



# Creative and Critical Thinking in Singapore Schools

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# **Creative and Critical Thinking in Singapore Schools**

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## **Abstract**

*This paper attempts to provide some fundamentals to help readers appreciate the conceptions of creative and critical thinking through a broad scan of the literature and findings within overseas and local contexts. The paper further provides a brief overview of the assessments used to assess creative and critical thinking to monitor how our thinking works. It brings to the fore the essential conditions for promoting creative and critical thinking. Approaches favourable to nurturing creative and critical thinking are discussed: classroom environment, teacher competencies and dispositions, and school-wide initiatives for promoting creative and critical thinking in our schools. We then suggest some recommendations for supporting teachers in their continuing efforts to promote this among students. We also make the case for the need for systematic baseline study to gauge our intervention developments so that we might better inform the Ministry of Education Singapore on recommended future directions.*

## **Introduction**

The development of creative and critical thinking skills (see Appendix A for the glossary of terms) in students is crucial for increasing a country's capability and effectiveness to cope with the changes of a transient economy in the light of globalization. In the case of Singapore, the Thinking Unit in the Ministry of Education (MOE) was set up in 1997 as a vehicle for change in developing a learning environment that includes educational institutions, teachers, parents and industries. In the same year, the "Thinking School, Learning Nation" (TSLN) initiative was launched, focusing on key strategies such as: (a) infusion of critical and creative thinking skills into the school curriculum, (b) reduction of subject content, and (c) revision of assessment modes, such as the introduction of project work. Over the years, TSLN has continued to be

an area of focus and is integral in MOE's Framework for 21st Century Competencies and Desired Student Outcomes. However, there seems to be little empirical evidence to show how successful or effective the TSLN initiative has been since its inception in Singapore schools (Yam, 2001). Much of the published research has been either case studies or intervention studies that were conducted in individual schools and over short periods of time. While some studies claim positive effects on creative and critical thinking, the development, transferability and sustainability of such effects are often not addressed.

### **Demystifying Creative and Critical Thinking**

Current views of the field recognize that creative and critical thinking are interwoven, and neither can be separated from the other (Paul & Elder, 2003, 2008). As Paul and Elder put it, "the very definition of 'creative' implied a critical component (e.g., having or showing imagination and artistic or intellectual inventiveness)" (2008, p. 4). For instance, when engaged in real-life problems, we would have to move back and forth several times between creative and critical reflection as we filter out inferior options, develop solutions or weigh the consequences of any one solution. Hence, in the process of developing an actual thought, they can be considered as a single process. Authors who subscribed to this view posit that creative thinking is the sense of thinking as a making, as a process of creating thought, as a process that brings thoughts into being to organize, shape, interpret and make sense of the world. Any critique of that making can be separated only artificially (Paul & Edler, 2008<sup>1</sup>). In the section that follows, the definitions of creative and critical thinking and how they should be assessed will be discussed<sup>2</sup>.

#### ***Creative thinking***

It is pertinent to note that many researchers have incorrectly used the notion of "creative thinking" interchangeably with "creativity"

(Puccio & Murdock, 2001). Although creative thinking and creativity are conceptually related, they are not identical. Creativity refers to the umbrella construct that subsumes creative thinking, which describes the cognitive aspect of creativity (Puccio & Gonzalez, 2004). Researchers studying creativity have generally acknowledged

the multifaceted nature of creativity, which comprises at least four discrete components. Typically classified under Rhodes' (1961) "Four P" framework, the four components include *press*, *person*, *process*, and *product*. Press refers to the social-contextual environment that influences creative behaviour. While research on the creative person relates to studies of personality traits and dispositions which are related to creative behaviour, research on creative process focuses on the cognitive processes or mental mechanisms underlying creative behaviour or activity (Kozbelt, Beghetto, and Runco, 2010). A focus on the creative product is in essence a focus on eminent creativity, also known as "Big C" creativity, which refers to the generation of a product or an outcome that is of originality (i.e., measure of creative performance; see Runco and Pagnani, 2011). Although Runco maintained that the assessment of product creativity is rarely used with non-eminent individuals, study of everyday creativity or "little c" creativity, which refers to the identification of creative products such as poems, stories and drawings, can be useful (Mallick, 2003). Notably, it is useful for research conducted in the classroom and school contexts to examine how and why students' creative ideas or products come about (Kaufman & Beghetto, 2009; Kaufman, Plucker, & Baer, 2008). Rather than solely focusing on answering "how creative is this student?", (i.e., examining an individual's personality, aptitude or measuring/quantifying one's degree of creativity), it is just as important to understand and seek insights to questions such as "how is this student creative?" and "in what ways does the student display/demonstrate his/her creative potential?" (Barbot et al., 2011). In doing so, the focus shifts from measuring a student's degree of creativity to that of identifying the context where the student puts his/her creativity strengths and talents to use, and the process through which such creativity is demonstrated.

One of the most important cognitive processes in creativity is *divergent thinking*, which is also frequently used as a synonym for creative thinking. The concept of divergent thinking was first proposed by J. P. Guilford (1956). Divergent thinking "occurs when ideas and associations move in varied directions, and as a result new and original ideas may be found" (Mednick, 1962; Torrance, 1995). Convergent thinking, on the other hand, "occurs when cognition is used to identify

one correct or conventional answer” (Kozbelt, Beghetto & Runco, 2010, p. 32). Guilford realized from his research that the cognitive process of divergent thinking is unique to creative problem solving (Russ & Fiorelli, 2010) and involves the following core skills: a) ideational fluency (the ability to generate many ideas), b) flexibility (the ability to generate different ideas), c) originality (the ability to generate original ideas), and d) elaboration (the ability to add details to ideas).

Paul Torrance, also known as the “Father of Creativity”, developed the Torrance Tests of Creative Thinking (TTCT) which is one of the most widely used assessments of divergent thinking. The five divergent thinking scales measure fluency, originality, elaboration, abstractness of titles and resistance to premature closure. Torrance (1974, p. 9) stated that the demonstration of “a high degree of these abilities does not guarantee that the possessor will behave in a highly creative manner”. Instead, many researchers (Hennessey, 2003; Torrance, 1998) have indicated that motivation is a necessary determinant of creative achievement.

Although traditional research have mainly studied the four components in isolation, modern theorists have begun to develop a multidisciplinary confluence approach to creativity (Amabile, 1983; Sternberg & Lubart, 1991), which emphasizes that the different components must work together for creativity to occur. Amabile’s landmark componential theory of creativity in 1983 integrated conceptualizations of intrinsic motivation and the social environment with the cognitive and personality constructs which earlier theorists had emphasized (Amabile & Pillemer, 2012). The theory includes the external component of social environment and three intra-individual components: (a) domain-relevant skills (expertise, technical skills and innate talent in the relevant domain, (b) creativity-relevant processes (flexible cognitive style, personality traits skill in using creative-thinking heuristics), and (3) intrinsic task motivation. Amabile and Pillemer (2012) asserted that these components combine in a multiplicative fashion, such that none can be completely absent if some degree of creativity is to occur. The social environment can influence each of the intra-individual components, and the most immediate and prevalent influence of the environment is exerted on

the motivational component (Amabile & Pillemer, 2012). Amabile, Barsade, Mueller, and Staw (2005) proposed for the construct of affect to be included. The affect construct was later shown to be particularly relevant to creative thinking and can be significantly influenced by the social environment (Amabile & Pillemer, 2012).

Although decades of creativity research have been devoted to making sense of this complex phenomenon of creativity, a number of issues have yet to be fully resolved. One of the most controversial debates in this field is whether creativity is domain-specific or domain-general. From the aforementioned systems perspectives of creativity, it seems apparent that whilst contemporary researchers acknowledge that domain-specific knowledge and skills are crucial components of creativity, they also maintain that certain generic processes transcend the particulars of any given domain. Moreover, the systems perspectives clearly indicate that none of the four Ps alone can adequately explain the emergence of creative behaviour. Hennessey and Amabile (2010) have advocated the adoption of the confluence approach to creativity to try to ascertain the interplay between the four Ps.

### ***Critical thinking***

The historical root of critical thinking can be traced back to the work of John Dewey, an early advocate and pioneer in the study of thinking (Fisher & Scriven, 1997, p. 88). Dewey defined critical thinking as "reflective thought" which involves suspending judgment, maintaining a healthy scepticism and exercising an open mind. In other words, they are activities that call for the "active, persistent, and careful consideration of any belief in light of the ground that supports it" (Dewey, 1909, p. 9). In the seminal study on critical thinking and education in 1941, Edward Glaser (p.5) defined critical thinking as: (a) an attitude of being disposed to consider the problems and subject that come within the range of one's experience, (b) knowledge of the methods of logical enquiry and reasoning, and (c) some skill in applying those methods (Fisher & Scriven, 1997, p. 88). Apparent from their definitions is both Dewey and Glaser recognized the importance of the careful consideration of dispositions (affective) aspect of critical thinking.

Modern day conceptualization of critical thinking is more encompassing, as it not only include considerations of dispositions but also the characterization of skills, (see, for instance, Kennedy, Fisher, & Ennis, 1991; Ennis, 1989; McPeck, 1990; Paul, 1995). Skills are the cognitive aspect of critical thinking, whereas dispositions are the more affective aspect (Kennedy et al., 1991). Of relevance to teaching and learning in school is Ennis's (1987) Taxonomy of Critical Thinking Dispositions and Abilities, that has greatly influenced the teaching and assessment of critical thinking. Thinking disposition is defined as a tendency to think given certain conditions, and 14 dispositions and 12 skills are listed under it as necessary in the process of "reasonable reflective thinking that is focused on deciding what to believe or do" (Ennis, 1987, p. 10). In 1990, the American Philosophical Association completed the landmark Delphi research project to articulate an international expert consensus definition and conceptualization of critical thinking for purposes of instruction and educational assessment (Facione, 1990; Facione, 2000). Experts came to a consensus that critical thinking comprises cognitive skills in interpretation, analysis, evaluation, inference, explanation and self-regulation. The common dispositions include truth-seeking, open-mindedness, analyticity, systematicity, inquisitiveness, maturity of judgment, need for cognition, curiousness and tolerance of ambiguity (Ennis, 1987; Facione & Facione, 1992).

Most of the well-known debates pertaining to the concept of critical thinking focus on whether critical thinking should be viewed as generic across different domains/disciplines or domain-specific. McPeck (1981, p. 3) argued that since "thinking is always thinking about something", and that something can never be "everything in general", there is no such thing as general critical-thinking ability. In contrast, Ennis (1989) argued that possessing a good grasp of domain-specific knowledge alone is not a sufficient condition for critical thinking. He concluded that there are general principles and strategies of critical thinking which are the same across domains and are applicable to many disciplines. According to Kennedy et al. (1991), one perspective that is often overlooked is that critical thinking requires a combination of general dispositions and abilities, as well as domain-specific experience and knowledge. In the recent years, most researchers



have accepted that whilst domain-specific knowledge plays a major role in the critical-thinking process, there exists some general critical-thinking skills that are widely applicable to different contexts (Angeli & Valanides, 2009; Tsui, 1999; Voss, Perkins, & Segal, 1991). Furthermore, the explicit teaching of thinking skills with many different types of examples (e.g., real-life tasks and problems) can promote trans-contextual transfer of critical-thinking skills (Halpern, 1998).

## **Classroom Practices and Student Thinking**

### ***Creative teacher, creative teaching, and creative learning environment***

Houtz's (1990) review of the literature revealed that a creative learning environment is characterized by democratic and open interactions, an atmosphere of safety to experiment with ideas, student-initiated and cooperative learning activities, nondirective teaching methods, and responsiveness to individual needs of students. Torrance and Myers (1970) found that when teachers create a "responsive" classroom environment, students are less apprehensive about their creative expression and sharing those ideas in class. A responsive classroom environment is optimized when teachers are "respectful of unusual questions, respectful of imaginative and unusual ideas, show that their ideas have value, occasionally have students do something 'for practice' without the threat of evaluation, and tie in evaluation with causes and consequences" (Torrance & Myers, 1970, p. 253). Environments that encourage independence, risk taking and intrinsic motivation have also been found to be the most conducive to creativity (Anderson et al., 1970; Hill & Amabile, 1993; Richardson, 1988; Shaughnessy, 1991). In creating this type of environment, it is recommended that teachers accept and encourage creative thinking, tolerate dissent, encourage students to trust their own judgments, emphasize that everyone is capable of creativity, and serve as a stimulus for creative thinking through brainstorming and modelling (Cole, Sugioka, & Yamagata-Lynch, 1999; Torrance & Myers, 1970; Woolfolk & McCune-Nicolich, 1980).

Whitlock and DuCette's (1989) categorized past research on teacher effectiveness in creative teaching into three areas: teacher characteristics, competencies and behaviours. Their review found

that teachers who are the most effective in teaching gifted children exhibit characteristics such as enthusiasm, empathy, dedication to students, personal flexibility, openness, creativity and imagination. Many studies (e.g., Dacey, 1989) have also found that the most important characteristics of effective teachers are their attitudes towards creativity and their ability to be accepting, open and flexible in relating to students. Houtz (1992) reviewed the literature on competencies of teachers in the areas of giftedness and creativity and suggested the need to develop teacher competencies in creative thinking, problem solving, experiential methods and creativities, teaching as an art, reflective thinking, and the ability to use research to guide classroom practices. These latter competencies are based on the view of teachers as “reflective practitioners” or as professionals who apply their own critical thinking, creativity and problem-solving ability to their classroom instruction (Esquivel, 1995). When teachers are exposed through training to creative methods and activities, they are likely to show attitudes and behaviours that are more receptive to their students’ creativity (McConnell & LeCapitaine, 1988; Treffinger, Ripple, & Dacey, 1968).

With regard to desirable teaching behaviours to foster creativity, Torrance’s Incubation Model (1979) of creative instruction specified three consecutive stages. The first stage of “heightening anticipation” involves activities to prepare the students to adopt a relaxed and motivated attitude and a divergent thinking state of mind. The second stage of “deepening expectations” involves engrossing students in the creative task by analysing and reflecting on the nature of the problem involved and by personalizing the problem on an affective level. The third stage of “extending learning” involves showing persistence and sustaining effort in generating new ideas or alternatives. Cropley (1997) also listed nine classroom behaviours which can foster creativity in the classroom:

- encouraging students to learn independently;
- have a co-operative, socially integrative style of teaching;
- motivate students to master factual knowledge, so that they have a solid base for divergent thinking;

- delay judging students' ideas until they have been thoroughly worked out and clearly formulated;
- encourage flexible thinking;
- promote self-evaluation in students;
- take students' suggestions and questions seriously;
- offer students opportunities to work with a wide variety of materials and under many different conditions; and
- help students to learn to cope with frustration and failure, so that they have the courage to try the new and unusual.

### ***Classroom practices conducive to critical thinking***

Past research has demonstrated that students' reasoning and critical thinking can indeed be affected by classroom practices and task structures (Ames & Archer, 1988; McKeachie, 1986; Nolen, 1988; Smith, 1977). Evidence shows that cooperative learning and group discussion promote increased use of higher order skills and higher reasoning strategies. Task structures such as focused discussion, student-led seminars, problem-based learning and role play have been shown to enhance critical thinking. In almost all studies on instructional procedures focusing on secondary and higher education, discussion and dialogue played a key role in promoting student thinking (Commeyras, 1993). Tsui (1999) described a number of more specific instructional variables. For example, critical thinking scores were found to be higher for an instructional protocol focusing on the active attribution of meaning by students; courses emphasizing inquiry and higher order thinking; courses utilizing feedback-reflecting phrases or statements to increase the quality and quantity of student responses. Assignments to give class presentations, critical analysis of papers by instructors, and taking essay exams rather than multiple-choice exams appeared to be positively related to students' self-reported growth in critical thinking (Tsui, 1999). Smith's (1977) findings demonstrated that courses eliciting a high level (number of occurrences and cognitive level) of student participation, instructor encouragement, praise and use of students' ideas, and the amount of peer-to-peer interaction were positively related to gains in critical thinking. Terenzini et al. (1995) also mentioned studies which indicated that a student's level of involvement and engagement in the classroom may have important

effects on their development of higher order cognitive functioning (e.g., Pascarella, 1989).

Halpern's (1998) model for the teaching of critical-thinking skills for transfer across domains comprises of four components: (a) a dispositional component, (b) instruction in and practice with critical-thinking skills, (c) structure-training activities designed to facilitate transfer across contexts, and (d) a metacognitive component used to direct and assess thinking. The author underlined that thinking skills need to be "explicitly and consciously taught and then used with many types of examples so that the skill aspect and its appropriate use are clarified and emphasized". As stated in Halpern (1998, p. 453), "when critical-thinking skills are to be taught so that they can be appropriately and spontaneously transfer, students learn to actively focus on the structure of problems or arguments so the underlying characteristics become salient, instead of the domain-specific surface characteristics". The author advocated that real-world tasks based on "authentic" materials which are rich in information is one teaching strategy to enhance transfer. The learning task should include the identification of relevant information that is important to the problem, as one major aspect of critical thinking pertains to the critical analysis and synthesis of information. The learning exercises should also emphasize the critical aspects of the problems and arguments that utilize the relevant skills.

## **Past and Current Creative and Critical Thinking (CCT) Research in the Singapore Context**

### ***Teacher competence and instructional practices***

Chye, Kong and Seng (2001) posited that preparing teachers to teach thinking involves equipping them with knowledge, skills, attitudes and dispositions. As stated in Tan (2004), findings from her previous research have indicated that teachers seldom conduct learning activities they believed would enhance creativity, and some of the reasons for this inconsistent behaviour included insufficient curricular time, inadequate support, feeling of incompetence and low self-confidence. Her analysis of teacher survey data also revealed a gap between teachers' perceptions of creative potential and creative ability. Whilst most teachers (91.8%) agreed that everyone has the potential to

be creative in one or more domains, only 70.6% agreed that everyone can think creatively. In addition, it was found that teachers find it difficult to remove the social stigma that creative people are less hard-working and less popular, and that creativity is only associated with those who are more academically able (Tan, 2003).

Ng and Smith (2004) examined a cultural model of creativity in the classroom, and argued that there is a paradox in promoting creativity in the Asian classroom. Their results demonstrated that cultural individualism had a positive and significant relationship with liberal-democratic teaching attitude, and a negative and significant relationship with conservative-autocratic teaching attitude. It was also found that a liberal-democratic teaching attitude had a positive impact on the tendency to promote creative but undesirable behaviours in class, whilst conservative-autocratic teaching attitude had a positive impact on the tendency to promote desirable but uncreative behaviours in class. To deal with this paradox, the authors suggested that Asian teachers need to relate to students in an egalitarian and reciprocal manner. By developing and maintaining good relationships with students, creativity can be promoted in the classroom without the surfacing of undesirable behaviours. This is in line with Tan's (2004) general framework for fostering student creativity, which stated that in addition to pedagogical competence and sufficient content knowledge, skills, and interest in teaching effectively and creatively, teachers should also cultivate dispositions related to fostering constructive creativity.

### *Singapore teachers' instructional practices and assessment literacy*

Beside the need to understand teachers' perceptions of creativity, literature also suggests teachers' instructional strategies and pedagogical methods as another important research focus. The study by Yeo and Zhu (2005) examined the types of classroom activities and the occurrence of higher order thinking in students. Their study found that Singapore classroom activities mainly involved transmission of knowledge and drill-and-practice routines. Such activities did not adequately provide opportunities for students to engage in higher order thinking, as the main mode of students' knowledge manipulation was found to be regurgitation or copying of what was taught. To

develop higher order thinking, the authors suggested that teachers create opportunities for students to engage in discussion with others, question, criticize and verify one another's workings and arguments, as well as learn through self-exploration, taking initiatives and becoming empowered in their own learning. In this regard, Koh et al. (2006) suggested that Singapore is already making some progress in this direction, as teachers are encouraged to move away from conventional didactic teaching to constructivist teaching.

Koh, Tan and Ng (2012) asserted that Singapore's exam-driven and teacher-centred assessment culture inhibits creative and critical thinking from surfacing. Koh et al. notes that this is also prevalent in other Asian societies such as Shanghai, Hong Kong, Taiwan, South Korea, and Japan. Similar to Singapore students, students from these societies are also strong in taking exams but weaker in higher order thinking and real-life problem solving (Koh, Tan, & Ng, 2012). Foo and Fan (2007) examined the effects of integrating performance tasks, specifically authentic and/or open-ended tasks in the Mathematics classroom. Results indicated that most students found that working on performance tasks challenged them to think harder and encouraged them to adopt different approaches in solving the task. The researchers asserted that exposure to authentic and/or open-ended performance tasks with non-routine problems helped students acquire higher order problem solving skills, but the teachers also played a crucial role in the implementation of these new assessment strategies.

The integration of alternative assessment strategies (project assessment, performance assessment, student self-assessment, and communication assessment) into Singapore Mathematics classrooms was the research focus of the Mathematics Assessment Project (Fan et al., 2008). The study aimed to assess the influences of these assessment strategies on students' learning of Mathematics in their cognitive and affective domain. Findings revealed that the new assessment tasks were useful in developing students' skills in higher order thinking, communication, self-regulation and self-reflection. It was also found that performance assessment appeared to be the most effective among the four assessment strategies. The overall results showed that the use of the new assessment strategies has positive or neutral influence on students' regular school exam performances.

In the Singapore Mathematics Assessment and Pedagogy Project, Fan et al. (2010) examined the integration of assessment and ICT into the teaching and learning of Mathematics, and the professional development required for teachers to implement these new approaches. The key research focus was to develop suitable Mathematics problems, or authentic “disciplinary tasks” for classroom assessment, to provide a new systematic and research-based approach to develop students’ higher order thinking skills (e.g., creative and critical thinking skills, meta-cognitive skills), problem-solving abilities (especially in Mathematics application and modelling) and other desired learning outcomes (e.g., communication skills, positive mathematics value and appreciation). Although students reported that they found the task challenging at first and they were not used to online work, findings from teachers indicated that they appreciated the pedagogical value of the SMAPP tasks, and they generally agreed that the tasks can help develop students’ logical reasoning, Mathematics application skills, and critical- and creative-thinking skills.

### ***Efforts in making thinking visible***

The general scan of Singapore’s literature also reveals efforts in terms of thinking-skills intervention and the use of ICTs to promote thinking in schools.

#### ***Thinking-skills interventions***

Yam (2001) conducted an evaluative study in Chinese High School on the effectiveness of a non-domain-specific Thinking Programme. Findings indicated that students were able to apply the thinking skills acquired through the programme not only in their academic studies, but also beyond the content-subject areas such as project work and debates. Lourdasamy, Koh and Koh (2002) also conducted a similar evaluative study in a neighbourhood school. Findings demonstrated that students who had undergone training in thinking skills performed significantly better in a standardized creativity test, and that student achievement scores in the four core subjects were all positively related to the measurements of creativity. These results appeared to indicate that the Thinking Programme has a positive impact on students’ creativity and overall academic achievement, particularly in English Language. However, while these studies tend to claim positive effects on creativity, it is not clear from the findings how

such programmes and curriculum foster creativity in students. As such, the factors that promote or hinder creativity in students through the delivery of school-based or special programmes are still not understood.

Chang et al. (2005) examined the effectiveness of the introduction of the “Philosophy for Children” (P4C) intervention (an educational programme developed to foster children’s questioning and reasoning skills). Findings showed that P4C was able to help students develop their ability to reason, to think deeper, to build on other people’s ideas, to see things from other people’s point of view and to look at an issue from multiple perspectives. Students in the experimental group felt that the lessons stimulated their thinking and have positive influence on their achievement in English, Math and Science. Teachers involved were also convinced that P4C can improve students’ reasoning skills, analytical skills, courage to disagree, communication skills and positive behaviour. Results from reasoning-skills tests also indicated that the experimental group showed significant gain in the post-test compared to the pre-test after the P4C intervention. The most notable improvement observed in student achievement was that at the end of Primary 3, five students were selected for the Gifted Programme, and all of them were from the experimental group. This was the largest number of students ever chosen for the Gifted Programme from that neighbourhood school.

### *The use of information and communication technologies (ICT) to promote thinking*

ICT can be used as tools for developing thinking skills to facilitate critical thinking and higher order learning. These tools enable learners to represent and express what they know as designers of artefacts. They construct knowledge bases, expert systems and multimedia presentations that represent personally relevant and meaningful knowledge, engaging them in higher order, mindful thinking and learning (Salomon & Globerson, 1987). When students use technologies, an intellectual student–computer partnership is established where the computer amplifies the student’s thinking. Cognitive tools are designed to make learners think harder about the subject matter being studied while generating thoughts that would be impossible without the tool. Chan (2002) shared a couple of examples



of their uses: (a) database construction is an analytical task that calls on a variety of critical, creative and complex thinking skills, (b) modelling tools allow students to show how ideas are dynamically related, (c) knowledge construction starts with the learner articulating an intention to build knowledge. That may be stimulated by a question or problem, a failure to achieve something, a general curiosity, an argument, or cognitive dissonance to want to make sense out of it.

Lim and Chai (2004) argued that ICT-based learning environment supports higher order thinking as it provides learners with more autonomy over their learning process. Students have a substantial amount of control over their rate of learning and learning sequences. Their study found that learner autonomy was essential for students to become engaged in higher order thinking and learner autonomy can be enhanced through the support of orienting activities. The five categories of orienting activities described were: introductory sessions to ICT tools, advance organizers and instructional objectives, worksheets and checklists, dialogues among participants, and tools for post-instructional reflection. In another study, Lim (2007) examined where and how ICT was integrated in Singapore schools to engage students in higher order thinking activities. The study recognized the pivotal role of the teacher in the ICT-mediated learning environment to design, revisit, revise their lesson objectives to engage students in higher order thinking activities, tapping on the affordances of ICT. Their report suggested that to support such learning environments for higher order thinking, necessary (classroom management and orienting activities) and sufficient conditions (scaffolding activities and supporting school policies) need to be in place for effective ICT integration. These two studies lend support to international research studies that have shown that ICT, primarily computer applications, coupled with the necessary pedagogical strategies, engage students in higher order thinking that supports them in constructive thinking, transcend cognitive limitations and cognitive operations that they may not be capable of otherwise (Jonassen, Carr, & Lajoie, 2000; Kearney & Treagust, 2001; Oliver & Hannafin, 2000; Salomon, 1993).

A case study by Cheong and Cheung (2008) on the effectiveness of online discussion to teach critical-thinking skills in lower secondary students found that students only minimally exhibited such skills

during the discussion. The data from the online discussion threads were analysed using the Thinking Model by Cheung and Hew (2005) to evaluate the level of information processing of students. Findings appeared to support the literature that although online discussion may stimulate critical thinking in students, most of the forum messages were about comparing and sharing information, which required lower order thinking skills. To support effective discussion on online platforms, teachers have to be aware of and knowledgeable about information-processing levels so as to scaffold students into critical thinking.

*The project work initiative to promote student thinking*

Koh and Velayutham's (2009) review identified four distinct features in Singapore's project work assessment: (a) its interdisciplinary nature, which typically integrated knowledge across two or more subjects; 2) its strong emphasis on the process skills such as planning, processing, presenting, reflecting and evaluating; (c) the requirement of both formal oral and written presentation of learning to teachers and peers; and (d) the inclusion of continuous reflective and metacognitive practices. The authors found that project work allowed for learner-centred instruction and emphasized on the authentic assessment of students' multidimensional learning. Students were able to take responsibility for their own learning, develop and apply knowledge and soft skills (e.g., inquiry skills, collaboration and communication skills, higher-order thinking, creativity, self-regulation skills) in solving real-world problems.

Yeong and Ng (2009) provided a comprehensive review of the Project Work initiative in Singapore and argued that the most pertinent challenge to its success is the deeply ingrained mind-sets of the various stakeholders, including students, teachers, school leaders and parents, regarding the goals of education. Primary school students reported that they have improved in the domains of knowledge application, communication and independent learning (Chua, 2004). At the secondary school level, improvements in students' teamwork skills, communication and social skills, problem solving skills, self-regulation and thinking skills were observed (Tan, 2002). However, a study on junior college students revealed that whilst students found that Project Work helped them in learning problem solving, conducting independent research and working collaboratively with others (Chang

& Chang, 2003), students also felt stressed and anxious about the additional workload. Since Project Work is examinable, students felt that they need to be “creative” just because “creativity” leads to good grades (Yeong & Ng, 2009, p. 118). The authors stressed that as long as Project Work is assessable, students will continue to focus on scoring well and not appreciate the more valuable and intangible learning experiences that Project Work provides.

## **Discussions and Recommendations**

NIE research and school-based studies tend to place their focuses on examining teachers’ competence and professional development, assessment modes and strategies, intervention and evaluative studies of school-based Thinking Programmes, as well as the effectiveness of ICT-supported initiatives and applications in promoting creativity and critical thinking. Against the above backdrop, the following crucial question emerges: How can teachers be better supported in their efforts to foster creativity and critical thinking in students? We shall now consider these in further detail, drawing together the findings from the above discussions to discuss some implications for supporting teachers in their efforts to promote creativity and critical thinking in students.

### ***Supportive school cultures***

Confucian philosophy may be part of the reason Singapore students lack the spirit of inquiry (Stankov, 2010). A society influenced by the Confucian culture and values uphold respect for the authority and discourage criticism of the others or the status quo. This may impede the efforts to encourage creative and critical thinking among our students and schools. Large class size, limited physical space, lack of resources, insufficient time to complete the syllabuses, and readiness of the students are among the factors that hindered the fostering of such thinking. The constraints of insufficient curricula time and the haste to cover the curriculum has often led to rigid and structured ways of teaching that leaves little room for creativity or flexibility. A supportive school culture is needed to cultivate dispositions related to fostering constructive creativity and critical thinking.

### ***Teachers’ role in promoting CCT***

Teachers are the fundamental lever for promoting students creativity. A teacher who gives learners respect and encourages confidence and

self-belief could help them maximize their opportunities to contribute to their own learning and thinking that could lead to the fostering of critical thinking. This finding has implications for our initial teacher education programme, which is to augment teachers' skills in fostering and scaffolding creativity and critical thinking. In this regard, some essential points in helping teachers uncover and develop the potential of students include:

- Teachers believe that creativity is within every individual and happens in everyday life.
- Teachers are convinced that creativity can be nurtured when the prerequisite components (e.g., motivation, intelligence, knowledge, skills) exist within an individual, and between the individual and his or her environment.
- Teachers understand that creative processes are developmental and involve the intrapersonal and the interpersonal domains.
- Teachers acquire pedagogical competence (e.g., planning lessons, selecting suitable teaching models, and managing behaviours) to cultivate dispositions related to fostering creativity (Tan, 2002).
- Teachers shift their mindset, from seeing themselves holding on to the uni-directional (hierarchical) role, as a transmitter of content knowledge, to the mind-set of themselves as facilitators, who lead their learners to explore new knowledge and to construct new ideas.
- Policy and practice need to consider how to establish, maintain and enrich student–teacher relationships as the studies have found that intensive interaction between students and teachers favour the nurturing of creativity and critical thinking.

### ***Curriculum organization and assessment***

The way in which the curriculum is presented and organized within the school day may offer greater or fewer opportunities for fostering learner and teacher creativity and critical thinking. The most common inhibitor being cited in the literature is that the teachers simply do not have time to engage in creative teaching or the training of learning strategies. There is the tendency in some teachers to over-teach and provide explicit training to predict or

arrive at one correct answer, as students prepare exams such as the Primary School Leaving Examinations and the O-Level Examination (Saravanan, 2005).

The curricula could be organized to provide optimal learning situations. Variations in activities to allow flexibility in student behaviours and to be open to unconventional classroom settings should be promoted. Multidisciplinary subjects can be promoted as opposed to discrete subjects, which may constrain learner and teacher creativity in discouraging thinking about themes which cross subject boundaries. Future research could focus on how the curriculum could be organized to stimulate creativity. The review so far has pointed towards a flexible curriculum that offers teachers and students plenty of opportunities to express and recognize that their creative- and critical-thinking skills can promote experimentation, self-directed and independent learning, and self-initiated projects.

Assessment criteria could be changed from product-oriented methods to support a process-based curriculum. Unless the criteria of assessing students' behaviours and achievement are modified to accommodate unusual ideas and unexpected behaviours, teachers and students are likely to maintain their current mindsets. To facilitate a more process-based curriculum assessment, assessment should be viewed as a feedback for how well teaching and learning have taken place. Alternative assessment should include open-ended, practical and investigative tasks.

## **Conclusion**

Moving forward, past research and current studies on creativity and critical thinking seem to have focused on efforts to promote creativity and critical thinking through developing teacher preparation and professional development programmes, changing assessment modes, introducing interventions efforts such as the Thinking Programmes and incorporating ICT in teaching and learning. There seems to be no existing systematic baseline study with respect to understanding if these efforts moving in the right direction, whether the proposed interventions are indeed helpful, or if we are measuring them correctly at the right places. It is therefore critical and urgent that we should

embark on a systematic baseline study that measures some of these interventions so that we might from these more systematic approaches subsequently inform MOE on the recommended future directions for “moulding the future of the nation”.

## **Notes**

1. For more information on the fundamentals of thinking and the use of the Intellectual Standards and Subject-Specific Standards to assess thinking, see Appendix B.
2. For more details on the Operationalisation and Measurement of Creative and Critical Thinking, see Appendix C.

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## **Appendix A: Glossary of Terms**

**Convergent Thinking** is a term coined by Joy Paul Guilford as the opposite of divergent thinking. It describes the type of thinking that brings together information focused on solving a problem and is oriented towards deriving the single best, or most often correct answer to a question.

**Creative Thinking** refers to one's ability to generate new ideas within or across domains of knowledge, drawing upon or intentionally breaking with established symbolic rules and procedures.

**Creativity** refers to the umbrella construct which subsumes creative thinking, which describes the cognitive aspect of creativity (Puccio & Gonzalez, 2004). Typically classified under Rhodes' (1961) "Four P" framework, the four components of creativity include person, process, and product.

**Critical Thinking** refers to the "reflective thought" processes which involves suspending judgment, maintaining a healthy scepticism, and exercising an open mind, i.e., activities that call for the "active, persistent, and careful consideration of any belief in light of the ground that supports it" (Dewey, 1909, p. 9). It also refers to one's attitudes, skills and dispositions in considering the problem or issue at hand that which requires one to tap on prior knowledge and experiences to solve (Glaser, 1941, p. 5).

**Dialectical Thinking** is often used to describe the type of thinking that is conducted to test the strengths and weaknesses of opposing points of view. When thinking dialectically, one would pit two or more opposing points of view in competition with each other, developing each by providing support, raising objections, countering those objections, raising further objections, and so on.

**Divergent Thinking** refers to the type of thinking that produces a variety of fresh, diverse possibilities. It "occurs when ideas and associations move in varied directions, and as a result new and original ideas may be found" (Mednick, 1962; Torrance, 1995). It is often used in contrast with convergent thinking.

**Lateral Thinking** is a term coined and popularized by Edward de Bono (1967) in his book *The Use of Lateral Thinking*. It emphasizes changing concepts and perceptions. It is concerned about reasoning that is not immediately obvious and about ideas that may not be obtainable by using only traditional step-by-step logic. Whilst critical thinking is primarily concerned with judging the true value of statements or finding a single best solution to a problem, lateral thinking is more concerned with changing concepts and perceptions in creating new ideas. For example, a person would use lateral thinking when they want to move from one known idea in creating new ideas.

**Parallel Thinking** is a term coined by Edward de Bono in 1985 to describe the thinking that focus on specific direction at any one time. When done collaboratively in a group or team, it allows the members to engage in constructive thinking and finding a way forward. It focuses on what can be rather than what is.

## **Appendix B: Inseparability of Critical and Creative Thought and the Use of Intellectual Standards and Subject-specific Standards to Assess Thinking**

According to Paul and Elder (2003), not all thinking is of the same quality. There is random or aimless thinking versus purposeful or excellent thinking. Random or aimless thinking that meanders without an organizing goal is neither creative nor critical. Purposeful or excellent thinking requires both critical and creative thinking. To achieve any challenging end, we must have criteria: gauges, measures, models, principles, standards or tests to use in judging whether we are approaching that end. The mind like our body has its own form of fitness or excellence. The fitness is caused by and reflected in activities performed in accordance with standards (criticality). A fit mind's generative power (creativity) and its judiciousness (criticality) can be separated only artificially. In the process of actual thought, they are one, and such thought is systematic.

Paul and Elder (2003) explained that intellectual work is essential to the creation of intellectual products, and that production, presupposes intellectual standards judiciously applied. The intellectual standards ultimately derive from the nature of thought itself and what we

characteristically need thought to do. Questions focused on intellectual standards (clarity, accuracy, precision, relevance, depth, breadth, logic, significance and fairness) must be applied to assess thinking (refer to Table 1).

Paul and Elder made the point that it is through the careful application of intellectual standards to our thinking that we create high-quality reasoning. Hence, these standards can be used to distinguish high- and low-quality reasoning. They also clarified that beyond universal intellectual standards, there are subject-specific standards to which thinkers must adhere in any discipline. Chemists are expected to adhere to chemical standards, historians to historical standards, sociologists to sociological standards, artist to artistic standards. Each field of art generates a vocabulary of art-specific standards and assessment occurs at multiple levels. For example, in pictorial composition, some art standards that are identifiable and intuitive to the skilled artists include:

3. Dominance, which requires that there be one object or centre in a picture of major interest, to which all other objects are subordinate.
4. Opposition, which requires that the various elements in a picture show contrast and variety of line, shape and value.
5. Balance, which requires that these contrasts create a harmonious effect.

In these, it is trite to note that “criticality and creativity work hand-in-glove, mutually dependent, mutually interacting, mutually influencing each other” (Paul & Elder, 2003, p. 30).

Table 1. Questions Focused on Intellectual Standards (Paul & Elder, 2003, p. 26).

Intellectual standards	Questions
Clarity	Could you elaborate further? Could you give me an example? Could you illustrate what you mean?
Accuracy	How could we check on that? How could we find out if that is true? How could we verify or test that?
Precision	Could you be more specific? Could you give me more details? Could you be more exact?
Relevance	How does that relate to the problem? How does that bear on the questions? How does that help us with the issue?
Depth	What factors make this a difficult problem? What are some of the complexities of this question? What are some of the difficulties we need to deal with?
Breadth	Do we need to look at this from another perspective? Do we need to consider another point of view? Do we need to look at this in other ways?
Logic	Does all this make sense together? Does your first paragraph fit in with your last? Does what you say follow from the evidence?
Significance	Is this the most important problem to consider? Is this the central idea to focus on? Which of these facts are most important?
Fairness	Do I have any vested interest in this issue? Am I sympathetically representing the viewpoints of others?

## Appendix C: Operationalization and Measurement

Divergent-thinking skills (the ability to generate ideas and solutions that are novel and appropriate) and critical-thinking skills such as induction, deduction, inference, analysis, evaluation are all *domain-general*. They can be applied and are required in all domains. But within domains, there are *domain-specific knowledge* (e.g., math procedural knowledge such as syntax, rules, algorithms) and *domain-specific skills* (e.g., arithmetic and literacy skills) which must be applied together with the domain-general skills to solve problems.

### ***Creative-thinking skills***

One of the most important cognitive processes underlying creativity is divergent thinking, which is also frequently used as a synonym for creative thinking. Treffinger pointed out that many researchers have incorrectly used the terms “creative thinking” and “creativity” as if they were interchangeable (Puccio & Murdock, 2001). Although creativity and creative thinking are conceptually related, they are not identical. Creativity can be viewed as an umbrella construct which subsumes creative thinking, which describes the cognitive aspect of creativity (Puccio & Gonzalez, 2004). The concept of divergent thinking was first proposed by J. P. Guilford in the 1950s (Guilford, 1956). Divergent thinking “occurs when ideas and associations move in varied directions, and as a result new and original ideas may be found” (Mednick, 1962; Torrance, 1995). Convergent thinking, on the other hand, “occurs when cognition is used to identify one correct or conventional answer” (Kozbelt, Beghetto, & Runco, 2010, p.32). Guilford (Guilford & Hoepfner, 1971) realized from his research that the cognitive process of divergent thinking is unique to creative problem solving and involves the following core skills:

1. Ideational fluency (the ability to generate many ideas)
2. Flexibility (the ability to generate different types or categories of ideas)
3. Originality (the ability to generate original ideas)
4. Elaboration (the ability to add details to ideas).

One of the best-known assessments of divergent thinking is the Torrance Tests of Creative Thinking (TTCT) (Torrance, 1974, 1998), which has been the gold standard for measuring creativity for over 50 years. The TTCT includes a verbal and a figural version, each with two parallel forms (A and B). The verbal version involves six activities (asking questions, guessing causes, guessing consequences, product improvement, unusual uses, just suppose) to assess three divergent thinking components (fluency, originality, flexibility), and requires 45 minutes to complete. The figural version focuses on five main divergent thinking components (fluency, originality, abstractness of titles, elaboration, and resistance to premature closure) and involves three activities (picture construction, picture completion, lines/circles) which require 30 minutes to complete.

Kim's (2006) comprehensive evaluation of the TTCT-Figural indicated its many merits, including the availability of large norming samples, and the extensive research literature which affirmed its longitudinal predictive validity over a very wide age range (Cropley, 2000; Davis, 1997). The TTCT-Figural has also been shown to be fair in terms of gender, race, socioeconomic status, culture, as well as language background (Cramond, 1993; Torrance, 1977). However, the scoring of the test is labour-intensive, time-consuming and requires specialized training, thus rendering it impractical for large-scale administration. Moreover, although Torrance (1974) encouraged the use of individual component scores instead of a single score of divergent thinking, past studies have shown concern regarding the instruments' dimensionality and factor structure (Chase, 1985; Clapham, 1998; Dixon, 1979; Heausler & Thompson, 1988; Hocevar, 1979a, 1979b; Runco & Mraz, 1992; Treffinger, 1985). These researchers have found extremely high correlations among the fluency, flexibility and originality components, and results from principal component analysis have indicated that the TTCT scores primarily reflect one latent dimension (i.e., indications that the individual components may not be measuring independent constructs). But contrary to these findings, some researchers have found evidence of discriminant validity. Runco and Albert (1985), for example, have shown that the unique variance provided by the scores for originality and flexibility dimensions in the figural version



of the TTCT produced adequate score reliabilities. Furthermore, although past findings have indicated that the fluency scale was most predictive of creative achievement, research has also demonstrated that the other components contributed additional predictive validity (Runco, 1986). These findings are consistent with other studies which have also indicated that the figural version of the TTCT may show better discriminant validity than the verbal version.

Another very influential test of divergent thinking is the Wallach-Kogan Creativity Test (Wallach & Kogan, 1965). The test consists of three verbal subtests (instances, alternate uses, and similarities) and two subtests based on visual stimulus materials (pattern meanings, line meanings). Whilst the original developers only scored the tests for the two components of fluency and uniqueness, many researchers nowadays have also begun to score the tests for flexibility, unusualness, and usefulness/relevance to reality (Cropley, 2000). As reviewed by Kogan (1983), numerous studies have provided support for the validity and reliability of this test, and all subtests were made available in the book *Modes of Thinking in Young Children* (Wallach & Kogan, 1965). More recently, Cheung, Lau, Chan, and Wu (2004) have normed the Wallach-Kogan Creativity Test for school children in Hong Kong (based on a representative sample of 1418 students from Grade 1 to Grade 9). An electronic version of this test was also developed to allow for instantaneous scoring and comparison of individual scores to norms (Lau & Cheung, 2010). The developers compared the e-version to the original paper-and-pencil version and found that the two generated similar patterns of reliability coefficients and inter-correlation coefficients for the various divergent thinking components.

Barron and Harrington's (1981) extensive review of the literature found more than 70 studies which have demonstrated positive and statistically significant relationships between various divergent thinking test scores and creative behaviour or achievement. Empirical research has also demonstrated the association between divergent thinking and academic achievement. The empirical results were largely consistent in the literature in that learners with a divergent thinking style tend to attain higher academic achievement (Fan

& He, 2012). Feldhusen, Treffinger, and Elias (1970) found that divergent thinking mode was an important predictor of senior high school academic performance. In the college context, Taft (1971) also found that divergent thinking appeared to be more beneficial to academic achievement than convergent thinking. Eastwood's (1965) study demonstrated that the relationship between divergent thinking and academic performance was stronger for Science students than for Arts students. Milgram and Livne's (2006) also concluded that divergent thinking actually relates to real-life problem solving.

### ***Critical-thinking skills***

Although various lists of critical thinking skills have been proposed over the years, certain core skills are generally accepted among scholars as necessary for good critical thinking, including skills for making inferences (Ennis, 1985; Facione, 1990; Paul, 1992; Willingham, 2007), analytical skills (Ennis, 1985; Facione, 1990; Halpern, 1998; Paul, 1992) and evaluation skills (Case, 2005; Ennis, 1985; Facione, 1990; Lipman, 1988; Tindal & Nolet, 1995). From a learning-science perspective, the top three categories of analysis, synthesis, and evaluation (sometimes the next two levels of comprehension and application are added) of Bloom's cognitive taxonomy of educational objectives (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956) are also often equated with critical thinking (Kennedy, Fisher, & Ennis, 1991). The expert panel from the Delphi research project (Facione, 1990) came to a consensus that critical thinking comprises of cognitive skills in six areas, namely interpretation, analysis, evaluation, inference, explanation, and self-regulation.

Two widely used critical thinking test instruments which are suitable for school-age children are the California Critical Thinking Skills Test (CCTST) (Facione & Facione, 1992) and the Cornell Critical Thinking Test (CCTT) (Ennis, Millman, & Tomko, 1985). The California Critical Thinking Skills Test (CCTST) consists of a series of tests which were developed to assess the same set of critical-thinking skills (analysis, evaluation, inference, deductive reasoning, and inductive reasoning) in different age groups. The CCTST M-Series for young children and adolescents utilize a multiple-choice format with questions based on everyday common sense topics. There are two alternate forms

(A and B) with items that parallel one another. According to Facione et al. (2002, p. 18), “each of the items on the CCTST was carefully chosen for its theoretical relationship to the Delphi critical thinking conceptualization”. Past research has indicated that the CCTST demonstrated adequate psychometric properties and that the scores were found to be significantly correlated with SAT scores (Facione et al., 2002). The Cornell Critical Thinking Test (CCTT) comprises Form X for students in Grades 4–14 and Form Z for advanced and gifted high school students, university students and adults. Form X consists of 76 multiple-choice items which measures four critical thinking skills (inductive inference, credibility of sources and information, deduction, and assumption identification) and requires 45 minutes to complete. Modjeski and Michael’s (1983) evaluation has indicated that the CCTT-X has adequate reliability and validity. Yeh and Wu’s (1992) study found that academic achievement was significantly correlated with CCTT scores among elementary school students and junior high school students, and there were significant positive correlations between critical thinking and all subject achievements in both grade levels. Significant positive correlation between intelligence quotient and critical thinking was also detected for all grade levels (elementary, junior and senior high).

Although not suitable for primary and lower secondary school students (only appropriate for use with persons who have at least the equivalent of a Grade 9 education), the Watson-Glaser Critical Thinking Appraisal (WGCTA) (Watson & Glaser, 1980) is a popular measure in the business and industrial/organizational settings. The original version of the test (which has two alternate versions-: WGCTA-A and WGCTA-B) comprises 80 items (that can be completed in 60 minutes) which measure five critical-thinking skills: inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments. The short form (WGCTA-S) comprises 40 items and can be completed in 45 minutes. The test is composed of reading passages or scenarios that include problems, statements, arguments, and interpretations of data similar to those encountered on a daily basis at work, in the classroom, and in newspaper or magazine articles. Each scenario is accompanied by a number of multiple-choice items to which the participant responds. Although past

research has indicated its usefulness in assessing the effectiveness of training and instructional programmes in the organizational settings, many aspects of the tests have been criticized (McPeck, 1981). For instance, Fischer and Scriven (1997) asserted that some of the questions in the WGCTA seem to measure common knowledge and political beliefs rather than critical thinking. Also, the multiple-choice questions in four out of the five sections have only two options, so guessing could well be an issue.

***Thinking dispositions: Creative personality, affect and motivation***

One major aspect of creativity research pertains to the study of personality traits. Studies in this line have tried to determine what characteristics distinguish highly creative individuals from the rest of us. "Openness to experience" has consistently been shown to be positively associated with creative behaviour and creative production (e.g., Feist & Brady, 2004, McCrae & Costa, 1987). Social personality traits such as nonconformity and introversion have also been identified as common attributes of creative people. Feist (2010) also noted that previous findings have indicated that highly creative individuals are generally not sociable or outgoing, but tend to be more independent, confident and assertive (Chavez-Eagle, Lara, & Cruz-Fuentes, 2006; Feist, 1999). As stated in Feist (2010), recent work on confidence and assertiveness has been integrated into research on self-efficacy. According to Bandura (1997), strong self-efficacy is a necessary attribute for creative productivity, and that highly creative individuals possess a high sense of self-efficacy in their domain of expertise, if not in general. Past empirical research on student creativity has provided support for this argument (e.g. Beghetto, 2006; Hill, Tan, & Kikuchi, 2008). Beghetto (2006) found that middle and secondary school students with higher levels of creative self-efficacy hold more positive beliefs about their academic abilities in all subject areas and have higher levels of educational ambition.

Motivational-affective dispositions are related to an individual's interest and desire to persist in activities and to be successful (Feist, 2010). Intrinsic motivation is often associated with highly creative thought or behaviour, and quite a body of research provided support

for this claim (Amabile, 1996; Hennessey, 2000, 2003). Other studies have also shown that motivational goals such as fear of failure, mastery goals, performance-approach goals and performance-avoidance goals are all related to creative thinking (e.g., Butler, 1995). With regard to affective dispositions, past experimental research have demonstrated that positive affect leads to higher levels of creativity (Hennessey & Amabile, 2010). Findings indicated that positive affect does not only enhance intrinsic motivation (e.g., Isen & Reeve, 2005), but also facilitates flexible thinking and problem solving even in complex tasks (Isen, 2000). However, Hennessey and Amabile (2010) have pointed out that the relationship between affect and creativity is not as straightforward, as some previous studies have shown that positive mood may promote creative productivity but not the quality of creative ideas (e.g., Vosburg, 1998).

With a more comprehensive view, Runco (2007) maintained that creative personalities and dispositions include a large number of attributes such as autonomy, curiosity, flexibility, openness to experience, preference for complexity, sensitivity, tolerance of ambiguity, intrinsic motivation, self-efficacy, positive affect and more. He also concluded that certain characteristics depend on an individual's intention and choice, in that a person can choose whether or not to be creative. This is in line with Sternberg's (2006b, p. 93) affirmation that "creativity is as much a decision about and an attitude toward life as it is a matter of ability".

Personality assessments (self-reports) and biographical inventories (observational checklists) are commonly used to determine characteristics of creative people. The Khatena-Torrance Creative Perception Inventory (Khatena & Torrance, 1976) consists of two self-rating scales, What Kind of Person Are You (WKOPAY) and Something About Myself (SAM), which are suitable for anyone aged 10 or above. The WKOPAY was designed to "yield an index of the individual's disposition or motivation to function in creative ways" (Khatenna, 1992, p. 134). It comprises of 50 forced-choice items corresponded to five measures: acceptance of authority, self-confidence, inquisitiveness, awareness of others, and disciplined imagination. The SAM was designed to reflect an individual's

personality characteristics, thinking strategies, and creative products. This instrument measures the six constructs of artistic inclination, intellectuality, individuality, sensitivity, initiative, and self-strength based on 50 statements.

### ***Critical-thinking dispositions***

The importance of critical-thinking dispositions has been heavily stressed in the literature (Facione, 2000; Halpern, 1999; Paul, 1984; Sternberg, 1985). Halpern (1999, p. 72) asserted that "critical thinking is more than the successful use of the right skill in an appropriate context. It is also an attitude or disposition to recognize when a skill is needed and the willingness to exert the mental effort needed to apply it". Scholars acknowledge that in order to effectively develop critical thinking, the disposition or inclination to think critically must also be nurtured (Facione, 2000). Some dispositions commonly mentioned include truth seeking, open-mindedness, analyticity, systematicity, inquisitiveness, maturity of judgment, need for cognition, curiousness and tolerance of ambiguity (Ennis, 1987; Facione & Facione, 1992).

The California Critical Thinking Disposition Inventory (CCTDI) is the premier tool for surveying the dispositional aspects of critical thinking. The CCTDI measures the "willing" dimension in the expression "willing and able" to think critically. The CCTDI is designed for use with the general adult population and students in Grade 10 and above. There are seven scales on the CCTDI: Truth seeking, Open-mindedness, Analyticity, Systematicity, Confidence in Reasoning, Inquisitiveness and Maturity of Judgment. Each scale score describes an aspect of the overall disposition towards using one's critical thinking to form judgments about what to believe or what to do. People may be positively, ambivalently or negatively disposed on each of seven aspects of the overall disposition toward critical thinking. The CCTDI also provides an overall score which gives equal weight to each of the seven.

As Giancarlo, Blohm, and Urdan (2004) have stated, due to the lack of suitable assessment tools, little research has been done to examine the critical thinking dispositions of elementary and secondary school students. For this reason the authors developed the California Measure of Mental Motivation to assess young students' dispositions

and motivation to engage in learning and critical thinking. The 25 items instrument measures four dimensions: learning orientation (disposition toward increasing one's knowledge and skill base), creative problem solving (disposition toward approaching problem solving with innovate ideas and solutions), mental focus (disposition towards being diligent, systematic, task-oriented, organized and clear-headed), and cognitive integrity (disposition towards interacting with differing viewpoints for the sake of learning the truth or reaching the best decision). The authors demonstrated the stability of these four disposition dimensions across different high school student samples. These four factors were also found to be correlated with measures of student motivation, GPA, and Preliminary SAT scores.

Review of literature found clear evidence that the dispositional aspect of critical thinking is different but related to the cognitive aspect in influencing performance. The study of Giancarlo and Facione (1994) based on 193 high school students found a significant positive correlation ( $r = .41$ ) between critical-thinking dispositions and critical-thinking skills. Results suggested that up to 16.8% of the variance in critical-thinking skills test scores was potentially attributable to the differences in students' critical-thinking dispositions scores (Facione, 2000). A number of studies also demonstrated that dispositional factors explained unique variance in critical-thinking performance, even after controlling for cognitive abilities (Macpherson & Stanovich, 2007; Sá, West, & Stanovich, 1999; Toplak & Stanovich, 2002; West, Toplak, & Stanovich, 2008). The positive association between the disposition of need for cognition and critical-thinking performance has been demonstrated in several studies (e.g., Halpern, 2007; Taube, 1997; West et al., 2008). Dispositions associated with openness to experience, such as intellectual curiosity and flexibility, have also been found to be important for the making of sound judgments and decisions (Perkins, Jay, & Tishman, 1993). Sá and colleagues (1999) found that scores on the disposition of actively open-minded thinking contributed unique variances to critical-thinking performance tasks. Giancarlo and Facione (2001) found that GPA was significantly related to four scales in the California Critical Thinking Disposition Inventory: open-mindedness, analyticity, systematicity, and maturity, but not significantly associated with the dispositions of truth seeking, confidence and inquisitiveness.

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