes to the field (social institutions). The information forms the basic knowledge of a field/subject, and is stored in the

symbol system of the culture, in the customary practices, in the language, and in the specific notation of the "domain" (Csikszentmihalyi, 1988, p. 330). The three systems, namely the individual, the field and the domain are open systems. They share and exchange information freely.

In the case of creative education in Singapore, we have observed continuous evidence in socio-cultural innovations. To illustrate my view, I refer specifically to the release of the Thinking School Learning Framework (TSLN) with reference to Cskizentmihalyi's view above.

In 1997 the then Prime minister and the ministers selected the TSLN framework to be the core message of the nation's aspiration to nurture creativity, problem solving competence and critical thinkers. Prior to the release of this framework, inter-ministerial teams were formed and international study tours were conducted. Eminent researchers in the field of thinking and creativity were invited to deliver key notes at an international conference jointly organized by the Ministry of Education and the teacher educational institution. School leaders, teachers, and teacher educators were sponsored to attend the conference. In the first half day of the conference three key note speakers presented their models of creativity. In attendance were the Prime Minister, Minister of Education and other leaders in the fields of education and teacher education. Prior to and before this event, the teacher educational institution designed and conducted modules on thinking, problem solving and creativity for all initiate teachers and in-service teachers. The identified intent, i.e., to promote critical thinking, problem solving and creativity was transmitted explicitly or through infusion into the school, higher educational institution and teacher education curricula.

Various ministries (social institutions or the field) have engaged in selectingpromising thinking programs, defining desired outcomes of education which incorporated nurturing curiosity, imagination, problem solving and creativity, and identifying possible strategies such as designing new modules on thinking and creativity (variations in Csikszentmihalyi's term, 1988). These strategies aimed to construct a Singapore's *creativogenic* (Arieti, 1976) culture (domain in Csikszentmihalyi's term, 1988). The leaders and residents have communicated the selected variations in the forms vigorous educational initiatives(e.g., the Thinking School Learning Nation framework, the Innovation and Enterprise call and the Teach Less Learn More dialogues), science and technology programs (e.g., establishment of the DNA centre, the Agency for Science, Technology and Research, and the School of Biological Sciences at the Nanyang Technological University), and research mechanisms (e.g., Centre of Research in Pedagogy and Practice, Learning Science Laboratories) as well as programs that support creative industries (e.g., Beyond 2005: The Global Summit fir Creative Industries) in arts, design and media (e.g., Singapore Design Festival). All the activities engaged a chain of changes in the educational programs and

demanded structural and cultural transformations (e.g., higher number of publication in the identified area and economic return from creative industries).

Learning Point 2: Creativity is Multi-componential and is for Every Person

Sternberg and Lubart (1991) view creativity of an individual as an interactive result of his/her intelligence, knowledge, thinking styles, personality, motivation, and environment. Creativityis conceptualized from components such as an individual's dispositions, skills, types of work, and social and cultural resources (e.g., Gardner, 1993). Similarly, Amabile (1983) proposes a componential model of creativity. *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.

Creativity when it is conceptualized as a trait (e.g., Guilford, 1950) has a biological base, and hence is every person's potential (Reuter et al, 2005 Reuter, Roth, Holve & Hennig, 2005). Successful creativity education does not merely rely on the teaching of numerous techniques, skills, and expertise, but likely are dependent on "(t)he capacity to exercise control over the nature and quality of one's life in the essence of humanness" (Bandura, 2001, p. 1). Curricular developers should refer to the above mentioned components of creativity and incorporate them when they design programs and activities. Teachers should be encouraged to allow the learners to discover their creativity and use observation of real life phenomena and problem solving to arouse curiosity and interest in learning. One way of doing this is suggested by Paulovich (1993) to replace traditional classes with workshop as the latter accepts naivete, allows active learning, fosters self confidence, encouragesdiscussion, and engages critical

reading.

Learning Point 3: Multiplicity in Creativity in the IT World

The *multiplicity*of creativity highlights the existence of creativity in every facet in life and in all disciplines. Creativity is featured by two qualities, that is, novelty and usefulness. According to the field of expertise, creativity is termed differently (e.g., innovation, discovery, or invention). Technical creativity differs from scientific creativity because the former emphasizes practicality of creative products, whereas the latter focuses on discovering new theories (Quartermain & Watson, 1967).

In what way can the IT existing infrastructures in Singapore facilitate creativity in multiple disciplines?

As mentioned, nearly three fourths of Singapore's households own personal computers. All classrooms are equipped with a desktop and an overhead project. All schools should have at least one computer room with a total of 20 desktop personal computers. With the implementation of the Information Technology (IT) Master Plan (Teo, 1997), teachers in Singapore have attempted to integrate IT skills into their instructions such as using Java Applets or Blackboard as part of their web-based teaching tools. To encourage teachers to share their learning experiences through networking, MOE has started developing web-based materials and a platform for on-line discussions. Schools are encouraged to use web-based learning approaches. MOE supports the schools by providing clearinghouse services for IT resources, developing CD-ROM courseware and web-based collaborative tools. Some schools in Singapore have embarked on the on-line management, web-based assessment, and on-line courses. The desired outcome of the IT based education is to enable students technologically flexible to meet challenging job demands in a knowledge-based economy world. In the Singaporean context, the quality of human resources is regarded as a key to knowledge-based economy. Hence, life-long learning is highly regarded. The curricula of design, media, and other programs have included web-based educational formats such as e-textbooks, e-journals, and e-learning materials. Using the existing IT infrastructures as platforms for effective learning and designing, projects that engage multiple or inter-disciplinary creativitycan be proposed and encouraged. The IT infrastructures can be used by teachers of all subject matters, researchers of all disciplines to discover every learner's creativity in doing inter-institutional and international collaboration, co-operation, and sharing of ideas, resources and expertise.

Learning Point 4: Learner-Center Pedagogy

Creativity is for all, and giftedness is for individual differences. Taking this new notion in mind, it is essential for today's educators to examine and adopt learner-centered pedagogy. It is believed that this pedagogy providesthe learners the opportunities to acquire autonomous forms of motivation (e.g., intrinsic motivation) (Amabile, 1983), feelings of self-determination (Karsenti & Thibert, 1995), high internal locusof control and self-esteem (Sterbin & Rakow, 1996), which in turn have a positive impact on school performance (Fortier, Vallerand & Guay, 1995).

The process of constructing scientific knowledge demands individualized cognition through social acts in which the individual, a social being, interacts in a distinctive way with society and culture to create something. Knowing of science and doing of science are processes taken place in the historical, social, and political contexts. In these contexts, scientific knowledge is shaped through internal channels (cognitive and affective) and at the same time is influenced by external needs (the community, the society, and other individuals). Accordingly, we may suggest that the nature of science in the context of school science should look at the knower (novices), the known (experts/scientists), and the context (science contents) in which they interact. In school science, this means that the teacher-student-science triad ought to be viewed as shifting in nature, thatis, as continually co-creates with changing context and position. The relationship between the knower and the known is continuously recreated through the interaction of the subject and object and how each is positioned with the other. Learner-centered pedagogy thus should look into individualized knowledge construction processes of the learner in an interdependent environment with the presence of the teachers and the availability of scientific knowledge and skills.

Learning in technology-and-science comprises three characteristics: learning is driving by values (biological, cultural), learning as generating, testing, and regenerating of values, and the developmental and progressive nature of learning (Schaverien & Cosgrove, 1999a; Schaverien & Cosgrove, 1999b). Acknowledging the high societal status of science and science education, we regard highly the importance of inculcating positive and humanistic values and attitude toward oneself and society through science learning and science research. Knowledge is part of values, and values and the learner in turn are part of human culture. Values, either constructive or destructive, navigate accumulative directions of science and technological advancement, and hence our culture of living. The intimate relationship between science and society is revealed precisely in Russell's (1976) writing: "The effects of science are of various different kinds. There are direct intellectual effects: the dispelling of many traditional beliefs, … Then, here are effects on technique in industry and war. … [consequently led to] profound changes in social organization which are gradually bringing about

corresponding political changes. Finally, …a new philosophy is growing up, involving a changed conception of man's place in the universe." (pp. 11-12)

In teaching scientific skills and concepts, teachers are recommended to employ different approaches that can uncover children's potential such as the use of analogy, simulation, game, or role play; inquiry, investigation, problem-solving, and reflective approach. Teachers are encouraged to nurture children's creativity, innovative spirit and the ability to think independently, as well as prepare them with information technology and communication skills. Inter-disciplinary project work and enrichment programs in the life sciences are promoted. In line with these new efforts, teachers should be given supports in terms of receiving training and accessing resources. They are encouraged to take part in action research in science education and/or investigative research in science. In addition, curriculum developers can look into developing AD science curriculum materials/packages in various forms including in the electronic form (e.g. on CDROM or via web-sites).

Under the umbrella term thinking, frequent research topics are such as reasoning (e.g., Johnson-Laird, 1999), decision-making and judgment (e.g., Hastie, 2001), and problem solving (e.g., VanLehn, 1996). Analogies are forms of mental representations or mental models. Mental models can be referred to when a person makes deductive reasoning (Johnson-Laird, 1999), and wishes to represent the world (e.g., Glasgow, 1993) and situations (e.g., Johnson-Laird & Byrne, 1991). "A mental model is a representation of some domain or situation that supports understanding, reasoning, and prediction."(Markman & Gentner, 2001, p. 228) According to Johnson-Laird (1983), a mental model can be a working model of situations and events in/of the world. It is an analogical representation of reality. A mental model is never complete. It continues to be enlarged and improved as new information is incorporated into it. A conceptual model is "an external representation created by researchers, teachers, engineers, and etc., that facilitates the comprehension or the teaching of systems or states of affairs in the world." (Greca & Mareira, 2000, p. 5) Mental models are internal, personal, idiosyncratic, incomplete, unstable, and essentially functional. In contrast, conceptual models are external representations shared by a given community, and are precise and complete representations coherent with scientifically accepted knowledge. Modeling is "the learning of a series of steps to identify only those salient elements of a system, and to evaluate, according to the restrict rules, the chosen model"(Halloun, 1996, reproduced from Greca & Mareira, 2000, p. 7).

In learner-centered pedagogy, it is useful to explicitly teach procedures of modeling so that the students can construct mental models of a concept that will in turnenable them to understand the taught conceptual models. In other words,

the students who are novices can use modeling as a tool to generate mental models, which are personal constructions (make analogies, create mental simulations, as well as to make idealizations and generations), as an approach to understand conceptual models of scientists or experts (Greca & Mareira, 2000). Students should be encouraged to take part in constructing mental models when they learn new scientific concepts. They can be guided in using analogy to reason from a well-understood based domain (e.g., goreng pisang or baked banana) to less familiar concepts (e.g., mole) (Teoh, Goh, Khoo & Chia, 1997). Similarly, in teaching problem solving and particulate nature of matter, teachers can encourage students to use general problem solving strategies or models, and particulate model to develop students' problem solving skills and enhance their conceptual understanding of science). Students should be encouraged to construct insightful mental representations beyond the limited capacity of algorithms.

Concluding Remarks

The new trend of creative education that I observe in the context of Singapore's education can be summarized with the spirit of "openness". In the IT and knowledge-based economy, the human world has to operate in the mode of openness to generate and share knowledge welcoming opportunities to interact with every one within and beyond geographical boundaries, adopting vigorous and robust scientific spirit of research and teaching, as well as encouraging cross-institutional collaboration, and cross national co-operation.

Retrieving the development of creativityprogram in Singapore we learn that creativity was first introduced as a part of the thinking program for selected secondary school students in the eighties and gradually become part of every child's learning in the twenty-first century. Creativity education is open to every person, child, adult, professional and layperson. It is infused into formal and community educational program and activities. Today, in Singapore, even media and popular magazines employ the term "creativity" at ease. In the new school textbooks for elementary and secondary school children, themes and topics on facilitating original ideas and inventions are highlighted. At the school, community, and higher educational institutional levels, seminars and workshops are organized to support the nurturing of creativity spirit. This year, the spirit of Singapore's creative education gains its momentum to include developing positive characters and caring communities through social emotional learning and engaged pedagogies. The journey of creative education has just begun in Singapore, and convergent efforts and passion are crucial to ensure that this journey continues and brings benefits to every individual in the society.

The reflective points we gather from Singapore creative education can be made as a reference for gifted education. If creativity which is a potential in every

person, and creativity is a component of giftedness, then giftedness is not inherently exclusive, and thus should be inclusive for all. The gifted like the creative should first be the persons, learn to appreciate joy and love in human community, get interested in themselves and others. Only when the gifted and the creative are encouraged to open up their gifts to the others will the communities in which they live benefit from their gifts and creativeness. The conceptions of giftedness and creativity in education in the twenty-first century should include those who have the potential to be creative and gifted in one or more domains. The new trend of creative and gifted education should be the one that encourages openness and inclusion.

Note: This paper is built upon our previous papers on the theme related to creativity in Singapore's science education (Tan, Lee, Goh & Chia, 2004 &2005). Full references for these papers can be obtained from the author.

References

Amabile, T. M. (1983). The social psychology of creativity. New York: Springer Verlag.

Arieti, S. (1976). Creativity: The magic synthesis. New York: Basic Books.

Bandura, A. (2001). Social cognitive theory: An agentic perspective. Annual Review of Psychology, 52, 1-26.

Beittel, K.R. (1964). Creativity in visual arts in higher education: Criteria, predictors, experimentation, and their interactions. In Widening horizons in creativity: The proceedings of the fifth Utah Creativity Research Conference (pp. 379-395). New York: John Wiley.

Borland, J. H. (2005). Gifted education without gifted children: The case for no conception of giftedness. In R. J. Sternberg & J. E. Davidson (Eds.), Conceptions of giftedness (2nd Edition) (pp. 1-19). Cambridge: Cambridge University Press.

Csikszentmihalyi, M. (1988). Society, culture, and person: A systems view of creativity. In R. J. Sternberg (Ed.), The nature of creativity. (325-339). New York: Cambridge University Press.

Csikszentmihalyi, M. (1996). Creativity: Flow and the psychology of discovery and invention. New York: HarperCollins.

Dalta, L.E. (1964). Observations of a committee from industry on the creativity

conference. In C. W. Taylor (Ed.), Widening horizons in creativity: The proceedings of the fifth Utah Creativity Research Conference (pp. 424-436). New York: John Wiley.

Elliott, J.M. (1964). Measuring creative abilities in public relations and in advertising work. In C. W. Taylor (Ed.), Widening horizons in creativity: The proceedings of the fifth Utah Creativity Research Conference (pp. 396-400). New York: John Wiley.

Finke, R. A., Ward, T.B., & Smith, S.M. (1992). Creative cognition: Theory, research, and applications. Cambridge, MA: MIT Press.

Fortier, M. S., Vallerand, R. J., & Guay, F. (1995). Academic motivation and school performance: Toward a structural model. Contemporary Educational Psychology, 20, 257-274.

Freeman, J. (2005). Permission to be gifted: How conceptions of giftedness can change lives. In R. J. Sternberg & J. E. Davidson (Eds.), Conceptions of giftedness (2nd Edition) (pp. 80-97). Cambridge: Cambridge University Press.

Gardner, H. (1993). Creating minds. New York: Basicbooks.

Glasgow, J. I. (1993). Representation of spatial models for geographic information systems. In N. Pissinou (Ed.), Proceeding of ACM workshop on advances in geographic information systems (pp. 112-17). Arlington, V.A.: Assoc. Comput. Mach.

Goh, C. T. (1997). Shaping the future: Thinking schools and a learning nation. Speeches, 21, 3, 12-20.

Greca, I. M., & Moreira, M. A. (2000). Mental models, conceptual models,a nd modeling. International Journal of Science Education, 22, 1, 1-11.

Guilford, J. P. (1950). Creativity. American Psychologist, 5, 444-454.

Hastie, R. (2001). Problems for judgment and decision making. Annual Review of Psychology, 52, 653-83.

Heller, K. A. (2005). The Munich model of giftedness and its impact on identification and programming. Gifted and Talented International, XX, 1, 30-36.

Heller, K. A., Perleth, C., & Lim, T.K. (2005). The Munich model of giftedness designed to identify and promote gifted students. In R. J. Sternberg & J. E. Davidson (Eds.), Conceptions of giftedness (2nd Edition) (pp. 147-170). Cambridge: Cambridge University Press.

Jablonski, J. R. (1964). Developing creative research performance in public school children. In C. W. Taylor (Ed.), Widening horizons in creativity: The proceedings of the fifth Utah Creativity Research Conference (pp. 203-219). New York: John Wiley.

Johnson-Laird, P. (1983). Mental models. Cambridge: Harvard University Press.

Johnson-Laird, P. (1999). Deductive reasoning. Annual Review of Psychology, 50, 109-35.

Johnson-Laird, P. N., & Byrne, R.M.J. (1991). Deduction. Hillsdale, NJ: Erlbaum.

Karsenti, T. P., & Thibert, G. (1995). What type of motivation is truly related to school achievement? A look at 1428 high school students. Paper presented at the Annual Meeting of the American Educational Research Association (San Francisco, April 18-22).

Kuhn, T. S. (1970). The structure of scientific revolutions (2nd Ed.). Chicago: The University of Chicago Press.

Kuhn, T. S. (1977). Second thoughts of scientific paradigms (reprinted in the Essential Tension: Selected studies in science tradition and change). Chicago: The University of Chicago Press.

Lee, H. L. (1997). Developing a shared nationhood. Speeches, 21, 3, 41-52.

Lee, H.L. (2005). ICT and the knowledge-based economy.Speech by Prime Minister Singapore at the APEC CEO Summit, November 17, Busan, Koreal.

MacKinnon, D. W. (1964). The creativity of architects. In C. W. Taylor (Ed.), Widening horizons in creativity: The proceedings of the fifth Utah Creativity Research Conference (pp. 359-378). New York: John Wiley.

Markman, A. B., & Gertner, D. (2001). Thinking. Annual Review of Psychology, 52, 223-47.

McPherson, J. H. (1964). Prospects for future creativity in industry. Widening horizons in creativity: The proceedings of the fifth Utah Creativity Research Conference (pp. 414-423). New York: John Wiley.

MOE (1998). Desire Outcomes of Education. Singapore: Ministry of Education.

Norman, B. (1964). Readiness for creative explorations in a public school setting. In C. W. Taylor (Ed.), Widening horizons in creativity: The proceedings of the fifth Utah Creativity Research Conference (pp. 220-224). New York: John Wiley.

Paulovich, A. (1993). Creativity and graduate education. Molecular Biology of the Cell, 4, 565-568.

Quartermain, P.A. & Watson, J. (1967). English, engineering, and creativity. The Journal of Creative Behavior, 1, 351-365.

Reis, S. M. (1999). Reflections on policy affecting the education of gifted and talented students. American Psychologist, 44, 2, 399-408.

Renzulli, J. S. (1977). The enrichment trial model: A guide for developing defensible programs for the gifted and talented. Mansfield Center, CT: Creative Learning Press.

Renzulli, J. S. (2005). The three-ring conception of giftedness: A developmental model for promoting creativity productivity. In R. J. Sternberg & J. E.

Davidson (Eds.), Conceptions of giftedness (2nd Edition) (pp. 246-279). Cambridge: Cambridge University Press.

Reuter, M., Panksepp, J., Schnabel, N., Kellerhoff, N., Kempel, P., & Hennig, J. (2005). Personality and biological markers of creativity. European Journal of Personality, 19, 83-96.

Reuter, M., Roth, S., Holve, K., & Hennig, J. (2005). Identification of first candidate genes for creativity: A pilot study. To be published in Brain Research.

Rhodes, M. (1961). An analysis of creativity. Phi Delta Kappa, 42, 305-310.

Robinson, J. S. (2005).The three-ring conception of giftedness. In R. J. Sternberg & J. E. Davidson (Eds.), Conceptions of giftedness (2nd Edition) (pp. 280-294). Cambridge: Cambridge University Press.

Russell, B. (1976). The impact of science and society. London: Unwin Paperbacks.

Schavarien, L., & Cosgrove, M. (1999b). A biological basis for generative learning in technology-and-science Part II: Implications for technology-and-science education. International Journal of Science Education, 22, 1, 13-25.

Schaverien, L., & Cosgrove, M. (1999a). A biological basis for generative learning in technology-and-science Part I: A theory of learning. International Journal of Science Education, 21, 12, 1223-1235.

Simonton, D. K. (1988). Scientific genius: A psychology of science. NY: Cambridge University Press.

Statistics Singapore (2005). Singapore: Department of Statistics Singapore.

Sterbin, A., & Rakow, E. (1996). Self-esteem, locus of control, and student achievement. Paper presented at the Annual Meeting of the Midsouth Educational Research Association (Tuscaloosa, Alabama).

Sternberg, R. J. (1985). Implicit theories of intelligence, creativity, and wisdom. Journal of Personality and Social Psychology, 49, 607-627.

Sternberg, R. J. (2005). The WICS model of giftedness. In R. J. Sternberg & J. E. Davidson (Eds.), Conceptions of giftedness (2nd Edition) (pp. 327-342). Cambridge: Cambridge University Press.

Sternberg, R. J., & Lubart, T. I. (1991). An investment theory of creativity and its development. Human Development, 34, 1-31.

Tan, A. G. (1997). Educator roles in promoting creative thinking. Jurnal Pendidikan Tinggi, 4, 77-84.

Taylor, C. W. (1964). (Ed.), Widening horizons in creativity: The proceedings of the fifth Utah Creativity Research Conference. New York: John Wiley.

Teo, C. H. (1997). Opening the frontiers of education with information technology. Speeches, 21, 2, 92-98.

Teoh, C.C.A., Goh, N.K., Khoo, L. E., & Chia, L. S. (1997). A practical way to

infuse thinking skills into the teaching of chemistry. Zhongjiao xuebao, 23, 49-55.
VanLehn, K. (1996). Cognitive skill acquisition. Annual Review of Psychology, 47, 513-39.
VanTassel-Baska, J. (2005). Domain-specific giftedness. In R. J. Sternberg & J. E. Davidson (Eds.), Conceptions of giftedness (2nd Edition) (pp. 358-376). Cambridge: Cambridge University Press.
Winner, E. (2000). The origins and ends of giftedness. American Psychologist, 55, 1, 159-169.