Teaching mathematics creatively

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Teaching and experience

What is teaching for? In what way can teaching transform both teachers and students to become good thinkers? In what way can teaching enrich their lives? Teaching is a profound engagement of all parties involved in cultivating humanness or full personhood. In East Asian languages (Chinese/Japanese), teaching comprises two complementary characters, developing values (教, jiao/kyo, piety) and nurturing the person (育, yu/iku). Teaching is a commitment to the inquiry of the good (善, san/zen) or human flourishing (eudaimonia). It is a collaborative and a creative experience between the teacher and the learner. Teaching facilitates cultural development. Children experience culture, form habits and forms of cultural behavior, and develop cultural methods of reasoning (Vygotsky, 1929). A person’s (Japanese, 人間, ningen, human and space) actions are embedded in the environment (Kreppner, 1992). S/he strives to achieve a real, goal-oriented self-activity. Social values and norms guide realization of his/her development (Stern, 1916/2010). Humanness (Chinese, renwen, 人文, the person and literature) emerges from collective, good and higher order thinking such as collaborative problem finding, creative problem solving and critical reflection on the purpose of life. Our compassion to live in harmony (Chinese/Japanese, 人間, he/wa, 和) with nature and with all living beings guides development of humanness, and thus creates conditions and possibilities to attain full personhood (Tan, 2014).

Teaching takes growth for goodness as the means and outcome. According to John Dewey (1859–1952), experience is situational and is a moving force of physical, moral and intellectual growth. Growth exemplifies continuity in experience, the direction toward the good. The direction of growth influences formation of attitudes of desires and purposes of teaching (Dewey, 1938/1997). Quality learning occurs when personal experiences connect to classroom experiences. As learning is dependent on teaching, learning events are understood in terms of co-participation (Davis & Sumara, 2010). Teaching and learning occur in interaction spaces. Interaction which mediates and precedes development (Ponomarev, 2008a) is ongoing between a person and objects and with other persons (Dewey, 1938/1997). Space (Japanese, 場所, basho) is “the field in which the Self and the Other unfold their identity and at the same time their difference” (Botz-Bornstein, 2007, p. 274). In spaces of interaction the teacher and the learners transform constraints productively. Personhood emerges from the social and relational, humanistic spaces. We experience profound meanings in lives.
Mathematics and thinking

What does teaching mathematics mean for the teacher and the learners? How does mathematics learning and teaching relate to everyday life? Mathematics comprises information (i.e., memorization, recollection, reproduction) and know-how (i.e., judgment, originality, creativity) (Polya, 1962). Using an axiom, L. Burton (1984) sees thinking as “the means used by humans to improve their understanding of, and exert some control over, their environment” (italics in original, p. 35). Accordingly, he regards mathematical thinking as a style of thinking that uses particular means to improve our understanding of the environment. These particular means can arise from or pertaining to the study of mathematics: Operations, processes, and dynamics. Operations are tactics (e.g., ordering, making a correspondence), processes are orientations (e.g., generalizing), and dynamics link the cognitive (e.g., manipulating) and the affective (i.e., enter–attack–review). To Burton (1984), events (ideas, observations, and happenings) can provide stimuli to begin thinking and are elements on which mathematical thinking operates. Mathematical thinking uses means (operations, processes, and dynamics) that can be recognized as arising from or pertinent to the study of mathematics. Mathematics literacy unfolds in problem solving, mathematical modeling, conceptual understanding, development of critical thinking, the use of technology, probability and statistics, as well as cooperation between mathematics and other fields (Gordon, 2010). New frameworks of mathematics such as those used in Singapore (MOE, 2012) denote clearly the aim of learning mathematics for preparing citizens for a productive life. Mathematics learning shall enhance curiosity in exploring life and shall be useful for life (Whitehead, 1929; Woodhouse, 2012). In teaching mathematics, teachers guide students to inquire into life. Mathematics can serve as an instrument for arriving at effective strategies for good citizenship, and as a tool for cultivation of personhood.

Mechanisms in creative teaching

What are mechanisms of creating new experiences in teaching and for cultivating good thinking? Learning starts with the cycle of joy of discovery (romance, in Whitehead’s term) individually or in group. During this cycle, the learners pose questions, seek answers, and enhance interest in learning with curiosity for a relatively long duration. The cycle of precision follows. The learners gain the ability to pursue knowledge and develop discipline from within for a relatively short period of time. During the cycle of generalization, the learners maintain the balance of having freedom and cultivating self-discipline. They experience freedom to learn broadly and deeply connecting generalized abstract contents to concrete experiences (Whitehead, 1929; Woodhouse, 2012). The learners gradually see relations between mathematical concepts, operations, and vocabularies (see Burton, 1984). Teachers vary methods of teaching to induce and sustain interest in learning. They prepare instructions to meet the level of development of the learners. Stories of mathematicians (Woodhouse, 2012) trigger interest in acquisition of domain relevant skills and creativity-relevant skills (Amabile 1983a, 1983b). Teachers use concrete means to teach abstraction of mathematics, as well as apply mathematics thinking to solve everyday problems (Woodhouse, 2012).

Creativity in teaching for good thinking depends on openness to all experiences, variations in teaching (divergence), coherence in teachers’ and students’ beliefs in mathematics (convergence), and boundary-crossing knowledge creation (emergence) (Lim, 2007). Experience is the basis of imagination; and imagination is a new experience (Vygotsky, 2004). Two aspects of quality experience are important for creative teaching: Immediate agreeableness or disagreeableness, and influence on the later experience (Dewey, 1938/1997). Pure (immediate) experience is the basis from which the subject–object correlation can emerge (Noda, 1955). The truth of mathematics
is guaranteed by the evidence of pure experience. Pure experience is free from egocentricity. Mechanisms for creating new experiences (Tan, 2014) include: Divergence (differentiation: dissociation, distortion, Vygotsky, 2004), convergence (integration: association, combination, Vygotsky, 2004), and emergence (transformation: personhood, humanism). Teaching turns life into one full of creativity (Suzuki, 1986). The creativity in teaching is constructive (Rogers, 1961).

**Divergence.** In creative teaching, divergence involves changes in sets of instructions, strategies, methods, and habits of mind. To meet the needs of the learners, the teacher differentiates instructions and diversifies activities. Distractors that promote learning are employed skillfully to dissociate the minds from information overload. Play and games are introduced appropriately during lessons. Reproductive activities such as recall or memorization (e.g., what is 3 x 4?) complement productive activities (Vygotsky, 2004) such as imagination (e.g., what decision would I make were there three routes and four modes of transport to go to school?) or solving ill-defined problems (e.g., I want to buy nutritious food and have three dollars. I would like to buy three carrots and four tomatoes. Which grocery store should I go to so that I get the best offer for carrots and tomatoes?). The theory of unconscious thought espouses that when we are at a low energy level, we use unconscious thought or processes (Bos, Dijkstra, & van Baaren, 2012). Unconscious thinkers use a bottom-up, unbiased strategy (Bos & Dijkstra, 2011). The default brain, which is adaptive, engages in intrinsic activity, self-regenerated thought, spontaneous cognition, mind wandering, or free association (Callard, Smallwood, & Margulies, 2012). The holistic mind is synthesized and creative; the intellectual mind is analytical and contemplative (Suzuki, 1986).

**Convergence in divergence.** Convergence is related to changes of sets of elements such as combining experiences and associating thoughts. Convergence in divergence occurs when concepts are put together or when components are organized systematically. External (e.g., connection) factors and internal (e.g., imagination) factors converge in coherence within cultural development. In effortful creativity, the prepared mind experiences both convergent (evaluation of novelty) and divergent (generation of novelty) production (Cropley, 2006). In the classroom, teachers adopt multiple roles (divergence) and form role-identities (convergence in divergence) that facilitate a series of activities such as content delivery, management of time and task, design of instruction, and facilitation of personalized and group learning.

**Emergence.** While in convergence in divergence a person’s change is within the state of being, in emergence a person experiences a change for becoming a good citizen. Emergence emphasizes a qualitative change in a set of a system’s elements (Kastenhofer, 2007) and growth within the existing whole (Zittoun, Baucal, Carnish, & Gillespie, 2007). It is reflective, unpredictable, processual inter-subjective, and non-reducible to models of participating agents (Palmquist, 2007; Sawyer, 1999). Emerging teaching is a transdisciplinary process and a prerequisite for creating possibilities to face and to solve real life problems. In dialogues the teacher and the students reflect upon goals of learning, and create collaboratively positive attitudes toward achieving a good life (Gillespie, 2005). Emergent mathematics highlights the collective character of mathematics for teaching and the tacit nature of teachers’ mathematics knowledge (Davis & Renert, 2013).

**Multi-componential lessons**

**Multi-system organization**

How does a classroom for nurturing good thinking like? A mathematics classroom is like a multisystem organization comprising two open systems, teachers and students (a teacher and 25...
to 40 students) who are partners of learning (Tan, 2000). Organization in the classroom refers to relations among pupils, and their relations to the teachers (Dewey, 1938/1997). Open systems maintain stability or being as well as emphasize growth or becoming (Allport, 1960). Each system performs a specific function. The systems interact, and bring about creative objects or behaviors (Csikszentmihalyi, 1988). Cultures are resources and products of creativity (Vygotsky, 2004). As open systems, cultures preserve sustainable variations selected by the social institutions (Csikszentmihalyi, 1988). Materials and social cultural experiences interact with children and trigger development in their abilities to represent, imagine, invent, combine, synthesize, and to “think on the head” (Ponomarev, 2008a). Mental elements include ideas, theories, and images (Sawyer, 1999). According to Tan (2000), teachers and pupils also interact with other (open) systems such as social institutions and culture. In this manner, teachers and pupils are connected to the social world. The immediate social institution is the school, whereas examples of distant social institutions are interest groups, community academies, professional associations, and ministries. Outside the classroom and in the school, pupils interact with other teachers, fellow senior and junior pupils, as well as the administrative staff. Social institutions such as the ministry of education and ministry of family and community services do not have direct contact with the pupils but exert influence on their learning environments. Events in the society and cultural aspirations influence the climate of learning in the classroom, and how teaching integrates learning for the future.

Coherence in components

Mathematics lessons comprise basic pedagogical components, creativity components, interaction components, and assessment components (Tan, 2000), which organize in coherence for transformative pedagogy and inclusive learning. Coherence is about causally linked topics, tasks, activities, components in terms of instructional content and meaningful discourse which reflect the connectedness of a topic, a task, an activity or a component with the other topics, tasks, activities, or components (see Chen & Li, 2009). Physical movement is in coherence with freedom of thought and judgment. Coherence exemplifies the mechanism of convergence in divergence in lesson preparation (e.g., planning), lesson implementation (e.g., managing, communicating), and lesson evaluation (e.g., evaluating).

Teachers’ knowledge of the subject matter and pedagogical content knowledge are factors that influence coherence in instruction. According to Shulman (1987), pedagogical content knowledge refers to “the blending of content and knowledge into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of the learners and presented for instruction” (p. 8). Coherent instruction enhances deep learning. It spreads over a series of lessons of the same theme of learning. In coherent instruction, purposes or objectives of the lessons are formulated to align processes with outcomes of subject matter (planning). Teachers use a content-based approach to teaching mathematics (Brousseau, 1986). Lessons are structured in a cyclic and iterative sequence (managing): reviewing (prior knowledge), introducing new content, and closure. Instructional coherence includes coherent vision of knowledge through classroom structure and discourse. Curricular and instructional coherence facilitates coherence in representations (i.e., use of graphs, writing, and verbal presentation), contextual application (i.e., application of knowledge to various contexts in everyday life), and conceptual understanding (i.e., how concepts are related to each other) (Savinainen & Viiri, 2008) (communicating). Students and teachers share similar beliefs, values, and attitudes toward mathematics learning (Lim, 2007). Teachers incorporate content delivery into a series of activities (individual and group) that link to each other. They summarize the contents and deliver homework at the end of each lesson (evaluating).
Basic components. Basic components of a creative mathematics lesson include teachers’ curricular and content knowledge, pedagogy, developmental psychology, and pedagogical content knowledge (Deng, 2007; Shulman, 1987). Teachers deliver coherent instructions that connect behavioral and time management as well as that support effective content learning (see also Hansson, 2010). They recognize talents and special needs of individual children (e.g., visual thinking and sensory oversensitivity, Grandin, 2013). Teachers acknowledge multiplicity in levels of knowledge. Knowledge can be at the contemplative level, the empirical level, or active-transformative (practical) levels (see Ponomarev, 2008b). The child’s experience moves from concrete to abstract. For example, in counting, children move from unclear understandings of counting to counting with their fingers to mental counting (Vygotsky, 1929). Intellectual activity development is a continuous engagement in processes and successive advancements in our zone of proximal development (ZPD). In proximal space or ZPD, we reproduce a response, frame a problem and a solution, reproduce personal creativity, frame and solve problems with intuitive insights and conscious verbalization, and complete awareness of one’s action at the internal plan of action and for assessment by experts (Popov, 2010). Teachers introduce contents of mathematics innovatively such as with reference to the history of mathematics. They induce transformational learning such as using sensations to see the relations among objects in the world (Whitehead, 1916).

Creativity relevant components. Creativity relevant components of a mathematics lesson include teacher’s knowledge of creativity, knowledge of creativity in teaching, knowledge of creativity development, and pedagogical content knowledge for teaching mathematics. Knowledge of problem solving enables the learners to use information available to search for possible solutions. In creative lessons teachers put emphasis on the creativity skills that are integrated into the learning of subject knowledge (Montgomery 1997). Creative problem solving involves in a series of cyclic and iterative processes such as divergent thinking, convergent thinking, evaluation, and implementation (Brophy, 1998; Guilford, 1950).

In creativity development, the unperceived part of an action (in direct experiences) can be more important than the perceived part of an action (in subjective experience) (Ponomarev, 2008a). Children’s creative expression progresses from play, drawing, speech, and drama, to verbal and written communication (Vygotsky, 2004). They experience transformational learning and everyday creativity (Kauffman & Beghetto, 2009). Young children use diagrams or symbols to represent their ideas (iconic representation). Tools (psychological, technological) mediate development of higher mental functions (Kozulin, 1998). Tools of creative teaching include dialogues (Tan, 2014), conversations, and other innovative pedagogies which create space for different thoughts and ideas to converge. Conversations involve “interlocking consciousness—a quality of interpersonal engagement” (Davis, 2004, p. 177). In dialogue, teachers and students enact their values, beliefs, and assumptions within the existing frame of teaching and learning. Teachers and students negotiate their differences to find out ways to establish coherence in interaction for collaborative creativity. Intersubjectivity is about how a coherent interaction can proceed even when they have different representations (Sawyer, 1999). Through negotiation of intersubjectivity, the frame is transformed at the level of meta-communicative (Sawyer, 1999), which has an “indirect pragmatic effect to define the nature of the ongoing interaction itself” (p. 457). Within the transformed frame, students internalize speech and representation systems in actions and interactions (Wertsch, 1985). Dynamic visuals in the forms of video clips, social media, internet, and other virtual platforms facilitate authentic learning (Goh, 2012).

Assessment components. The responsibility of teachers is twofold, that is, giving purpose and overall direction to the goals of learning, and allowing students realistically to feel that they
play a role in determining social life in a classroom (Sarason, 1993, p. 43). Teachers can employ innovative assessments (see Campbell, 1997) that allow independent and interdependent learning. Pupils reflect in processes of learning and reflect on outcomes of learning (Schoen, 1987). Reflections serve as guides for (re-)construction of effective conditions for mathematical learning (Hansson, 2011). Open-ended assessment provides spaces for creative learning in mathematics (Hor, 2013). Self-efficacy of a person is enhanced when s/he experiences successes and constructive feedback for improvement, as well as when s/he receives persuasion to take part actively in a task (Bandura, 2001).

**Interaction components.** Interaction components include the learning climate and environment. Climate of learning is dependent on interactions among pupils, who are contemporaries, partners, or rivals who usually possess a similar repertoire of mental elements (e.g., methods, and questions) (Simonton, 1988a, 1988b). Environments include conditions that interact with the personal needs, desires, purposes, and capacities to create experience (Dewey, 1938/1997, p. 44). Experience of the child is an indicator that s/he attains mental development that reflects his/her affective relationship with the environment (Bozhovich, 2009). Positive emotions (e.g., joy, pride, and contentment) broaden cognitive repertoires of skills, and build personal and social resources for resilience and creative problem solving (Fredrickson, 1998, 2001). Intrinsic motivation (Amabile, 1983a, 1983b) facilitates an ongoing task commitment. Games and quizzes (see Baer, 1994) invite participation and create spaces for interaction. Humor and love maintain humanism even under unavoidable suffering conditions (e.g., tsunami, earthquake, cultural revolution, and anti-Semitism) (Frankl, 1984).

**Multiple roles and supports**

**Role-congruence**

The teacher in the learning organization adopts multiple roles. “*The role of the teacher is one of coaching, managing and arranging the learning environment*” (italics in original, Sarason, 1999, p. 43) A teacher defines his/her role, and accordingly selects suitable pedagogical approaches, materials, and activities. Role-congruence is essential in attaining effective and creative teaching. “Congruence” refers to subjective fit (Edwards & Cable, 2009) of a person’s values, behavior, beliefs, and attitudes with those of other persons, organizations, social institutions, and culture that can possibly induce positivity, desire, interest, and motivation to change, adopt, adapt, cooperate and collaborate. In a multisystem classroom, teacher role is like the role of consciousness in the individual (Davis, 2004, p. 178). Teaching is being mindful in the collective (Davis, 2004). Congruence exemplifies convergence in divergence in teachers’ readiness to undertake roles for mentoring, innovating, managing, and arranging the classroom environment for learning.

Teachers adopt roles in teaching in the classroom to match the needs and reactions of pupils. The selection of a role is bound to the influence of the type of content, instructional activities, assessment, resources, and current educational policies. During a lesson, teachers adopt selectively one or multiple roles simultaneously or in sequence. Teachers are actors, who initiate and engage in creativity actions and activities, and who turn creativity to affordable products (Glaveanu, 2012). Social processes facilitate learning and development of minds (Wertsch, 1985). Teachers are predecessors and experts who can pass on selected cultural and social variations to the young (Mercer, 1995). Scaffolding, imitation, observation, and the like tools are employed to facilitate development of higher mental functioning and construction of meanings in mathematics (Kozulin, 1987; Tan,
Teachers mediate learning by assuming their active role in facilitating learning when they acknowledge children’s actual and zone of proximal development (Vygotsky, 1978).

**Role-supports.** Creative teaching depends on ample supports that teachers receive so that teachers are motivated intrinsically to engage continuously in inventing and re-inventing teaching (Davis, 2004) for the growth of the students. A teacher needs support from his/her colleagues and students’ parents to sustain his/her motivation to adopt multiple roles in teaching and to invite co-participation from the students. Role-support that manifests in words and/or behaviors, intentionally or unintentionally, confirms the contents of a role-identity. A teacher can have multiple identities associated with a given role, and can have multiple roles associated with a given identity (Petkus, 1996). The role-identity theory (McCall & Simmon, 1978; Petkus, 1996) indicates that the role-identity, role-performance, and role-support function in a cyclical relationship. A teacher with a given role (e.g., a creative mathematics teacher) undertakes role performances (e.g., creating environments that include learners with learning difficulties) that are designed to elicit role-support (e.g., policies of creative education and inclusive classroom) which reinforces the role-identity.

**Professional development**

Teachers develop competencies to connect mathematics contents, pedagogical content knowledge, and practical pedagogies of everyday life. An analysis on data from 18 participating countries of the *Trends in International Mathematics and Sciences Studies* (TIMSS) recommended that schools have supportive environments to retain teachers (Hong, 2012). Teacher experience is a predictor of students’ success in mathematics. The analysis suggested that professional developmental programs are essential for in-service and prospective teachers to deepen teacher competencies to reconstruct mathematics and mathematics education to empower culture. To teach creatively, teachers need to be granted supportive environments that mediate experiences for nurturing creativity (see Csikszentmihalyi, 1988, 1996). Prospective mathematics teachers can benefit from deliberate deepening of mathematical, didactical, and creativity knowledge (Shriki, 2010). Through professional development programs, teachers acquire skills and develop methods to teach critical mathematical literacy (understanding the word in the context in which it is written).

**(Cross)-disciplinary supports.** To attain goals of professional development, teachers interact with scientists and experts for cross-disciplinary (Wechsler & Hurst, 2011) and collaborative dialogues (Zittoun, Baucal, Cornish, & Gillespie, 2007). Such cross-disciplinary dialogues among teachers and experts are meant to support growth of the child. Taking the child as the core of teaching and learning mathematics, teachers work with experts and together they investigate factors that contribute to mathematics learning. For instance, how valid are the findings of mathematics achievement as a stronger predictor than attitudes toward mathematics and self-perceived creative abilities and gender (Mann, 2009) for children with learning difficulties? Cross-disciplinary research and teaching examine trans-contextual issues related to emergent mathematics learning. Boundary crossing supports at the structural, content, and pedagogical levels focus on transforming existing frames of teaching and on connecting classroom learning to cultural practices and habits.

**Concluding remarks**

This chapter presents our view on the essentiality of teaching mathematics creatively for ethical and righteous life and for the good (e.g., happiness, morality and ethics) (see Table 34.1 for main
points). To conclude this chapter, we pose two reflective questions: What is the ultimate goal of teaching a subject matter like mathematics creatively? How does education empower the young to lead a humanistic and productive life? Teaching mathematics creatively is a collaborative experience for care, well-being, and constructive responsibility. Teachers improvise disciplinary knowledge and values. They reframe boundaries of disciplinary expertise and co-construct spaces of learning for children to re-experience the real world in which they live (Sarason, 1993). Teaching creatively means teaching with variations and innovations. Teachers develop culturally responsible and relevant pedagogies so that students experience success in learning and maintain their cultural identities (Tutak, Bondy, & Adams, 2011). Value-based pedagogies highlight among others cultivation of diligence, sincerity, discipline, patience, contemplation, and wisdom (see Walsh, 2011). Curricula in mathematics (e.g., in Singapore, MOE, 2012) emphasize developing higher order thinking such as problem solving and cultivating values such as metacognition and self-regulation. Evidently, scores in mathematics can be predicted by students’ types of family (single parent family, nuclear family, mixed family), occupation class of parent, educational attainment of parents, and students’ learning strategies (elaboration, rehearsal) (Bailey & Borooah, 2010). Memorization, self-beliefs of hard work, and diligence improve mathematics achievements of Japanese students (House, 2006). Across nations, differences are observed in the sequences of activities, which may lead to different methods of teaching and hence different learning experiences (Givvin, Herbert, Jacobs, Hollingsworth, & Gallimore, 2005). Boys reported more positive attitudes toward mathematics than girls did (Else-Quest, Hyde, & Linn, 2010). Girls learn better in a co-operative setting (Gibbon, Lynn, & Stiles, 1997), whereas boys perform well in a competitive environment.

**Transformation**

A creative mathematics lesson is *transformative*. That means, the act of teaching allows teachers to think of ways to understand the subject matter and to translate it in accordance to the learners’ minds and motivations (Shulman, 1987). To share disciplinary knowledge creatively, teachers master curricular design, content or subject matter, pedagogical knowledge, and pedagogical content knowledge (Deng, 2007). Transformation exemplifies *emergence in development*. Teachers improvise knowledge through three levels of transformation prior to and during creative teaching. The first and *basic* level is related to the pedagogical transformation. The pedagogical and curricular experts convert, translate, and transform knowledge of mathematics to the level of understanding of the children. The first level of transformation incorporates the second or the *intermediate* level of transformation. The curricular transformation takes place among the teachers and the curricular-educators and content-knowledge experts. In *conversion*, knowledge of mathematics has to be re-organized in various representations: Enactive (a set of actions), iconic (as set of images or graphics), and symbolic (a set of symbolic or logical statements) (Bruner, 1966). *Translation* is a deliberate process (Schwab, 1969); teachers develop a thorough plan, select materials, manage time, create incremental tasks and design processes of learning.

Experience guides teachers to develop plans, formulate purposes of learning, and consider signified judgment (Dewey, 1938/1997). A plan with method of action is proposed based on foresight of the consequences of acting under given observed conditions in a certain way. Purposes of learning are formulated with reference to detailed observation of surrounding conditions. Teachers refer to knowledge of what has happened in similar situations in the past, a knowledge obtained partly by recollection and partly from the information, advice, and warnings of those who have had a wider experience. They consider judgment which puts together what is observed and what is recalled to see what they signify.
The third level of transformation is *psychologizing* transformation. Knowledge is transformed with reference to the level of understanding of the learners according to their developmental phases and needs. Psychologizing involves transforming knowledge of academic mathematics to knowledge that fits children’s development (Dewey, 1897/1972). Concrete objects are effective tools in helping children to understand mathematical concepts (Ginsburg & Amit, 2008). Knowledge of human development enriches translation of content knowledge and application of pedagogical content knowledge according to the needs of children and adolescents. Teachers investigate how young and adolescent pupils understand mathematical concepts. Taking teaching geometry of primary two as an example, teachers may find it useful to employ diagrams and objects (see Bohning & Althouse, 1997). When learning processes involve hands-on experiences, pupils may understand new concepts easily (Lee, 2010).

### Inclusion

Creative lessons are *inclusive* of all students for developing personhood. Inclusion exemplifies *emergence in social integration*. Taking the child as the focus, teachers gain professional and interdisciplinary supports. Personalized programs are established to address needs and accordingly to provide support for positive growth of each individual child. Teachers work with colleagues of various specializations. Together they identify strengths of each child and design coherent instruction for the child. Coherent in lessons is considered at the individual child’s level by adopting strength-based, personalized pedagogies and assessments. Inclusive lessons build on personalized pedagogies and highlight unique behavior and strengths of the child. For instance, teachers adopt effective teaching approaches such as art therapy that can engage children with special needs who are nonverbal (i.e., the interactive square, Bragge & Fenner, 2009). They use movement-based sensory intervention to address self-stimulatory behaviors (Mays, Beal-Alvarez, & Jolivette, 2011). Teachers acknowledge and support autistic children who display reality-creativity (Craig & Baron-Cohen, 1999) and who are good at elaborating details (Liu, Shih, & Ma, 2011). Contemplative pedagogies (e.g., Yoga and meditation) support empathetic connection, compassion, emotional balance, and altruistic behavior (Zajonc, 2013). Video self-modeling enhances positive learning behavior (e.g., Bellini & McConnell, 2010). Lego games facilitate linguistic and fine motor development (Pang, 2010). Individualized education plans remove barriers of learning without compromising quality of learning of special needs children (see also Powell, 2009). The plans include goals that incorporate priority needs, specific objectives related to the particular goals, detailed teaching strategies, and evaluation procedures (see Mount, 1987). Children with special needs either learn a subject matter such as mathematics in the small class size classroom or in an integrated class together with mainstream children. Multiple choice items are suitable for special needs children (Powell, 2009). Reversed plans of learning highlight strengths of autistic children such as symbolic skills for mathematics and reading (Beals, 2003).

### Final words

Teaching mathematics creatively challenges multiple parties (e.g., teachers, learners, and policymakers) to revisit their beliefs (e.g., every child matters) and re-instate values (e.g., respect, compassion) for humane curricula and personalized experiences. Accordingly, a multisystem framework of mathematics classroom regards the teacher and the learners as open systems. They interact with each other and with other systems such as the school, the family, the community, the social institution, and culture (Tan, 2000). Multiplicity in components of teaching
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**Table 34.1 Main points of creative teaching**

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*Note: The points are listed in arbitrary sequence.*

unites in meta-(reflective) processes of creative teaching such as role-congruence and coherence in instruction. Creative teaching in mathematics embrace strengths of all individuals (including those who possess the ability to perceive the world as it is and who are able to anticipate biological relevant events and predict the unpredictable (Gaigg, 2012)). Creative teachers are open to new understanding of human cognition (e.g., spontaneous cognition (Mok, 2012); and unconscious thoughts (Zhong, Dijksterhuis, & Galinsky, 2008)) that nurture good citizenship and the individual learners’ strengths. This chapter holds on to the belief that “[e]ducation is the creation of power of self-control” (Dewey, 1938/1997, p. 69). Knowledge is regarded as virtue. Knowledge creation begins with inquiry into life. Twenty-first century education aims to nurture non-dogmatic, caring, and compassionate persons. Unless teaching is transformative, learning is ethical and interpersonal relationships are inclusive, the aim of education to nurture caring and compassionate thinkers cannot be realized. Teaching mathematics and other subject matters creatively is a key to cultivating humanistic thinking and flourishing life.

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**References**


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