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Teachers' Creativity Perceptions for Mathematically Gifted Student

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Teachers' Creativity Perceptions for Mathematically Gifted Student

by

Yewon Sung

A Thesis

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Abstract

This paper examines the research related to the definition of creativity related to the mathematically highly capable learners. Using definition of creativity and mathematical creativity, this paper looks specifically at creativity related perceptions of different teacher groups. The journey for figuring bountiful teachers' creativity resources and opinion take responsibilities, especially in propping up mathematics gifted education. The purpose of this study is to investigate teachers' perceptions of creativity to implement a successful mathematics lessons to mathematically highly capable learners whether they have their special needs or traits. The research was carried out using qualitative research methods. Ten teachers completed structured interviews which contained 20 questions focused on creativity and mathematical creativity. The independent variable consisted of 10 teachers' backgrounds from four different teacher groups: general education teachers, instructional coaches (Mathematics coach), teachers of gifted and talented programs (enrichment programs), and special education teachers. All participants have experience of teaching mathematically-talented students. The dependent variable of responses from teachers' is categorized based on seven definitions of creativity from different giftedness models (Miller, 2012) and mathematical creativity (Sriraman, 2005). By doing comparisons of perceptions from interviews and questionnaires, the research accepts the mathematical creativity interpretation from different teacher groups including general education, instructional coaches (Mathematics coaches), mathematics education, and special education.

Keywords: perceptions, mathematical creativity, creativity, giftedness, twice exceptional, teachers

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Everybody is a genius.
But if you judge a fish
by its ability to climb a tree,
it will live its whole life believing that
it is stupid.
Albert Einstein

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Chapter 1: Nature of the Problem

Introduction

If a superhero did not know how to control their power, they might get in trouble from using limitless power inadvertently. Likewise, creative students should be aware of how they activate creative ideas under appropriate instruction by teachers (Kaufman & Beghetto, 2013). Few educators would disagree that a teacher takes on an essential responsibility in stimulating creativity, which is one of core traits toward academically high-functioning students (Aktas, 2016). Is creativity always encouraged in the school system? Unfortunately, there are challenging issues in the function of school systems with regard to activating creativity. Robinson (2006) points out that the current education system might switch off creativity of students in the classroom, especially in talented students. Although his background is not directly from mathematics education, those negative, accepted perceptions of creativity instruction should be reconsidered and reevaluated to progress these school systems. Furthermore, as one of the essential traits of mathematically-talented students, creativity cannot be neglected in mathematics education. In terms of marginalized instruction toward creativity, researchers are exploring to uncover crucial factors that could effectively reverse the perceptions of creativity in the school systems.

History of teaching mathematics to capable students dates back to the 16th-17th centuries. Karp (2009), for example, says that the significance of students achieving mastery in accounting and recognition has increased significantly because of the increasing possible profit in capitalist societies. However, teaching and accepting students were only allowed to nobility, including mathematics to the mathematically-gifted students. As a result, the efforts

for achieving equality in education guided the elimination of the division between social classes. Thus, a focus on instructing mathematically-talented students has been stipulated in the NCTM standards (Deal & Wismer, 2010). However, there is still a growing concern in the United States over less curricular focus on mathematically-talented students (Renzulli, 2008).

Mathematical giftedness is the recently accepted terminology. In a document written for mathematics teachers, *The Psychology of Mathematical Abilities in Schoolchildren*, Krutetskii (1976) researched students who were mathematically talented or gifted and who had been pursuing an elegant path to the mathematics problems. Krutetskii found a tendency of gifted students to understand and connect the world mathematically, which he called a “mathematical cast of mind.” Mathematically-gifted students recapitulate the world in flexible and innovative ways. Although Krutetskii did not mention creativity, he revealed that gifted students have a different way of thinking from those of general students. The research suggests that mathematically-talented students have flexible thinking abilities to solve mathematical problems which are different from general students. This suggests that teachers should be aware this creative power can change the way that students focus on their potential abilities or not.

Similar to Krutetskii (1976), Renzulli (1986) agreed that creativity is a core factor to define giftedness by illustrating an image of the three-ring perceptions of giftedness. Renzulli explains that creativity includes fluency, flexibility, an originality of thought, an openness to experience, sensitivity to stimulations, and a willingness to take risks. Therefore, this assertion became the axiomatic concept leading to the success of defining gifted students. Such success in the classroom may assure the level of differentiated instruction to

mathematically-talented students to help them absorb better ideas during their school days, including general classroom and enrichment programs. These concerns led to the development of the schoolwide enrichment model (Renzulli & Reis, 1997). After the awareness of mathematically-talented students, there have been adjustments to mathematically-talented students in the regular classroom. However, the approaches do not take into account appropriate programs of creativity. Renzulli (2008) emphasized that the role of teachers is to challenge the academically talented, advanced students to keep them engaged within the regular classrooms. By stating the importance of teachers' roles, Renzulli insisted that teaching talented students in regular classes was not studied substantially in this field. In addition, Archambault (1993) pointed out only meager modifications for gifted students have been implemented in regular classrooms across the United States. Although the creativity-stimulating program of mathematically-talented students in regular classrooms was not used to encourage the gifted individuals, the nurturing creativity for mathematically-talented students is needed. By pointing out that a teacher is more concerned about who did not understand than who did, Barger (2009) introduced do-and-don't guidelines to maximize students' potential to advance mathematics. Because she thought differentiating as a crucial point in the classroom, Barger promoted multiple solutions, encouraging questions, and admitting mental health in "do-guidelines," this is related to the precipitating creativity. Likewise, Sung (2013a & b) revealed the mathematically-talented students activate new mathematical thinking when they invent their own mathematics board game using "what if (not)" strategies, and it is likely that teachers of mathematically-talented students also have knowledge of gifted student's creativity.

To shed light on mathematics-talented education, students' creativity can be boosted by teachers' efforts in classroom. Although mathematically-talented students follow an efficient and beautiful approach to mathematics, their abilities should be honed by instructional support (Tjoe, 2015). When advanced instructional strategies were delivered appropriately by teachers, gifted students from all backgrounds proved substantial academic progress (Young & Balli, 2014).

Because teachers' perceptions with the different backgrounds could affect their instructional lesson plans and inspirations, detecting those perceptions and categorizing their responses is crucial to conduct authentic instruction for mathematically-talented students. Admittedly, teachers' perceptions are covert (Coleman, 2014).

Further significance of these standards have been highlighted by the 2013 public declaration of support for mathematically-talented students by the National Council of Teachers of Mathematics (NCTM) as outlined in its teaching principle of *NCTM Principles and Standards for Mathematically-talented Students* (Deal & Wismer, 2010).

Beyond these standards and expectations, enriching creativity to mathematically-talented students can be very important to future innovational progress of a society. Starting out by themselves, mathematically-talented students face more highly complicated mathematics problems and make intricate patterns of choices for their geometry problems, not to mention the mathematical decisions they make on a daily basis. It is within this context that recent research for sparking the creativity for talented students has been explored (Kim, 2016). Kim's study was designed to enable the expression of creative potential, examine creativity, and create productivity in the math-science instruction of classrooms. This was designed to

assist enhancement for gifted students in Seoul, South Korea. The result of creativity-focused instruction indicated that divergent thinking and originality have a significant effect on the production process. The limitation of the research was that the sample size was small and did not represent all teachers' perceptions toward mathematically-talented students.

Taken together, there were several approaches to reveal the teacher's perceptions and instruction to enrich creativity. However, there are not specific comparisons from different teacher groups, including general education teachers, instructional coaches (Mathematics coaches), teachers of mathematically gifted/talented programs (enrichment programs), and special education teachers who teach and take care of mathematically-talented students. Thus, there is need for comparison research between different backgrounds of teachers' perceptions of mathematically-talented students.

Purpose

The purpose of this study is to explore the three different kinds of teachers' perceptions of creativity to support mathematically-capable learners' progress. The research was carried out using qualitative research methods. The sample consisted of 10 teachers: general education teachers, instructional coaches (Mathematics coaches), special education teachers, and teachers of mathematically gifted/talented programs (enrichment programs).

Structured interviews were used as data collection tools. This research used seven definitions of creativity from different giftedness models to assess the responses of teachers' perceptions of creativity (Miller, 2012). In addition to Miller, this research integrated questions from Sriraman (2005) regarding mathematical creativity. Therefore, four types of

teachers were assessed on how they perceived creativity and implemented support for mathematically-talented students.

In summation, the research examines teachers' perceptions of the creativity of mathematically-talented students. Teachers' perceptions of creativity affect how they encourage and support mathematically-talented students.

Research Questions

The following research questions aim to illuminate different concepts of teachers who have experience with mathematically-talented students.

1. Do teachers' perceptions of mathematical creativity vary among different teacher groups, including general education teachers, instructional coaches (Mathematics coaches), talented programs (enrichment programs), and special education teachers?
2. How do teachers address twice-exceptionality?
3. How do teachers perceive the relationships between mathematics, creativity, and giftedness?

Definition of Terms

Creativity. Creativity includes novelty and appropriateness (Kaufman & Beghetto, 2013).

Mathematical creativity. Mathematical creativity is a tendency which is prone to reformulating a problem or finding analogous problems (Frensch & Sternberg, 1992; Polya, 1945, 1954; Sriraman, 2005). Mathematical creativity is sufficient conditions for mathematical giftedness (Sriraman, 2005; Usiskin, 2000).

Mathematical creativity in grade K-12. Mathematical creativity in grades K-12 can be defined as (a) the process that results in unusual (novel) and/or insightful solutions to a given problem or analogous problems, and/or (b) the formulation of new questions and/or possibilities that allow an old problem to be regarded from a new angle requiring imagination (Einstein & Inheld, 1938; Sriraman, 2005).

Mathematical giftedness. Mathematical creativity can be fulfilled by mathematical giftedness.

Giftedness. Giftedness designates the possession and use of outstanding natural abilities, called aptitudes, in at least one ability domain, to a degree that places an individual at least among the top 10% of peers at the same age (Gagné, 2009).

Talent. Talent designates the outstanding mastery of systematically-developed abilities, called competencies (knowledge and skills), in at least one field of human activity to a degree that places an individual at least among the top 10% of peers of the same age who are or have been active in that field (Gagné, 2009).

Creativity in giftedness. Because of definition of creativity in giftedness requires literature reviews, this can be explained in Chapter 2.

Beauty in Mathematics. Gifted students feel beauty when they solve problems efficiently, but mathematicians feel the beauty in mathematic's originality and simplicity. (Tjoe, 2015)

Mathematically-talented students. The profile of the mathematically-talented student embodies three distinct themes: 1) mathematically-talented students understand mathematical concepts chronologically earlier than their peers by as much as 5-10 years; 2) mathematically-

talented students have parents who are actively involved in their learning of math; 3) mathematically-talented students are typically frustrated with the current educational curriculum (Hermann & Castellon, 2000).

Differentiated curriculum. Adaptation of content, process, and concepts to meet a higher level of expectation appropriate for advanced learners. Curriculum can be differentiated through acceleration, complexity, depth, challenge, and creativity (NAGC-CEC, 2013; VanTassel-Baska & Wood, 2008).

Differentiated instruction. Multiple ways to structure a lesson so that each student is challenged at an appropriate level. Differentiated instruction may include such features as learner centeredness; planned assignments and lessons based on pre-assessment; and flexible grouping, materials, resources, and pacing (NAGC-CEC, 2013; Tomlinson & Hockett, 2008).

Twice Exceptional. The term twice exceptional, often abbreviated as 2e, refers to intellectually gifted children who have some form of disability. These children are considered exceptional both because of their intellectual gifts and because of their special needs (Beckley, 2012).

Chapter 2: Review of Related Literature

In this chapter, the following concepts and strategies pertaining to perceptions of teachers' definition of creativity are discussed: (1) Definition of Creativity, (2) Teachers' Readiness to Teach Creativity, (3) Knowledge of Teachers, (4) Creativity in education, (5) Teachers' Perceptions About Creativity, (6) General Education Teachers in Inclusive Classrooms, (7) Mathematically Gifted and Talented Programs, (8) Special Education-Double Exceptional Children, and (9) Creativity, Mathematics, and Giftedness.

Definition of Creativity

It is important to note the difference in definitions of creativity used for some studies in the field and those used for the study pertaining to this thesis. They can be contrasted in the following ways.

To begin, the term of creativity has been used in many different ways in educational literature. Renzulli (1992) considered situational creativity, arising from prescribed activities and presented problems, and real product creativity, emerging from self-selected problems and resulting in unique products, to be important types of creativity. The interaction among the three clusters of ability, commitment, and creativity is often presented visually as three overlapping circles, and giftedness is said to be found in the center section where all of the circles overlap. Above average ability, task commitment, and creativity must all be present before the criteria of giftedness can be met. For instance, an individual might possess above-average ability and creativity but be lacking in task commitment; this person would not be considered gifted. Therefore, this model makes a direct connection between creativity and giftedness.

Conducting comprehensive case studies of talented students in Russia (Soviet Unions), Krutetskii (1976) found the nature and structure of mathematical abilities of gifted students. He found several abilities from an observation, such as “flexibility of thinking”, “a free and easy transfer from a direct to a reverse train of thought”, and a “distinctive tendency for economy of thought” among others. He insists that mathematically-talented students have a “mathematical cast of mind” which means a tendency to interpret the world mathematically. Even if he did not mention creativity, the abilities that he revealed indicates that mathematically-talented students have a distinctive and flexible way of thinking compared to general education students.

The most well-known theory that reveals the definition of giftedness including creativity is from Renzulli (1986), which explains that creativity includes fluency, flexibility, an originality of thought, an openness to experience, sensitivity to stimulations, and a willingness to take risks. After Renzulli explained the three-ring perceptions of giftedness, a great deal of writing and research came out that dealt with the creativity of talented students. Despite Renzulli’s explanation of creativity, there were several different explanations of the creativity of gifted students by different scholars who discussed and researched giftedness.

To extent clear definition of creativity, Kaufman and Beghetto (2013) suggested two core components of creativity both novelty and appropriate. Their approach is similar to Winner’s (2000). While Winner suggested little-C and big-C, Kaufman and Beghetto elaborated levels of creativity of four realms, Mini-c, Little-c, Pro-c, and Big-c, which spans from crucial element learning to global impact. Furthermore, he asserts that creativity metacognition is crucial because self-regulation and creativity are interdependent. He insists

that teachers should develop a broader understanding of the nature of creativity to encourage students' progress of creativity metacognition.

Since mathematical creativity was considered a complicated term in educational literatures, Sriraman (2005) suggested five overarching principles to maximize the potential for mathematical creativity in the K-12 classroom (see Figure 2). The five principles are labeled as (a) the Gestalt principle, (b) the Aesthetic principle, (c) the Free market principle, (d) the Scholarly principle, and (e) the Uncertainty principle. In addition, Sriraman pointed out mathematical creativity is a sufficient condition for mathematical giftedness, but mathematical creativity is not a necessary condition for mathematical giftedness. Because the definition of creativity of professional levels is a broad concept, Sriraman elaborated the definition of mathematical creativity. In this research, the definition of the creativity will followed Sriraman's mathematical creativity in the K-12 classroom. This is defined as (a) process that results in novel and/or insightful solutions to a given problem or analogous problems, and (b) the formulation of new questions and/or possibilities that allow an old problem to be regarded form a new angle requiring imagination. Mathematical creativity could be also related to the mathematical aesthetics (Tjoe, 2015). While searching elegant problem solving strategy, mathematically-talented students activate their creativity as much as possible.

Sriraman (2005) suggested mathematical creativity in the K-12 classroom, the teachers' perceptions will vary based on their experience. Further, authentic research is still needed to study teachers with different backgrounds.

By comparing seven different theories and models, Miller (2012) asserted that there were not only common ideas but also discrepancies in comprehension of the terminology of creativity in giftedness. Pointing out obscure definitions of the creativity, Miller (2012) compared seven theories and models of giftedness including: 1) the three-Ring model (Renzulli, 1986); 2) the triarchic theory of intelligence (Sternberg, 2000); 3) the WICS Model of Gifted Leadership; 4) the Star Model (Tannenbaum, 2003); 5) the Dynamic Theory of Giftedness (Vygotsky, 1997); 6) the Domain-Specific: Artistic and Musical Giftedness (Winner, 2000); and 7) the Differentiated Model of Giftedness and Talent (Gagné, 2009). Miller's comparison not only shows perceptions of creativity are unique in each theory, but also reveals that some models of giftedness are more comprehensive and consistent in terms of the creativity literature. Specific comparison of creativity in giftedness, which this study focus on, is described Table 1.

Table 1

Comparison of Creativity in Giftedness

Model and Theory	Definition of Creativity in giftedness.
Three-Ring model	Creativity is sufficient condition for giftedness.
Triarchic theory	Creativity consists abilities of create, invent, discover, imagine, suppose, and hypothesize.
WICS model	Creativity is ability to incorporate ideas and one of ability of leadership.
Star model	Creativity is one of non-intellective requisites. Creativity is nurtured aspect of giftedness.
Dynamic theory	Creativity increased over time for children who were placed in classrooms using challenging curricula like zone of proximal development.
Domain	Creativity is an inextricable part of giftedness but makes a distinction between "little-C" and "big-C" Giftedness is a developmental progression toward creativity.
DMGT 2.0	Creativity falls within the realm of giftedness, or natural abilities. Creativity is one of many domains in which an individual can have an aptitude, and the expression of creativity is reliant on the various influential elements

Because this research focuses on mathematically-talented giftedness, the instrument will cover the creativity in giftedness. This disparity of definition of creativity from giftedness suggest the needs to reveal how creativity is perceived by the teachers who teach mathematically-talented students including general education teachers, instructional coaches (Mathematics coaches), enrichment program teachers, and special education teachers.

Based on Table 1, the research would include questionnaire of requesting teachers' thinking. Thus, this research will explore the breadth of creativity perceptions of teachers of mathematically-talented students.

Teachers' Readiness to Teach Creativity

In terms of teachers' readiness to teach creativity, there has been teachers' voice who insists the needs of gifted and talented learners in their classroom (Berman, Schultz, & Weber, 2012). A master's degree student witness "I never really spent much time thinking about what happens in the mind of a gifted and talented kid who is bored" (Berman et al., 2012, p. 1). This example challenges the teachers' sufficient readiness about encouraging gifted and talented students. In addition, the creativity stimulating plan from the teacher is still dubious.

Creativity, however, is crucial factor to support both teachers' and student's progress of application in mathematics. In terms of creativity of teachers of Mathematically-talented Students, Karp (2010) concludes that teaching mathematics content and various experiences broaden teachers' perspectives to stimulate the development of the teachers' creativity. He researched the teachers of mathematically gifted experiences as to how they became teachers and specific traits of their teaching. Although every participant of the study was recommended based on their mathematics background to come to the mathematics schools, the teachers

revealed that they had to put in much effort during their first years. The participants highlight that teachers in training should have a sound comprehension of difficult problems of school-level mathematics to present the content to the students. The teachers had to learn mathematical content and the new ways of presenting the content to the student. Karp states that there are interactive progresses between creative teachers and creative students. Karp asserts that providing various pedagogical situations for future teachers is substantial to maximize creativity what is available in the classroom. The common help for the participants was assistance from their colleagues that greatly helped to overcome the weakness of a beginning teaching. Karp's assertion about cooperation of teachers is similar to Kögce's (2015) findings about importance of teachers' feedback in the mathematics instruction. Kögce (2015) asserted that teachers' feedback and peer feedback have a positive effect on their work.

Shayshon, Gal, Tesler, and Ko (2014) conducted a teachers' view comparison research study which is based on questionnaire response among teachers in Israel, Republic of Korea and USA. While conducting comparative research, Shayshon et al. interpreted the responses of teachers of mathematically-talented students. Even the scope of the research is broad including knowledge, attitude, readiness, preference and differentiation, the responses from teachers implies the readiness of inspiring creativity of mathematically-talented students. Although teachers responded that their mathematical competency and attitude toward mathematics is enough to teach mathematically-talented students, teachers answered that they do not always prepare challenging activities intended especially for talented students. This suggests that encouraging teachers' readiness about creativity is needed, thus figuring out teachers' perceptions about creativity would be beneficial.

Knowledge of Teachers

In terms of relationship between knowledge and creativity, Karp (2010) insisted that the content knowledge of teachers results in the implementation of activating creativity in classroom. In addition, with regard to elementary mathematics teacher content knowledge, Thanheiser et al. (2014) reviewed 112 research studies from 1978 to 2012 about five content areas: whole numbers and operations, fractions, decimals, geometry and measurement, and algebra. The researcher concludes that there are increasing numbers of research related to the content knowledge of teachers. In addition, the researcher revealed that the teachers put higher priority to procedural thinking skills than concept itself. Although content knowledge of teachers was reviewed thoroughly from five content areas, the limitation of the research is that it does not specify the perceptions, trait of mathematics teachers, or developmental changes in learning. Knowledge could be needed to implement proper implementation of creativity curriculum. Thus, the research about teachers' perceptions toward creativity is still needed to disclose the relationships between knowledge and teachers' perceptions for boosting the gist of mathematics creativity.

Creativity in Education

Mathematics creativity also could be related to the beauty of mathematics. In terms of innate ability and nurtured ability in mathematics, Tjoe (2015) disclosed discrepancy between mathematician's perceptions of aesthetics of mathematics and mathematically-talented students. Tjoe reveals the different awareness of beauty of mathematics. While mathematically-talented students found mathematical elegance as efficiency, professional mathematicians saw beauty in mathematics originality and simplicity. This inequality could

come from the education to mathematics and attitude to a sense of mathematical creativity. This research suggests gifted and talented programs could find contemplation of creativity to be valuable to maximize the students' developmental acquisition of creativity. As Kaufman and Beghetto (2013) suggested by suggesting levels of creativity of four realms, Mini-c, Little-c, Pro-c, and Big-c, teacher could also strengthen power of creativity metacognitions. Based on Kaufman's assertion, teachers' creativity also progress with a plethora of creativity related experience. As a result, mathematically-talented students could be benefited by the teachers' effective input of creativity. This influential input result from sufficient awareness of stimulating creativity. Teacher's formidable affect could be a double-edged sword. This suggests that teachers could also enjoy the procedure of creative thinking and necessary information of teachers' perception.

With regard to reassuring creativity, Barger (2009) suggested the instructional do-and-don't guideline to maximize students' potential progress. Barger asserts that instructional support could substantially affect the result of teaching, including creative progress. The research of Barger suggests promoting multiple solutions in class. This is a way of keeping talented students involved and challenged to work on problem solving. In addition, challenging tasks are recommended in the guideline to differentiate lessons for the mathematically-talented students. Barger mentions that a teacher can easily become less concerned about the students who understand than about those who struggle with mathematics. These perceptions could affect the chance of providing enough stimulants toward creativity.

When it comes to instructional support toward creativity, Guo and Woulfin (2016) suggested P21 as a new model of creativity. The research says, in the 21st century, teacher

should search for accessing guidance and resources to activate creativity even if they are not an innovative idea bank. Policy makers and reformers should also include creativity into educational policies and standards. Thus, teachers, through careful thinking, should take responsibilities to implement creativity strengthened standards by doing ponderous considerations. This research also reveals the required support to progressing creativity, teachers of mathematically-talented students also should be supported by tenable instructional standards, and materials including a myriad of creativity. As Karp (2010) suggested, collaborative atmosphere and extensive interaction with other teacher will also support to prepare mathematically-talented students.

Taken together, to cultivate creativity philosophy themselves, teachers also need to receive adequate learning opportunity related to creativity curriculum. Instructional standards, and materials and teachers' cooperation could be supervised for enriching creativity based teachers' need and experience toward mathematically-talented students. The first step to maximize teachers' possibility can be seen present teachers' authentic definition and experiences.

Teachers' Perceptions about Creativity

Because teachers know the importance of creativity in mathematically-talented students, there was comparison research about teachers from different cultural backgrounds. In terms of teachers' attitude toward creativity, Applebaum, Freiman, and Leikin (2011) compared the attitude of Canada and Israel's teachers of mathematically-talented students. The authors explained that teachers of mathematically-talented students from both countries endeavor to meet the needs of mathematically-talented students which is challenging task

including creativity-stimulant for the development of the student. In this research, teachers answered that the challenging tasks for mathematically-talented students should include higher order thinking, theory building, and enhancement of suitable strategies. By studying the responses, Applebaum et al. suggested that especially challenging, open-ended and investigative tasks of higher difficulty level and increasing complexity are needed for students who have higher needs. This recommendation shows that teachers agree that they have a substantial role in stimulating mathematical creativity. Adding to Applebaum et al.'s assertion of increasing opportunity to give flexible task to the students, the teachers' hidden curriculum, or their awareness of creativity could be a fundamental fact to affect student learning it. Coleman (2014) observed and interviewed a teacher, and explained that teachers have covert worlds of practical knowledge when they teach talented students. The teacher knew that if he made certain curricular adjustments, the probability of student achievement was positively correlated.

In Turkey, there was a study about high school teachers' perceptions of creativity in mathematics. Aktas (2016, p. 44) interviewed high school teachers' awareness of creativity by using four questions: 1) What are mathematics teachers' definitions of creative thinking?, 2) What do mathematics teachers think are characteristics of creative mathematics teachers and students?, 3) What kinds of activities do mathematics teachers use in the classroom in order to foster creativity?, and 4) What do mathematics teachers believe are the barriers to creativity? Aktas concludes that teachers' responses commonly reveal that education system including standardized tests and curriculum limit creativity rather than teachers' lacking preparation toward creativity related instruction. This suggests the importance of supporting

teachers' awareness of mathematically-talented student. To do that, first step is to follow teachers' perceptions and their needs based on a plethora of research. Specifically, teachers from different educational environment could be aware.

To extend cross-cultural research of teacher's perceptions of creativity, Zhou, Shen, and Wang (2013) suggested that teachers define creative traits as novelty, imaginative, original, curious, and willing to try from all three countries of Japan, China, and Germany. This research is meaningful by revealing the discrepancy and common ideas of teachers' perceptions. The limitation of the research is that a working concept of creativity would be necessary in the further research. If working perceptions of creativity is required, it is also needed data from in-service teacher from different teaching environment: general education teachers, instructional coaches (Mathematics coaches), mathematics enrichment program teachers, and special education teachers.

General Education Teachers in Inclusive Classroom

Because general education teachers, instructional coaches (Mathematics coaches), special education teachers, and teachers of mathematically gifted/talented program (enrichment program) have different scope and sequence to teach mathematically-talented students, knowing the working concepts of creativity of these three groups is fundamental to learn about creativity awareness of teachers. Thus, collecting information would be evocative from three different groups: general education teachers, teachers of gifted and talented programs, and special education teachers.

An inclusive classroom has students of all ability levels. There may be students with learning disabilities, students who are gifted and/or talented, students who work at grade level,

and students who work below grade level in one class (Eredics, 2016). There have been different perspectives of effectiveness because an inclusive classroom is a teaching setting in which students are educated with their age peers whether or not students are talented or have special needs. As to gifted and talented students should be educated with their age peers or their intellectual peers, Moltzen (2006) asserts that inclusion with their age peers could work very well. Even if there could be possible existence of excluded gifted and talented students, Moltzen suggests that teachers' knowledge can be a crucial key to solve the limitation of support. Moltzen's research reinforces that teachers need to be offered inclusive education in training and courses. This implies that boosting creativity in general classroom would be effective when general education teachers have strong awareness and knowledge about creativity curriculum to encourage mathematically-talented students.

As Moltzen (2006) insisted, the gifted and talented students report the weakness of content and lack of meaningful applications of the content (Gentry, Peters, & Mann, 2007). There is consensus about the insufficient education from both teachers and students. This concludes that there is a lack of opportunity to increase students' creativity within this context.

In terms of focused study about preservice teachers' perception, Berman et al. (2012) asserted that preservice teachers of general education lack an understanding about the nature and needs of gifted and talented students. Berman also points out that gifted and talented education has limited space and place in the general education class. A lot of teacher candidates have perceptions that gifted students are not more than peer-tutoring candidates before summary game activities. This suggests that creativity related curriculum and instruction to teachers and teacher candidates are significant to support general education

teachers. Thus, research about the definition of creativity by teachers could be conducted to find as a starting point.

To give sufficient educational opportunities in general education classrooms, differentiated instruction has been conducted based on compelling researches. However, the student who takes differentiated instruction reports that there is still frustration about a lack of level appropriate consideration. Teachers believe they still need more training to implement appropriate differentiated instruction for students (Tomlinson, 2003; Young & Balli, 2014). This shows that teachers should receive support to prepare proper level of differentiated instruction in the general classroom. In addition, the creativity related differentiated instruction is needed to require sufficient input to teachers.

Mathematically Gifted and Talented Programs

In terms of leaders' recognition in gifted education, leaders in gifted education champion apposite instructional programs with discrete characteristics of gifted and talented students (Pyryt & Bosetti, 2006). Students' ability and needs result in distinctive traits of gifted educational programming (Young & Balli, 2014).

The National Association for Gifted Children (NAGC) and Council for Exceptional Children (CEC) suggested teacher preparation standards in gifted and talented education. The Standard 1.2 mentions that teachers should understand the differences to respond to the needs of individuals with gifts and talents. (NAGC-CEC, 2013) This suggests that teacher should have enough awareness of creativity related needs. In addition, the Standard 5.5 also recommend that teachers should use instructional strategies that enhance the affective development of talented individuals. Thus, teachers of gifted and talented programs should

prepare enough educational prompts to teach creativity. The Standard 7 addresses the power of collaboration with families, other educators, related-service providers, and community agencies to support the needs of talented individuals across a range of learning experiences. This summarizes the mathematically-talented students' creativity can be supported by various resources: differentiation, teachers' preparation, and collaboration.

Yet the standard was suggested, there should be consideration of feasible classroom setting including funding resources. In Minnesota, where this study was conducted, there are not public gifted and talented program which are supported by state funding (CSDPG-NACA, 2008-2009). In university level funding, however, the University of Minnesota Talented Youth Mathematics Program (UMTYMP) has been provided since 1980. Because the mathematics departments at the University of Minnesota agreed to fund and administer the entire sequence of courses, in the fall semester of 1980, the first UMTYMP high school and calculus level courses were offered at the University. In addition, local schools have enrichment program after school. Taken together, the data could be collected from the UMTYMP teachers and enrichment program teachers to discover teachers' awareness of creativity in mathematically gifted and talented program.

Special Education–Twice Exceptional Children

Some would think it strange that gifted and talented students come across difficulties to learning. However, there are double exceptional gifted children with special educational needs (Montgomery, 2006). For instance, the movie *Shine* (1996) illustrates a real story that David Helfgott suffered a mental breakdown caused from father's rejection and forceful training. David's father was obsessed with winning and had no tolerance for failure or

disobedience. If David Helfgott grew up in a supportive and warm environment, David's shiny talent could engender musical legacy to the people. In the classroom, likewise, teachers encounter gifted children with special educational needs and teachers educate them based on their perception and experience. Montgomery explains that the school system thwarts many gifted students from expressing their abilities because of lacking supportive environments. Gifted and talented students have underachieved 40% by the Curriculum Based Identification (CBI) test in 2004 (Montgomery, 2006).

To define double exceptional students, Montgomery (2006) defined three kinds groups: a discrepant double exceptionality, a deficit double exceptionality, and a deceptive double exceptionality. The first group, for example, has students who have been identified by disparity between high scores on ability test and low scores in school subjects. The second group could have cases that the disability masks the abilities. The third group is usually not recognized, but students could be daydreamers, who are not interested in school. In school, educators have found scapegoating. Specifically, student who seems different between other students are easily bullied. To avoid seeming different, gifted and talented students conceal their excellent skills. Gifted students also sometimes develop the habit of drifting off to overcome tediousness with tiresome class content. They "daydream" (Montgomery, 2006).

Taken together, Montgomery's research suggests that bored students could lose their interest about increasing their creative power. Special education teachers could offer support to overcome this learned habit of ennui. Figuring out the special educational needs would help to save the victimized students. Thus, there is still a need to capture the definition of special

education teachers' perception of creativity to support mathematically-talented but having disabilities.

Creativity, Mathematics, and Giftedness

Trying to comprehend the nature of mathematical giftedness and mathematical creativity, there have been several researches (Leikin, 2011; Schoenfeld, 2000, 2002). Lacking research data, however, caused that creativity of mathematically-talented student have not been depicted vividly including both the mathematical giftedness and mathematical creativity (Leikin, 2011). As aforementioned above, there are both common areas among creativity, mathematics, and giftedness and separate areas. If there is a clear line between those concepts, education will be mathematics because it is linear like mathematics *per se*. Teachers' perceptions affect their teaching in the classroom. Specifically, to find the relationship between teachers' thought and instruction, a teacher conducted extensive observation and interviewing. The result is a teacher's thought affect how to implement their instructional plan (Coleman, 2014). This implies that trying to understand teachers' perceptions toward creativity when it comes to mathematically-talented students would be a catalyst to support the requirement of real classroom. Bringing covert world of teachers' perceptions to creativity could be a great catalyst to implement better education for mathematically-talented students.

Creative thinkers regardless of gifted eminence contain and enjoy chances to be innovative. Becoming creative involves a progression to be raised into presence. Thus, teachers are demanded to support students and point out the importance of divergent thinking (Flint, 2014). Despite Flint encouraged creativity is not only for the gifted and talented people,

to the mathematically-talented students, open-ended assignments could be amusing involvement to accept it within teachers' encouragement. This also implies that creativity in mathematical giftedness also could be nurtured by teachers' supporting and consideration. In addition, the role of teacher can be strengthened by enriching teachers' experience and facilitating the development of their creativity. Teachers come from all different background. The school environment also needs to provide to shape and help to develop and expand teachers' creativity to increase the quality of program (Karp, 2010). Creativity has dynamic characteristics that can be developed during the educational process (Panoura & Panoura, 2014). As Panoura and Panoura suggested, having a sense of creativity requires the inspiration of deciding which activity would foster students' originality the best.

Even if there is not clear division between creativity, giftedness, and mathematics, this does not mean that it is weakness of creativity. Rather the broaden meaning of creativity could support to think outside of the box (Kaufman & Beghetto, 2013). By overcoming its constraint, the merged area of creativity, giftedness, and mathematics could be a platform to enlarge the flexible thinking of both teachers and students. If educators would be aware of the teachers' perceptions of creativity, there could be a better way to teach students (Miller & Cohen, 2012). By exploring different teacher groups' perceptions toward creativity, the research reveals various awareness of creativity from those teachers' own experience. In summation, this research will be a precious resource to create a blueprint to guide a new paradigm by revealing teachers' perceptions of creativity within different educational environment including general education classroom, special education classroom, and enrichment program classroom. This research will be a guide to deliver the definition of

creativity is how perceived to the teacher who teaches mathematically-talented students from general, mathematics enrichment program, and special education programs. Thus, this research will explore the difference of creativity perceptions of teachers of mathematically-talented students. The interview of teachers and their activity plan or story would show how creativity perceptions are similar or different based on seven definitions of creativity from different giftedness models.

Chapter 3: Methodology

Introduction

The purpose of this study is to explore the three different kinds of teachers' perceptions of creativity to support mathematically-talented students' progress. The research was carried out using qualitative research methods. The sample consisted of ten teachers who have experienced mathematically-talented students of general education teachers, instructional coaches (Mathematics coaches), teachers of mathematically gifted/talented program (enrichment program), and special education teachers. Structured interviews were used as a data collection tool. This research used the definitions of creativity, based on seven models of giftedness, to evaluate and interpret the responses of teachers when asked about creativity with regard to mathematically highly capable students.

This chapter addresses methodology and related questions in the following framework: (a) research questions, (b) participants, (c) setting, (d) instrumentation, (e) design, (f) treatment, (g) fidelity of treatment, and, (h) treatment of data.

Research Questions

These three questions are conducted for teachers who have experienced mathematically-talented students. The following research questions have been answered in this study:

1. Do teachers' perceptions of mathematical creativity vary among different teacher groups including general education, instructional coaches (Mathematics coaches), talented program (enrichment program), and special education?
2. How do teachers address twice exceptionality?

3. How do teachers perceive relationship between mathematics, creativity and giftedness?

Participants

A total of 10 teachers from four different group of general education teachers, instructional coaches (Mathematics coaches), teachers of mathematically gifted/talented program (enrichment program), and special education teachers with teaching experience in elementary schools in elementary level participated in this study. The teaching experience range for these participants was from 1.5 years to 27 years. Eight females and two males comprised the group, and of these, 10 were ethnically Caucasian people.

Participation pool. A convenience sample was used to select the participants. These teachers worked at publically funded elementary schools located in a small mid-western town. The pool of participants consisted of teachers who qualify for teaching experience of mathematically-talented students in the area of mathematics instruction. Four different licensed teachers in general education teachers, instructional coaches (Mathematics coaches), enrichment program teachers, and special education teachers received interview questions. See Table 2 for a participant demographic summary.

Table 2

Participant Demographic Data

Number	Name	Group	Grade	Gender	Ethnicity	Teaching
1	G01	General Ed	5 th	F	WH	25
2	G02	General Ed	5 th	F	WH	16
3	M03	Math Coach	K-5	F	WH	10
4	M04	Math Coach	5-8	F	WH	19
5	E05	Enrichment	2-5	M	WH	27
6	E06	Enrichment	5 th	M	WH	12
7	E07	Enrichment	K-4	F	WH	23
8	S08	Special Ed	5 th	F	WH	5
9	S09	Special Ed	3-5	F	WH	3.5
10	S10	Special Ed	K-2	F	WH	1.5

Name: Name has been made by numbering order and the group.

G: General education teacher –G01 and G02

M: Math Coach-M03 and M04

E: Teachers of mathematics enrichment program-E05, E06, and E07

S: Special education teacher-S08, S09, and S10

WH: White, H: Hispanic; B: Black/African American, A: Asian F: Female; M: Male

Participation selection. Each participant was required to meet specific criteria to be eligible for this study. The participants must have: (a) met the state of Minnesota teaching license to teach student services; and (b) be enrolled teaching mathematically-talented students. Also, each participant must have submitted a signed informed consent (Appendix A).

Teachers' group formations. Four different groups of teachers were selected. The first group was general education teachers, two teachers have teaching experience of mathematically-talented student in inclusive general classroom. The second group was instructional coaches (Mathematics coaches); they have been working with general education teachers and special education teachers to support curriculum planning. The third group was mathematics talented enrichment program teachers. They teach mathematically-talented student after regular school hour or within regular class hour. The last group was special education teachers. They have experienced gifted and talented students teaching and additional support.

This study was conducted to teachers from seven schools within four small school districts in a mid-western state with K-5 students. This state has a student population of 874,827 students. 37.7% of students qualify for free or reduced lunch. About 15% are identified as students with disabilities. 8% of students are English learner and 1.1% of students are homeless.

Further demographic information:(a) 6.8% of the student population is Asian/Pacific Islander, (b) 10.7% of the student population is Black/African American, (c) 9.0% of the student population is Hispanic, (d) 1.6% of the student population is Native American, (e) 67.5% of the student population is White, and (f) 4.4% of the student population is two or more races.

Instrumentation

Structured interview question is detailed in this section. The dependent variable of responses from teachers' will be categorized based on seven definitions of creativity from

different giftedness models. By comparing different responses from different groups based on seven definitions of creativity from different giftedness models, teachers' perceptions of creativity in giftedness are revealed. Based on theories, the interview questions were written by the researcher.

Table 3

Comparison of Creativity in Giftedness and Interview Questions

Model	Definition	Interview Questions
Three-Ring model	Creativity is sufficient condition for giftedness.	1) How do you think creativity? 2) Creativity is (sufficient, necessary, or necessary sufficient) condition for giftedness.
Triarchic theory	Creativity consists abilities of create, invent, discover, imagine, suppose, and hypothesize.	3) How do you think of factor of creativity? Could you give me some examples of words which represent creativity? 4) As a teacher, what do you think about the requirements to stimulate creativity? 5) How could you define mathematical creativity? 6) Are there differences between creativity and mathematical creativity? 7) What characteristic can be expressed in mathematical creativity?
WICS model	Creativity is ability to incorporate ideas and one of ability of leadership.	8) Do you think creativity is one of ability of leadership of mathematically-talented students?
Star model	Creativity is one of non-intellective requisites. Creativity is nurtured aspect of giftedness.	9) How do you think that creativity is to be nurture, or inherent ability of mathematically-talented students?
Dynamic theory	Creativity increased over time for children who were placed in classrooms using challenging curricula like zone of proximal development.	10) Do you think creativity can be increased over time or short time in your classroom? 11) Do you have any idea or classroom activities to challenge creativity? If you have, please explain those classroom activities. 12) How would you improve your instructional plan to encourage students' creativity? 13) How do you stimulate the creativity development of mathematically-talented students? 14) Do you pursue to learn about creativity by yourself?
Domain-Specific	Creativity is an inextricable part of giftedness but makes a distinction between "little-C" and "big-C" Giftedness is a developmental progression toward creativity.	15) How do you think the relationship between creativity and giftedness? 16) Do you think there is some level of creativity? 17) If you think there are levels, how do you separate those levels? 18) If you think there are levels, how many levels do you want to divide to explain creativity?
DMGT 2.0	Creativity falls within the realm of giftedness, or natural abilities. Creativity is one of many domains in which an individual can have an aptitude, and the expression of creativity is	19) Could you draw a Venn diagram that shows the relationship of creativity, giftedness, and mathematics? 20) What kind of factor can affect creativity progress to mathematically-talented students?

	reliant on the various influential elements	
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This research will explore the creativity perceptions of teachers of mathematically-talented students. Above questions are categorized five sections related to the concept and complexity: 1) creativity, 2) mathematical creativity, 3) mathematical creativity and giftedness, 4) twice exceptionality and 5) one's image of math, creativity, and giftedness.

Total questions are provided with 16 questions.

Table 4

Revised Interview Questions

Question	Sub-Questions
1. How do you address creativity?	1) How do you address creativity? 2) Creativity is (sufficient, necessary, or necessary and sufficient) condition for giftedness. Could you tell me your reason? 3) Could you give me some examples of words which represent creativity? 4) As a teacher, what do you think about the requirements to stimulate creativity? 5) Could you explain your teaching experiences about creativity? How would you plan to encourage students' creativity? 6) Do you pursue to learn about creativity by yourself?
2. How do you define mathematical creativity?	7) How do you define mathematical creativity? 8) Could you explain the relationship between mathematics and creativity? 9) Are there differences between creativity and mathematical creativity? 10) What students' characteristics can be expressed in mathematical creativity?
3. How do you address mathematical creativity with regard to gifted students?	11) How do you address mathematical creativity with regard to gifted students? 12) How do you perceive giftedness? 13) Is there a relationship between creativity and giftedness? If so, how? 14) What factors can affect the creativity of mathematically-talented students?
4. 15) How do you address mathematical creativity when you teach twice exceptional students who are gifted but also have disabilities?	
5. 16) Could you draw a diagram or image to show the relationship between creativity, giftedness, and mathematics?	

Design

A probe design across seven definitions of creativity from different giftedness models was used in this study Miller (2012). In addition to Miller, when it comes to mathematical

creativity, this research referred to a question from Sriraman (2004). Each person in a teacher group strengthen the internal validity of the design. Moreover, conducting four groups of teachers is considered a requirement to avoid unrepresentative responses. Each teachers granted permission by signing a consent form.

Fidelity of Treatment

The principal investigator of this study interviewed sessions to ensure the teachers received a *consent form* which was developed for this purpose (Appendix A).

Treatment of Data

Each answer of three groups of teachers related to definitions of creativity from giftedness models, were recorded and transcribed. 1) the three-Ring model (Renzulli, 1986), 2) the triarchic theory of intelligence (Sternberg, 2000), 3) the WICS Model of Gifted Leadership, 4) the Star Model (Tannenbaum, 2003), 5) the Dynamic Theory of Giftedness (Vygotsky, 1997), 6) the Domain-Specific: Artistic and Musical Giftedness (Winner, 2000), and 7) the Differentiated Model of Giftedness and Talent (Gagné, 2009).

This data comparison not only shows perceptions of creativity are unique in each way, but also reveals teacher's different group how affect the perceptions of creativity toward mathematically-talented students.

Research Question One

Do teachers' perceptions of mathematical creativity vary among different teacher groups including general education teachers, instructional coaches (Mathematics coaches), talented program (enrichment program), and special education?

Four groups of responses can offer insight to answer this question. The response of each group can be interpreted and categorized. This will reveal the teachers' perceptions of creativity vary among different teacher groups including general, talented, and special education teachers. From question 7 to 10, this is related to the mathematical creativity. Teachers related their responses from creativity and mathematical creativity. This could show, research question one 'Do teachers' perceptions of mathematical creativity vary among different teacher groups including general education, instructional coaches (Mathematics coaches), talented program (enrichment program), and special education?

Research Question Two

How do teachers address twice exceptionality?

If a teacher has experience to stimulate creativity to twice exceptional learners, they would response with specific examples. Through interview question 15, teachers address mathematical creativity when you teach twice exceptional students who are gifted but also have disabilities.

Research Question Three

How do teachers perceive relationship between mathematics, creativity and giftedness?

This research explores how teachers address the concept of relationship between mathematics, creativity and giftedness. From question 11 to 14 and 16, teachers respond about mathematics, creativity and giftedness. Question 16 is conducted at the last part of each interview. Because this is about teacher's image which takes time to express relationship

between mathematics, creativity and giftedness. This question includes teachers' explanation of the image.

Chapter 4: Results

Introduction

The purpose of this research was to explore the four different groups of teachers' perceptions of creativity to support mathematically-talented students' progress. The research was carried out using qualitative research methods. The sample consisted of ten teachers: general education teachers, instructional coaches (Mathematics coaches), teachers of mathematically gifted/talented programs (enrichment programs), and special education teachers.

Data were collected to answer three research questions including five categories: 1) creativity, 2) mathematical creativity, 3) mathematical creativity and giftedness, 4) twice exceptional, and 5) image of math, creativity, and giftedness. These answers from five areas address the dependent variables of the study. The independent variable is the three groups of teaching experiences.

This chapter presents findings relative to the three research questions in a sequential fashion. Afterward, fidelity of treatment data is presented. The chapter concludes with a summary of the results from this study. Because interview questions start with research question one, three, and two, this chapter introduces those responses by this order.

Research Question One

Do teachers' perceptions of mathematical creativity vary among different teacher groups including general education teachers, instructional coaches (Mathematics coaches), talented program (enrichment program), and special education?

Ten interviewee's data were generated to detect participants' awareness of 1) creativity, 2) mathematical creativity definition, 3) mathematical creativity in terms of giftedness based on teaching experiences. Since responses categorized by grouped teachers, four groups of responses can offer insight to answer this question. The response of each group can be interpreted and categorized. This will reveal the teachers' perceptions of creativity vary among different teacher groups including general teachers, instructional coaches (Mathematics coaches), enrichment program teachers, and special education teachers. For your comprehensions of all results, refer to Appendix C. Because of conciseness for showing results, this chapter only includes related responses and interpretation.

Creativity. First question is about creativity. Each teacher answered based on their definition caused from their experiences.

Q1	How do you address creativity?
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Since teachers teaching experiences come from different setting such as whole group instruction or small group instruction, teachers defined their activities brings their teaching setting up. Commonly, general education teachers, instructional coaches (Mathematics coaches), enrichment program teachers addressed creativity by providing a lot of activities for students. For instance, students address various activities and options. From G01, G02, M03, M04, E05, E06, E07 agree with allowing students options by providing different activities. Both general education teachers admit that they should provide various options based on level or needs of students .G01 says "I think just provide different activities that I do in the classroom. When I heard the word creativity, I thought that it like how to I keep interesting in

the classroom.” Likewise, G02 mentions, “I think the biggest things of creativity is giving student choice, academic choice, level based ability choice.” She agrees with the various choices are crucial. Mathematics coach M03 also says,

I try to encourage creativity; makes sure to have positive experience, having different ways of problem solving, letting kids collaborate to get an idea from each other. Classroom assignment should reflect that creative is important, not having all worksheets or multiple choices questions.

M04 allow differentiation in her classroom. On the same sides, enrichment program teacher E06 says,

We are trying to allowing them options. And, we offer many extension as we can, we use menus, Tic-Tac-Toe board to students, kind of being charged of proving their knowledge whether they are strong at picture, graphic, making video, or using of technology.

E07 encourage various ideas, “I stress there are more than one way, and offer choice as much as I can to often their own.” Thus, general education teachers, mathematics coaches, enrichment program teachers commonly shared this opinion. This context prop up the Dynamic Theory of creativity, as a teacher, teachers focus on providing challenging curricula.

However, special education teachers and one enrichment program teacher focused students’ strength and interest. Enrichment program teacher E05 asserts the importance of each individual’s needs, “I tried to find out of students, their skills and what they are interested in.” S08 focus on strength of student, “I am doing that what students are comfortable with, but also showing their strengths in the process.” S09 also says that students

can relate to in a personal level. “I address everyday creativity in classroom, it is a challenge. Because I can be creative enough to make the lesson one student can relate to in a personal level.” This view is close to DMGT 2.0 model since expression of creativity is reliant on the various influential elements. Lastly, special education teacher S10 also asserts that students learn differently and focus on individually various expressions. “Every student is unique and each individual bring their creativity to the table, I try to bring them.” To sum, general education teachers, mathematics coaches, enrichment program teachers commonly insisted providing challenging curricula is crucial for nurturing creativity. Special education teachers more focus on individual strength to bring up ideas from students. This shows that special education teachers focus on strength of student and individualized instruction, but other teachers focus more on choices and various activities.

Q2	Creativity is (sufficient, necessary, or necessary and sufficient) condition for giftedness. Could you tell me your reason?
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See Question 2, seven teachers responded that creativity is necessary and sufficient condition for giftedness. It was all group’s common factor, G01, M03, M04, E06, E07, S08, S10 insisted creativity and giftedness combined together. This opinion was not only shown one group of teachers, seven teachers think that creativity is necessary and sufficient condition for giftedness. E06 asserted own idea that creativity is related to show they are gifted.

Even if Renzulli (1984) asserted that creativity is necessary and sufficient condition for giftedness, some teachers bring their exceptional examples to explain creativity of

mathematically gifted students. Three teachers of three different groups, G02, E05, S09 responded that creativity is only necessary condition for giftedness. G02 mentioned, “I do not think that there is always sufficient condition. Because some gifted students are very linear thinkers, so you have to teach them how to think outside of boxes and be flexible thinkers.” Because of some gifted students who are very rigid and one way thinkers, G02 believes in some of gifted students could creative but not all gifted students are creative. E05 asserts “Teachers should find out interest of gifted students, and provide individualized education.” E05 think that some of gifted student could be creative, so education could provide individualized form.

Q3	Could you give me some examples of words which represent creativity?
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See Question 3, since it is open-ended question, all G01, G02, M03, M04, E05, E06, E07, S08, S09, S10 brought many different words which represent creativity. As ‘Triarchic theory’ suggested that creativity consists abilities of create, invent, discover, imagine, suppose, and hypothesize, teachers pointed students’ various abilities which enable to show creativity of students. G01 brings, “Variety, create, adapt concept of different things, collaborate, change, make choices, apply, draw, write, color, think, and plan.” G02 says, “Flexible, mindful, open-minded, and adaptable.” M03 thinks, “Create, make, discuss, dialogue, and solve.” M04 says, “I think explanation is huge part of creativity.” E05 explains, “Growth mindset and extend.” E06 brings his words, “Able to think about things differently in your own, able to take your knowledge and find the way to show your understanding without being given specific directions, looking to say working out find surface area, and

drawing net and using formula.” E07 says, “Flexibility, fluency, originality, elaborating their ideas, different activities, a long list of ideas and categorizing ideas, look for different viewpoint.” S08 thinks, “Investigate, question, multi-sensory; doing things with your hands and eyes and what you are hear and what you feel, collaborate, work with others, share ideas with other people around you.” S10 shows, “unique, different, positive, and successful.”

On the other hand, Special education teacher S09 pointed out “Self-esteem and humor” represent creativity, which is same context of DMGT 2.0 model and various influential elements.

Q4	As a teacher, what do you think about the requirements to stimulate creativity?
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See question 4, five teachers commonly think that responsibility of teacher is huge to support creativity progress of students. G01 says “Teachers could constantly change their lessons, and making things different, and offering variety”, likewise M03 says “I think that teacher can encourage curiosity, collaboration, problem solving, open-minded, and growth mindset.” M04 also asserts, “I think that the biggest what we have is teachers are continuing to provide options.” E05 focus on level and fun factors, “I never wanted to students be bored. I put them in leveled groups.” E07 recommend teacher can encourage student bring their ideas. “I think for lessons to have in their embedded writing, because it helps problem solving and critical thinking.”

Pointing out strict standard and curriculum, G02 sees problems of little flexibility in curriculum, and E06 think creativity is limited little bit because of standards, and teachers need more time to encourage creativity. “Sometimes I feel that we do what the standard so

push, push, and push. Sometimes it is easier to do just say, “Let’s do this workbook page 9, and move on.” The opinion of G02 and E06 strengthens Guo and Woulfin (2016)’s opinion that suggested policy makers and reformers should also include creativity into educational policies and standards.

Special Education teachers shared common opinion that figuring students out is needed for teachers to encourage creativity of their students. S08 says to give student a lot of student-led instructions based on student. “Teacher should know their kids. And, what makes them have stronger. All kids have their strength and barriers that they struggle with, and being able to pull out those moments, those skills that they are really good at.” S09 also insists that knowing student is important. “It is getting to know students, like or dislike background, culture really helps to stimulate creativity because I know where I would go with it. Frankly, I have always been interested in this, any this form can stimulate creativity.” S10 says that teachers should figure out students’ unique creativity, and bring teacher’s passion for student to express their ideas. To sum, even if some teachers admit that they are facing limited time and strict standards, general education teachers, enrichment program teachers, and mathematics coaches agree that responsibility of teachers and having enough time are very important factor to encourage creativity of students. Special education teachers focus on finding strength of students.

Q5	Could you explain your teaching experiences about creativity? How would you plan to encourage students’ creativity?
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See question 5, even though their teaching years vary, teachers explain their various teaching experiences about creativity. In terms of technology activities for creativity, G01, E05, S08 mentioned that using technology enables various choice student can be involved in classroom. Focusing on providing various activities, G01 deliver examples of creative activities with technology.

We do various activities like SCOOT which is like a Scavenger hunt. We do some online activities like Quizziz, which is online assessment where I put problems up. And, children can answer on their iPads. Kahoot is another online one that we do, that similar to where you put the questions up. And, children submit their answers on their iPad. Children could check how many they are right or wrong. It is a great way of review. I am just allowing kids to do Math talk, where they share their way of doing a problem. I am having children to do buddy-check verse the teacher is always checking, sometimes working in partners or in groups. Another thing, we do to be creative is to use QR codes.

E05 does a lot of technology based activities. “Students are doing a lot of project based activities, researching online, using iMovie, and google slides.” S08 also mentions that teacher and student can more cooperate with technology like the app. “We do a lot with technology; I think that you can more cooperate with technology. We are doing a lot of things with like the app, SESA. With the classes, we do a lot of social skills and interactions. I do have those in classrooms this year. It is more interactive bulletin board.”

Similar to Dynamic theory, G02 challenge students to learn frustration “Don’t be afraid of taking risk.” As Dynamic theory advocates, G02 experienced growth of creativity in

classroom within one year of teaching. G02 says, "Teaches should teach students to deal with frustration, it is the biggest thing of creativity." M03 points out collaboration with other teachers could broaden their perspectives and also teachers do not need to only follow standard.

My teaching experiences had been kind of all over the board, so I have done classroom teaching for 5 years, and I was a reading specialist, and I was interventionist for reading and math, and I was an academic coach. So, I have taught whole classes, small groups, co-taught with teachers, I have done with all the combination of all. I have been four different school district, they all did little bit differently. But, I think that collaborating, keeping open-minded and having the growth mindset is very important."

M04, E07, S09, and S10 give student choices and show representations. M04 mentions, "For me, I always use math menu type thing, try 'Tic-Tac-Toe board', 'Can do', 'Must do' those types of things, lots of choices. Because I wanted them to show what they knew, and they could pursue personalized learning." Similarly, E07 says, "I like to have students have choices in which problem they are going to work, 1st, 2nd, 3rd I like to compare strategy being used." S09 brought real representations to show the concept.

We are doing main idea and details activities. I brought my footstool from my rocker, and the legs screwed off. I put them all here. Without the legs, we talked about how tools comfortable without support. How the main idea is the comfort, what we are look for in the stool, just like we look for in a paragraph. But it is not as comfortable without support, so it doesn't mean as much as without support of its legs. And, so

then I put detailed signs on the legs of my stool. We went around the table, and one kids screwed in one leg, and he try to stand and fell over.

In addition, S10 also says, “I let them being creative moment how they are going to show me that number and represent things in their own ways without my saying. ‘You need to do tally, or you need to do 10 blocks’, they get to figure it out themselves, and things that they come up with is very creative sometimes, so it is pretty impressive.”

Academically, a teacher tried to bring his academic knowledge in his class. E06 did research based approach. E06 applied flipped learning based on master’s program, and found students could bring their creative ideas and show their ideas when they have time to focus.

I did my master’s project was the flipped class and in that we allowed students to show their knowledge before, so they were watching the lesson at home, and when they got to class, so we were able to have different activities are ready for the students when they came in instead of standing here and teaching the lesson. We were able to group them and have different activities set up based on their understanding, which was great and kind the start of what we have been able to do.

Q6	Do you pursue to learn about creativity by yourself?
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See question 6, every G01, G02, M03, M04, E05, E06, E07, S08, S09, S10 pursued to learn about creativity for their student. G01 says, “I am learning diverse technologies to integrate activities.” G02 admits, “I spend a lot of time to learn about creativity, how can we make it real world, how can we make it hands-on, how can we make it active. I work with

STEAM a lot, when we look at projects with the gifted students.” M04 learns creativity related resources during summer,

I do more of that in the summer than I do during the school year. I really think that it is kind of one of those things, again that same with kids. The more you do it, and find time for it, and they get more important. That sort of learning gets push to side. That is a good reminder.

E05 keeps learning to apply his class. “I am also looking at to Rubric cubes, how them I can use in the classroom. I did it last year and this year in my classroom. I am always looking at new things such as google classroom for my homework.”

E06 pursue to learn creativity as a team.

I work with five other 5th grade teachers as a team. We I think we push each other to be the best. We all have different strength, sometimes their creativity makes my classroom better and I hope vice versa, I can share an idea. We are just talking about always willing to change and flexible. None of us are set in one way and try to be flexible.

E07 reads journals and attends to gifted conference that has creativity session. “I read about journals that I see come across my Facebook, I have been to gifted conference that have creativity session that I attend.” This shows teachers eager to learn resources to activate creativity to be an innovative idea bank as Guo and Woulfin (2016) suggested P21 as a new model of creativity.

Mathematical creativity. From question 7 to 10, this is related to the mathematical creativity. Teachers related their responses from creativity and mathematical creativity. This

could show, research question one ‘Do teachers’ perceptions of mathematical creativity vary among different teacher groups including general education, instructional coaches (Mathematics coaches), talented program (enrichment program), and special education?

Q7	How do you define mathematical creativity?
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See question 7, mathematical creativity is commonly addressed various ways to solve mathematical problem. Especially, general education teachers, mathematics coaches, and enrichment program teachers shared similar opinion since G01, G02, M03, M04, E06, E07 expressed common definitions toward mathematical creativity. G01 defines, “Mathematical creativity is using a variety of strategy to solve problems.” Likewise, G02 asserts “Mathematical creativity is being flexible thinkers.” Also, M03 speaks, “Mathematical creativity is to address having different ways of problem solving. And, creativity and mathematical creativity are same but the difference is mathematical creativity would be more focus on the math skills.” M04 defines, “Mathematical creativity is able to explain in multiple ways.” E07 says, “Mathematical creativity sees in multiple ways that arrive at solution.”

One enrichment program teacher thinks that mathematical creativity is not visible. E05 says, “Mathematical creativity is covert process for gifted students. Students process everything in their brain. I think a lot of visual things like rubric cube, different types of patterns, children could figure out.”

Special education teachers see mathematical creativity with in-debt of thinking by having a question, deliver usefulness, and represent various things via math. S08 defines that

mathematical creativity is figuring out how to solve a problem or learning the concept of math, and students dig into more and ask themselves about their own questions of that concepts.

Mathematical creativity is more than just figuring out how to solve the problem or learning the concept of multiplication, and it is getting pass that point and actually wanting to they given to dig into more asking yourself questions about that you are creating your own questions about that concepts that you want to go further, kind of the whole concept of STEM. They are so interested and self-motivated to do more.

S09 says that mathematical creativity is relating math as a useful subject in various context.

“How is that going to help my future life? Student might think like this. I think that they take certain amount of creativity to do that.” S10 address that “Mathematical creativity is something that can be applied so many things that you really can’t get creative with math. It is about how you represent, number is one to one correspond that representation. For example, it is about how student represent numbers.”

Q8	Could you explain the relationship between mathematics and creativity?
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See question 8, teachers agreed with math and creativity has a relationship and mathematical creativity allows various ways to solve mathematics problem. This definition correspond Sriraman’s definition as (a) the process that results in unusual (novel) and/or insightful solutions to a given problem or analogous problems, and/or (b) the formulation of new questions and/or possibilities that allow an old problem to be regarded from a new angle requiring imagination (Einstein & Inheld, 1938; Sriraman, 2005).

G01 points out the math as a logical object and the ways to reach the result can be creative.

Because of the exact mass of math, you can really look at the final product, but maybe, how you get to the final product can be creative. And, especially certain things of higher level of thinkers can do a lot of work in their head. That is creative. I allow them to be creative as long as they get the right answer.

G02 also agree with the relationship, “I think that they go hand and hand. Math has never been looked at something creative, numbers and answers. But, there is a lot of thinking, there is a lot of problem solving, there is a lot of ways to explain you in math.” Similarly, M03 thinks that creativity support problem solving especially in the higher level of math.

I do think that they go a lot of times hand and hand. People who are good at math, many times are creative. I have been seen students, that don't necessarily always a way. I think that people who are creative will do better the higher math, yet. I think if you are not creative, you can get basic math. As it gets higher and higher and you have to think outside the box. I think you are not creative, it gets to be tough.

M04 says “I think mathematical creativity able to communicate what you know in math.” E05 brings an example to explain the relationship, “Doing different coding and different things are like the relationship between mathematics and creativity. All the way from looking at an array, 3 multiply 3 is 9 to being able to code a robot. Students can see the pattern. When I think creativity in mathematics, it is always patterning to me.” E06 says the relationship as color, “Math is traditionally black and white subject. Mathematical creativity is a grey which is interesting thing which forces students to understand that the process is very important.

Standardized test judge only answers, and cannot see the process of problem solving.” E07 thinks, “The creativity able to see a variety of strategy that would be handy to solve a certain type of word problem or in math expressions our curriculum.” S08 mentions, “Mathematical creativity allows questioning and going through higher level of math.” S09 sees interjecting creativity to math make it interesting, relatable, and fun and feels the relationship should be intertwined. S10 speaks “Math can be represented in different ways, how students carry out problem, how students carry out problem, how students show problem and numbers, and how students represent it.”

Q9	Are there differences between creativity and mathematical creativity?
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See question 9, seven teachers think that there are differences between creativity and mathematical creativity, but they agreed with mathematical creativity helps problem solving. G01 thinks, “The difference would be final products between creativity and mathematical creativity. But most of time, math is black or white.” G02 thinks that creativity helps mathematical creativity. “Mathematical creativity enables to be stronger mathematician.” Likewise, M04 asserts, “Creative activity supports mathematical creativity.” E05 also think those are supportive concept, “The difference between creativity and mathematical creativity is mathematical knowledge since mathematical knowledge is crucial factor for activating their mathematical creativity.” Similar to G01, E06 thinks, “Math sometimes limits how variously solve questions but, creativity is more open-ended to prove one’s understanding or solve the problem.” E07 says,

There are differences between creativity and mathematical creativity. I also can see somebody is real visual learner, they could see problem like a diagram or a map kind of draw a picture, whereas visual creativity in art might help in mathematics also. The ability to come up with lots of different ideas when you are stuck, now what things there up, now what posters when you are stuck, write down what you know, try a new strategy or new idea, try a different idea.

S10 admits differences between creativity and mathematical creativity, and says

“Mathematical creativity is driven more towards to mathematical side while you are trying to represent something showing how you got to. But, I also agree that they can be correlated.”

Three teachers, M03, S08, S09, think that creativity and mathematical creativity is inherently identical. M03 thinks that the essence of creativity and mathematical creativity is same. S08 asserts, “The concepts are same between creativity and mathematical creativity.” S09 thinks, “Creativity and mathematical creativity comes together.”

Q10	What students’ characteristics can be expressed in mathematical creativity?
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See question 10, teachers brings several students’ characteristics in mathematical creativity. G01 views “Mathematical creativity can be seen in different ways of solving problems.” G02 sees if from confidence of students, M04 asserts, “Attitude of students’ around their perceived math ability.” E05 says, “Figuring out everything in their brain.”

Three teachers, M03, E06, E07, commonly address perseverance in in mathematical creativity. M03 says, “Persistent and do not give up easily.” Similar to M03, E06 brings up

“Perseverance”, E07 also mentions, “Perseverance to move on different idea or different strategy and taking risk.”

Special education teachers see more individualized features in mathematical creativity. S08 address different strength of each student. “Some students are really good at one area and some of them are not really strong at other areas.” S09 mentions self-expression of creativity, humor, usefulness, self-esteem, curiosity, a sense of belonging, S10 also says humor from mathematically-talented students.

Research Question Three

Mathematical creativity with regard to gifted students. From question 11 to 14 and 16, teachers respond about mathematical creativity and giftedness. This could show research question three, ‘How do teachers perceive relationship between mathematics, creativity and giftedness?’ Question 16 is conducted at the last part of each interview. Because this is about teacher’s image which takes time to express relationship between mathematics, creativity and giftedness. This question includes teachers’ explanation of the image.

Q11	How do you address mathematical creativity with regard to gifted students?
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See question 11, teachers address their own way of mathematical creativity with regard to gifted students. Two general education teachers and enrichment program teachers challenge their curricular similar to Dynamic theory’s assertion. G01 gives differentiated activities and has an enrichment or extra credit worksheet that I offer to students that could give them extra credits.

I have an enrichment or extra credit worksheet that I offer to kids that is kind of how I give them extra credits. And I think, offering the above level of math is the next steps. We encourage those kids who we know gifted or higher to do above the work. I will show you one of the worksheet, like geometry town, this was the grade level, but the enrichment or higher level, the above grade level they had to do little bit more complex about math. We are just allowing them to do the problems.

G02 provides “Growing your brain” activity which gives a chance to create the problems in their own way to solve it by providing problem context. G02 says to students, “Here is the problem context. Here are your ranges about you’ve got to do. And then, we left them of pile of ways to solve it. You can use number tiles, you can use linking tools, you can use cubes, you can use maker boards.” Also, E05 addresses mathematical creativity with regard to gifted students by doing various activities. “For instance, I have a group of 5th grade students who are doing a geometry activity. And, we are doing Geo-Metro city which had 2 by 6 grid, and they had to put a 3D dimensional city on there.” E06 suggests doing a project instead of just doing traditional worksheets which makes students to think about things differently.

Like I mentioned before, recently I had a Tic-Tac-Toe activity, for students to prove what they knew about area and surface area. Students who were able to find create cereal boxes and create a project instead of just doing traditional worksheets which makes them think about things differently. It makes slow down with project because it enabled to go quickly through problem when they are given tasks. They fully understand the concept.

E07 addresses, “It is important to acknowledge multiple methods. Teachers might have how to solve it, but there might be many other answers that you didn't think of.”

Mathematics coaches bring mindset and importance of explanation. M03 stress positive mental attitude that having the growth mindset to student, “You have to know your mind can grow, just like your body.” M03 let students know that they can grow as high as they want to. This is same position as Star Model-Nurtured aspect of giftedness. And M03 try to challenge curricula like Dynamic theory. Also, this context falls into developmental progress in Domain model. M04 thinks, “Explanation should be encouraged for gifted students to activate mathematical creativity and interpretation in a non-literal way or in a way that they haven't thought about yet.”

Special education teachers focus on strength of each student who is gifted. S08 insists individualized support for the gifted area.

It is important to know what their areas are gifted in, making sure that you are providing a lot of opportunity for them to express themselves, ask questions to be creative and showing what they know in that specific category. But, teachers should be mindful that there are other areas that they are learning at the same pace, or maybe even slower face more than the other students.

S09 asserts to allocate enough time for students who are mathematical giftedness could try to learn more with open-ended activities.

I think with gifted students, you need to make creative enough to have them invest time to learn more. So, they realize that they don't know at all. And, I think that is kind of a tap dance, but just let them have a cardboard box and some masking tapes,

and let them go add it. I think the maker stations that they are doing now are really great idea. But I think they can be a little bit too programmed, sometimes.

S10 also says. “I think bringing out their strength, letting them show how they see it, rather than just teaching formula. I think being them kind of power little bit to control their own learning.”

Q12	How do you perceive giftedness?
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See question 12, teachers perceive giftedness as effortlessly earned, innate, above peer, or everyone has different gift. Some teachers, G01 and M03, are aware of giftedness as an inherent characteristic. G01 speaks out, “I believe in that gifted students know without thinking with real hard.” M03 says, “I perceive giftedness as being certain one specific skill or several, or someone is above the norms or above their peers. So, they are born with it, they can be somewhat cultivated, too. But, I think that there is innate giftedness. ”

Other teachers, G02, S08, S09, and S10 hesitate to define the concept adamantly. G02 says, “It is hard to decide the students who are really gifted.” G02 says, “It is hard to just say what is giftedness and it is hard to necessarily make a whole group of gifted kids.” Likewise, special education teachers assert that giftedness cannot be noticed when they have disabilities also such as twice exceptional. S08 points out, “There are myth and truth toward students who have gifted area: They are gifted in some area, but they are not always good at doing everything. They also need accommodation.” S09 mentions, “Giftedness is really if teachers were to define and perceive it. It would be beyond the norm and average, stand out accomplishment, but not necessarily just in math or reading.” S10 speaks, “Giftedness is a

significant strength in an area of learning, but the strength often goes unnoticed and not visibly outside, often negative towards them because people don't recognize that."

All enrichment program teachers and one math coach think that student who are gifted have a strong curiosity and challenge more. M04 believes, "Giftedness is a whole package of attitude and perseverance with students who don't avoid to challenge." E05 insists, "Gifted students want to learn more and who wants to challenge more." E06 also points out, "Gifted students are not waiting for knowledge. They are interested in main topic, and they need to be more of a mentor and a coach to try to obtain the knowledge that they are looking forward. They exceeded level of the standards we are looking for." Similarly, E07 identifies giftedness, "Gifted students have strong curiosity, perseverance and questions, and aren't satisfied before they could figure out."

Q13	Is there a relationship between creativity and giftedness? If so, how?
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See question 13, most of teacher address that there is a relationship between creativity and giftedness. Both general education teachers and one enrichment program teacher, G01, G02, and E06 admit relationship but also agree that there are some students who are gifted but they just want worksheet or pursue one way. G01 witnesses, "Some students who are gifted but they just want to receive worksheet and say please tell me what I should do." G02 also mentions, "Some of gifted students are very rigid and pursue one way." E06 doesn't think there are strong relationship between creativity and giftedness. "Because some students are more programmed go through the equation, or process or the algorithm."

Mathematics coaches, two enrichment program teachers, and all three special education teachers agree that there is a relationship between creativity and giftedness. M03 points, “Creativity and giftedness usually go hand and hand. Gifted kids are creative.” M04 also thinks, “Gifted students who really have mathematical giftedness can take situation and apply them in a different way.” Likewise, E05 agree with the relationship between creativity and giftedness that go together. “Students who are good at art and different things, and they are good at math and everything.” E07 sees the relationship between creativity and giftedness. “Because bank of ideas and that ability to have fluent ideas keep walking from solve problems to come up with responses.” In addition, all three special education teachers show common opinions which admit gifted students are creative. S08 thinks, “Students are considered gifted in think outside of the box.” Also, S09 absolutely points, “There is a relationship between creativity and giftedness. Gifted students are comfortable with being wrong and wanting to know why, and going down a different road or different path being comfortable with that.” S10 says, “Gifted students are very creative in their thinking, because I believe their creative mind can brings out their giftedness.”

Q14	What factors can affect the creativity of mathematically-talented students?
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See question 14, teachers brings several categorized factors that can affect mathematical creativity to gifted students. This various elements are same context as DMGT 2.0. Teachers think there are several things that can affect the creativity of mathematically-talented students: Teacher, Student, Demographic and environment, and Administration. This

is same context as Karp (2010) suggested, collaborative atmosphere and extensive interaction with other teacher will also support to prepare mathematically-talented students.

This question shows epitome of different opinions based on teaching group of general education teachers, mathematics coaches, enrichment program teachers, special education teachers. General education teachers address teacher's factor. G01 address that teachers could give students different choices. "We play games to reinforce the skills that we are done." G02 also addresses, "Teacher could encourage student by giving them to be risk takers, and make them the confidence."

Mathematics coaches see both teacher and students factors. M03 mentions, "Teachers' teaching strategies, philosophy, and students' factors might affect. For example, peers how making fun of them, being supportive, social pressure, and difficulty and their special needs." M04 says, "Both teachers' effort and students' mindset affect creativity. Teachers could avoid students get bored."

Enrichment program teachers focused more on student's factor. E05 says, "Students' emotional and environmental factor affect creativity such as their home life, friendship, any sort of emotional things and concern." E06 thinks students' brain development. E07 also see students' factor such as perseverance and perfectionism.

Special education teachers see various factors such as teacher's factor, students' environmental factor, and administration factor. S08 says, "Teachers' knowledge, demographic factor and administrators might affect." S09 says, "Environment of student such as their leader has a big thing to do with it." S10 asserts, "Limited space and limited time affect to use their creativeness."

Otherwise, with regard to leadership, M03 and S09 shares student's relationship and leader affects mathematical creativity. This position could be related WICS model, creativity is one of ability of leadership.

Research Question Two

Mathematical creativity with twice exceptionality. This could show research question two, 'How do teachers address twice exceptionality?'

Q15	How do you address mathematical creativity when you teach twice exceptional students who are gifted but also have disabilities?
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See question 15, teachers address mathematical creativity when you teach twice exceptional students who are gifted but also have disabilities. Teachers modify their expectation, collaborate with other teacher, address social and emotional needs, and support disorganization issues. General education teachers and mathematics coaches provide modified support and admit their struggle. G01 speaks, "I think modifying the expectation of student is required." G02 ask parents' support, and teacher's collaboration.

I think all different things we do accommodate. I went through that whether they are gifted or twice exceptional children. I think that there are multiple steps of expectation. We email to parents back and forth explaining organizational skills is usually a big barrier for gifted and talented or twice exceptional students. Sometimes we make them sitting who moves around, once we gave them assignments.

M03 address social, emotional needs for the twice exceptional students. "Teachers could address those students being included and getting along with other students." M04 agreed that

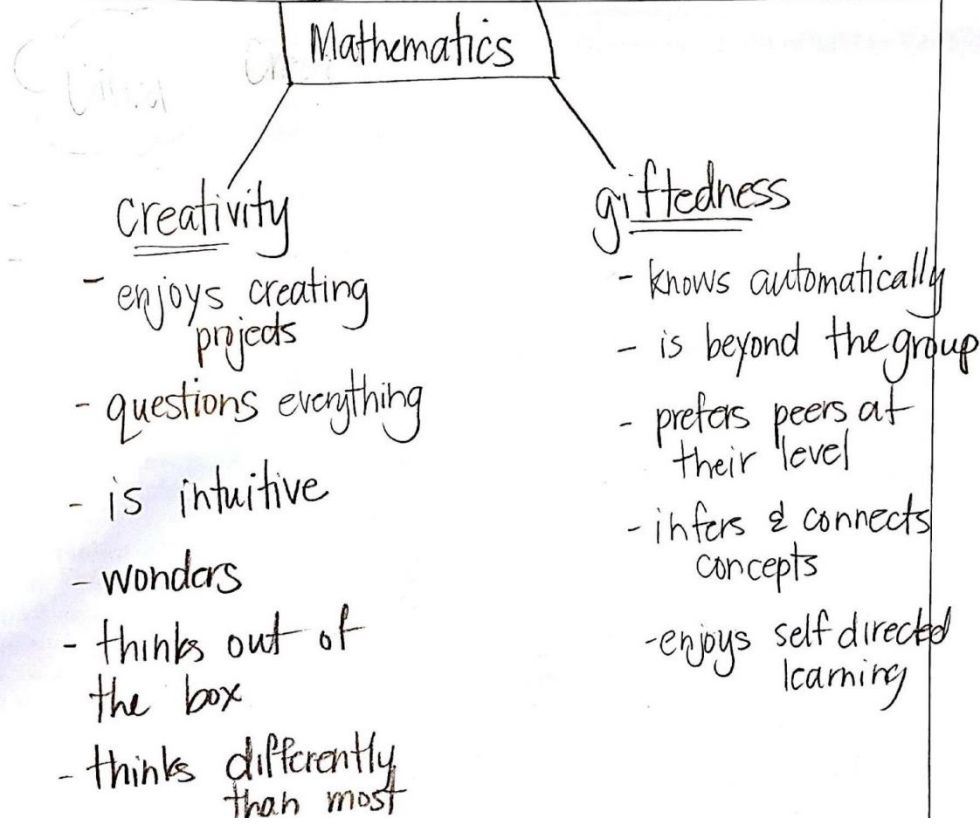
teachers struggle a lot with that group. “Because twice exceptional students who are really smart, they frequently have disorganization issues.”

Enrichment program teachers encourage small group or partner activities. E05 says, “I have a small group, be able to work with that type of students, and try them to trust teacher.” Likewise, E06 asserts, “I try to do a lot of small group work trying to set those students up for the real world. Students who have ASD spectrum whether it is Asperger or autism social piece are hard for him to be creative in a group even though they are great number. Students are sometimes more afraid to make mistakes.” E07 says, “I try to pick a partner type of activities that have comfortable personality, comparable intellectual levels where they would find a way on that particular assignment.”

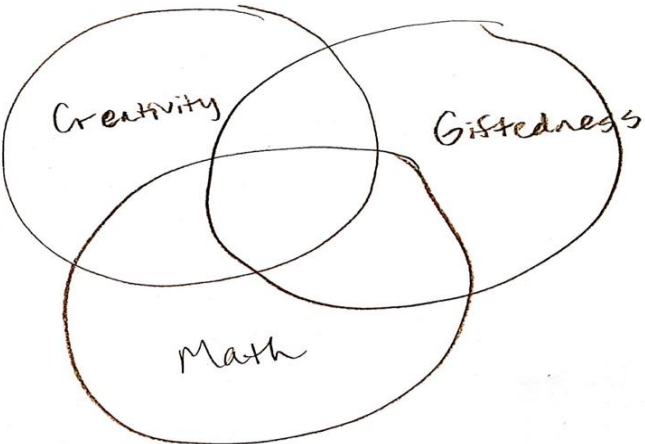
Special education teachers strengthen individual support and discuss hardness. S08 addresses, “Teachers should get to know individual strength of twice exceptional students who are tough because there are a lot of things especially with organizing, socializing or some of those things can go hand and hand.” S09 admits,

Encouraging twice exceptional students is a big challenge even if there are trustful relationship between a student and a teacher. I failed the creativity task. Because I was not able to progress, we make a little progress and go back, we make a little progress and go back. One of my students has a spectrum and his home life was ended up losing his mom this summer. So, it is very tragic.

S10 mentions, “I support twice exceptional students that they need. They may have the ability, but they may need support in another area where they have that disability. One of my students is very smart in mathematics, but because of disability he needs to support from an adult.”

Q16	Could you draw a diagram or image to show the relationship between creativity, giftedness, and mathematics?
G01	 <p> Creativity - enjoys creating projects - questions everything - is intuitive - wonders - thinks out of the box - thinks differently than most </p> <p> Mathematics giftedness - knows automatically - is beyond the group - prefers peers at their level - infers & connects concepts - enjoys self directed learning </p> <p>Creative students appear gifted in math, but may not necessarily be gifted.</p>
G02	<p> $\text{mathematics} + \text{creativity} = \text{giftedness}^2$ </p> <p>When I think of mathematics mixed with creativity, giftedness grows exponentially.</p>

M03

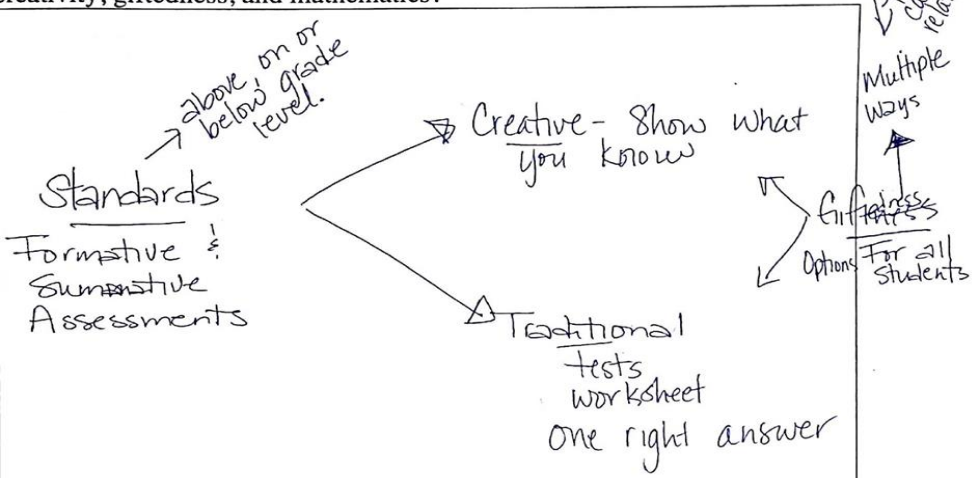


They can each exist on their own or with each other. They can all be together in a student, too.

M04

'EACHERS' CREATIVITY PERCEPTIONS FOR MATHEMATICALLY GIFTED STUDENT
 Principal Investigator: Yewon Sung (ysung@stcloudstate.edu)

5. Could you draw a diagram or image to show the relationship between creativity, giftedness, and mathematics?



Standards
 → above, on or below grade level.
 Formative & Summative Assessments

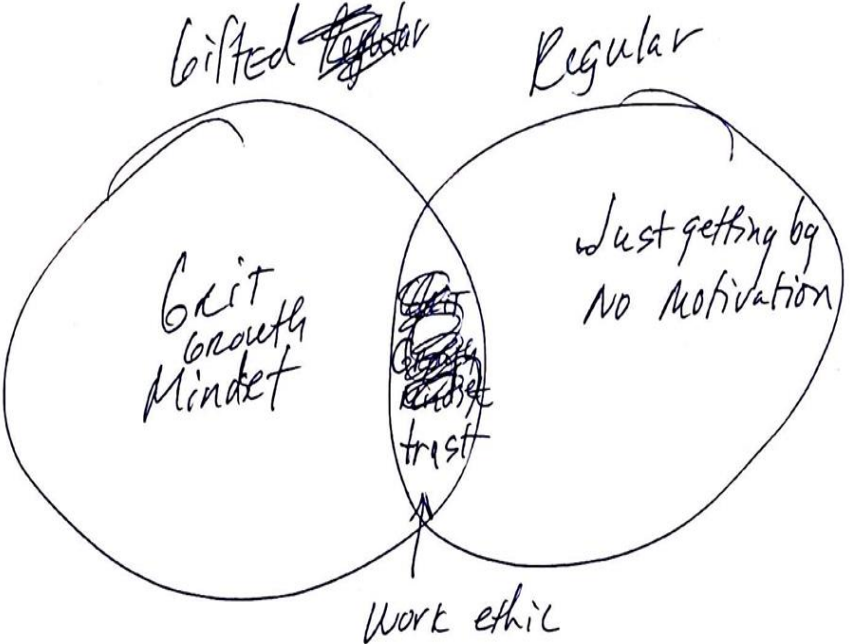
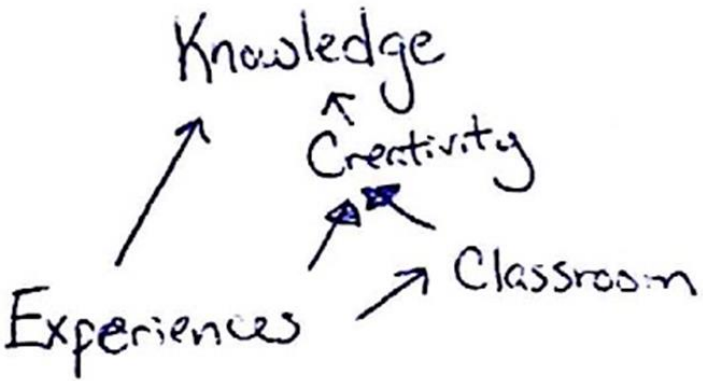
Creative - Show what you know

Traditional tests worksheet one right answer

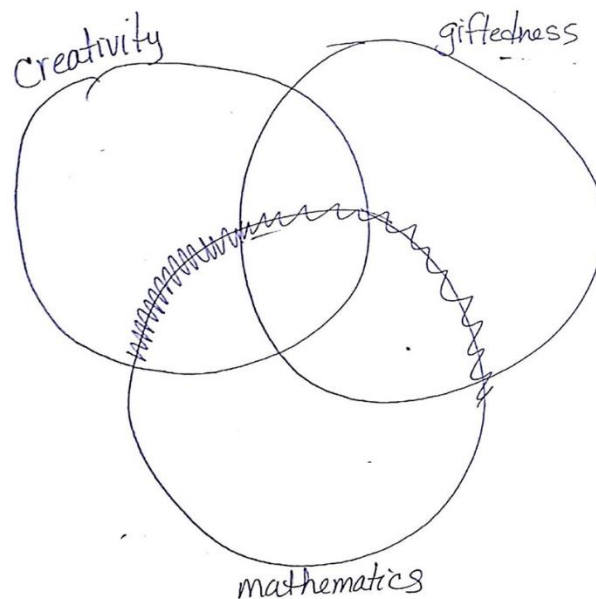
Giftedness
 Options For all students

connections
 Thinking can be applied to relationships
 Multiple Ways

Giftedness can be shown within traditional methods of assessment; also being able to show multiple levels of understanding on any standards. Often students who are gifted are working outside grade level standards.

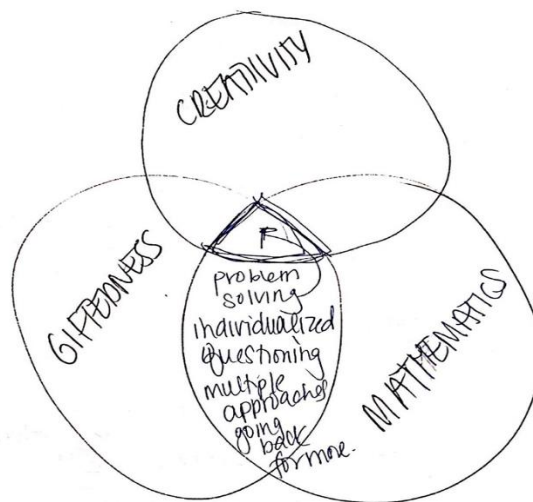
E05	 <p>I am showing how gifted learners and regular education learners are the same and different.</p>
E06	 <p>Creativity is part of a sequence that leads students to math knowledge.</p>

E07



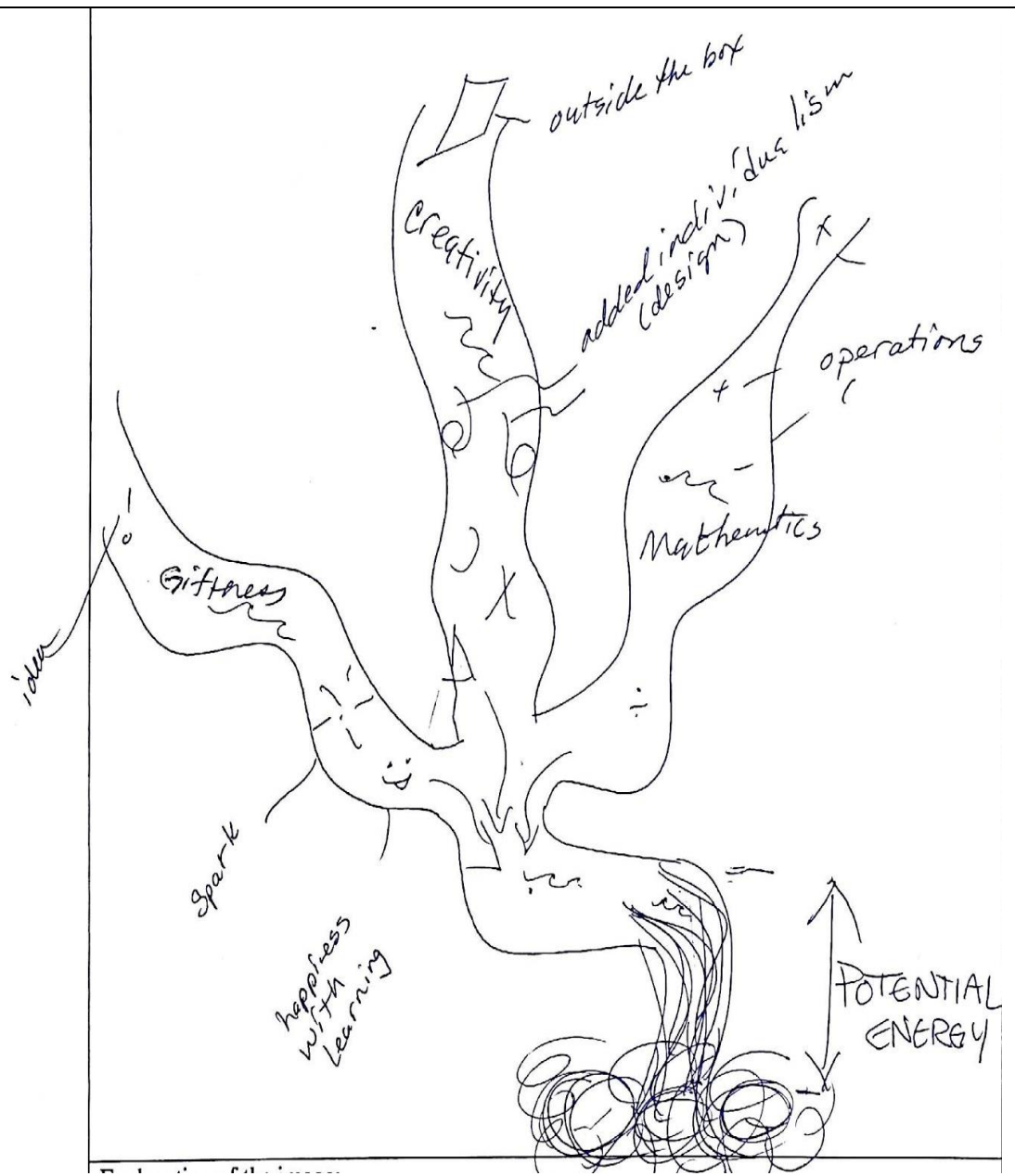
There is some overlap between these three as well as domain-specific concepts.

S08

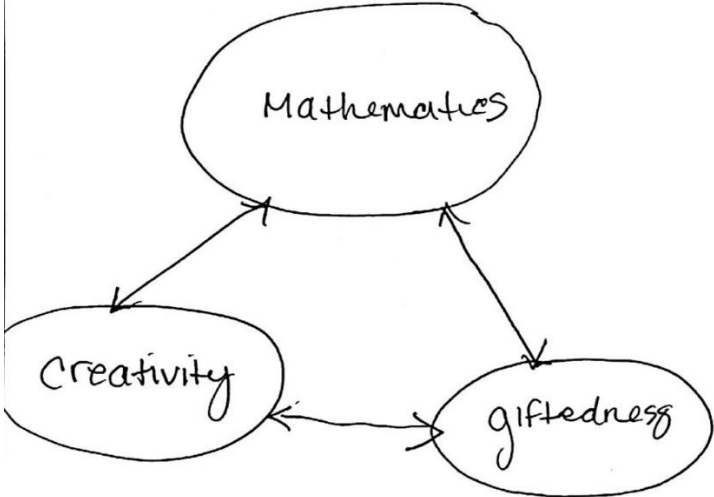


All three components require foundational and basic knowledge, pushed past that and questioning more; creating and solving own problems.

S09



Three rivers converge before cascading over the falls. Creating maximum potential energy-falling. The water creates excitement and beauty at the bottom.

S10	 <p data-bbox="321 850 1307 1029">Both creativity and giftedness can play a role in mathematical thinking either separately or concurrently. They each have an impact on each other whether negative or positive.</p>
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See question 16, teachers bring their image to show the relationship between creativity, giftedness, and mathematics. This is very open-ended question and images vary up to teachers. Question 16 is conducted at the last part of each interview. Because this is about teacher's image which takes time to express relationship between mathematics, creativity and giftedness. This question includes teachers' explanation of the image. This question includes teachers' explanation of the relationship.

G01 expressed creative students appear gifted in math, but may not necessarily be gifted. Mathematically-talented students belonged to mathematically creative students. G02 thinks when mathematics mixed with creativity, giftedness grows exponentially. This assumes that there are growth levels of giftedness. S09 thinks math, creativity, and giftedness are

similar to three rivers converge before cascading over the falls. Creating maximum potential energy, falling water creates excitement and beauty at the bottom.

M03 suggested relationship between math, creativity, and giftedness can be each exists on their own or with each other. They can all be together in a student, too. E07 also expresses unclear border line overlapping between these three as well as domain-specific concepts. Similar to M03 and E07, S10 insists that both creativity and giftedness can play a role in mathematical thinking either separately or concurrently. They each have an impact on each other whether negative or positive.

M04 asserts that giftedness can be shown within traditional methods of assessment; also being able to show multiple levels of understanding on any standards. Often students who are gifted are working outside grade level standards.

E05 shows how gifted learners and regular education learners are the same and different based on motivation. But, it did not mention math and creativity. E06 focuses on mathematics knowledge. Creativity is part of a sequence that leads students to math knowledge. S08 also focus on math knowledge since all three components require foundational and basic knowledge, pushed past that and questioning more and allowing creating and solving own problems. This position is within same context as Karp (2010) suggested that teacher should deliver mathematical knowledge.

Summary

Results of this study gave insight to the four groups of teachers. Also revealed were the results of mathematical creativity accepted in a various way, but teachers keep learning creativity related resources.

Even if teachers' responses and perception vary, general education teachers focused on instructional technology and curricular support. Mathematics coaches, similarly, tried to support general education teachers to think outside the box and provide various activities. Since mathematics coaches have experienced general education teaching, their thinking was similar to general education teachers.

Otherwise, enrichment program teachers encourage small group activities and challenge above level experiences. Special education teachers agreed that finding individual strength and building trustful relationship to support different type of mathematical creativity. Chapter 5 provides a discussion of these results.

Chapter 5: Discussion, Recommendations, and Conclusions

Introduction

Included in this chapter is a summary of the findings for this study. Also, links to current research, observations, limiting factors, and implications for the future are addressed. Research in the area of teachers' creativity perception for mathematically gifted students is limited because lack of data (Leikin, 2011). Leikin (2011) says since there are both common areas among creativity, mathematics, and giftedness and separate areas, if there is a clear line between those concepts, education will be linear like mathematics.

This qualitative research shows how teachers variously approach to encourage mathematical creativity student who are gifted in math in general classroom, enrichment classroom or special classroom. Whether students has another difficulties or not, teachers have worked on accommodate their needs.

In an effort to extend existing research in the area of teachers' creativity perception for mathematically gifted students involving creativity, mathematical creativity, mathematical creativity with giftedness, relationship between mathematics, creativity and giftedness , the following questions have been addressed: (1) Do teachers' perceptions of mathematical creativity vary among different teacher groups including general education, instructional coaches (Mathematics coaches), talented program (enrichment program), and special education? (2) How do teachers address twice exceptionality? (3) How do teachers perceive relationship between mathematics, creativity and giftedness?

Chapter 5 is organized by discussing each research question in a sequential format. The chapter will end with detailing conclusions based on the results of the study, and making recommendations for future research.

Research Question One

Do teachers' perceptions of mathematical creativity vary among different teacher groups including general education, instructional coaches (Mathematics coaches), talented program (enrichment program), and special education?

Ten interviewees' data were collected to address this question: Findings for this research question is also supported by the creativity in giftedness models and theory, and definition of Sriraman (2005) mathematical creativity.

Fourteen questions were suggested from (1) creativity, (2) mathematical creativity, and (3) mathematical creativity with regard to giftedness.

Choices and creativity. Since teachers' teaching experiences come from different setting such as whole group instruction or small group instruction, general education teachers, mathematics coach, enrichment program teachers addressed creativity by providing a lot of activities for students. For instance, students address various activities and options. From G01, G02, M03, M04, E05, E06, E07 agree with allowing students options by providing different activities. This context prop up the Dynamic Theory of creativity, as a teacher, teachers focus on providing challenging curricula. General education teachers, mathematics coaches, enrichment program teachers commonly shared this opinion.

Special education teachers, however, are aware of individually different ability as creativity. S08 focus on strength of student, S09 also mention that students can relate to in a

personal level. This view is close to DMGT 2.0 model since expression of creativity is reliant on the various influential elements. S10 asserts that students learn differently and focus on individually various expressions. To sum, general education teachers, mathematics coaches, enrichment program teachers commonly asserted providing challenging curricula is crucial for nurturing creativity. Special education teachers more focus on individual strength.

Standard and creativity. Pointing out strict standard and curriculum, G02 says limited flexibility in curriculum, and E06 think creativity is limited little bit because of standards and need more time to encourage creativity. Their opinion strengthens Guo and Woulfin (2016)'s opinion that suggested policy makers and reformers should also include creativity into educational policies and standards.

Technology integration for creativity. When it comes to technology activities for creativity, G01, E05, S08 mentioned that using technology enables various choice student can be involved in classroom. Focusing on providing various activities, G01 deliver examples of creative activities with technology. E05 does a lot of technology based activities. Students are doing a lot of project based activities, researching online, using iMovie, google slides. S08 also mentions that teacher and student can more cooperate with technology like the app.

Challenging curriculum. Similar to Dynamic theory, G02 challenge students to learn frustration "Don't be afraid of taking risk." As Dynamic theory advocates, G02 experienced growth of creativity in classroom within one year of teaching. M03 points out collaboration with other teachers could broaden their perspectives and also teachers do not need to only follow standard.

Research based approach and effort of teachers. Enrichment program teacher, especially E06 did research based approach. E06 applied flipped class based on master's program, and found students could bring their creative ideas and show their ideas when they have time to focus.

From question 6, it is clear that every G01, G02, M03, M04, E05, E06, E07, S08, S09, S10 pursued to learn about creativity for their student. This shows teacher already eager to learn resources to activate creativity to be an innovative idea bank as Guo and Woulfin (2016) suggested P21 as a new model of creativity. M04 learns creativity related resources during summer vacation. E06 pursue to learn creativity as a team. E07 reads journals and attends to gifted conference that has creativity session.

Mathematical creativity. From question 7, this is related to the mathematical creativity. Teachers related creativity and mathematical creativity. Mathematical creativity is commonly addressed various ways to solve mathematical problem. Especially, general education teachers, mathematics coaches, and enrichment program teachers suggests similar opinion. G01, G02, M03, M04, E06, E07 shared similar definition toward mathematical creativity. G01 defines mathematical creativity is using a variety of strategy to solve problems. Likewise, G02 asserts that being flexible thinkers. Also, M03 mathematical creativity is to address having different ways of problem solving. And, creativity and mathematical creativity are same but the difference is mathematical creativity would be more focus on the math skills. M04 defines mathematical creativity is able to explain in multiple ways. E07 sees in multiple ways that arrive at solution. E05 says mathematical creativity is covert process for gifted

students. Students process everything in their brain. While E05 teaching rubric cube, there were different types of patterns.

Special education teachers see mathematical creativity with in-debt of thinking by having a question, deliver usefulness, and represent various things via math. S08 defines that mathematical creativity is figuring out how to solve a problem or learning the concept of math, and students dig into more and ask themselves about their own questions of that concepts. STEM related foundational skills can also be found in mathematical creativity. S09 says that mathematical creativity is relating math as a useful subject in various context. S10 address that mathematical creativity is something that can be applied so many things that you really can't get creative with math. For example, it is about how student represent numbers.

Teachers agreed with math and creativity has a relationship and mathematical creativity allows various ways to solve mathematics problem. This definition correspond Sriraman's definition as (a) the process that results in unusual (novel) and/or insightful solutions to a given problem or analogous problems, and/or (b) the formulation of new questions and/or possibilities that allow an old problem to be regarded from a new angle requiring imagination (Einstein & Inheld, 1938; Sriraman, 2005).

Mathematical creativity with regard to giftedness. Teachers address their own way of mathematical creativity with regard to gifted students. Two general education teachers and enrichment program teachers challenge curricular similar to Dynamic theory. G01 gives differentiated activities and has an enrichment or extra credit worksheet that I offer to students that could give them extra credits. The above grade level they had to do little bit more complex about math. G02 provides "Growing your brain" activity which gives a chance to

create the problems in their own way to solve it by providing problem context; ranges left them of pile of ways to solve it such as number tiles, linking tools, cubes, maker boards. Also, E05 addresses mathematical creativity with regard to gifted students by doing various activities. E06 suggests doing a project instead of just doing traditional worksheets which makes students to think about things differently. It makes slow down because it enables to go quickly through problem when they are given tasks and choices. E07 addresses to acknowledge multiple methods.

Mathematics coaches bring mindset and importance of explanation. M03 stress positive mental attitude that having the growth mindset to student, “You have to know your mind can grow, just like your body.” M03 let students know that they can grow as high as they want to. This is same position as Star Model-Nurtured aspect of giftedness. And M03 try to challenge curricula like Dynamic theory. Also, this context falls into developmental progress in Domain model. M04 thinks that explanation should be encouraged for mathematical creativity and interpretation in a non-literal way or in a way that they haven't thought about yet.

Special education teachers focus on strength of each student. S08 insists individualized support for the gifted area. S09 asserts to allocate enough time for students who are mathematical giftedness could try to learn more with open-ended activities. S10 thinks bringing out their strength, letting them show how they see it, rather than just teaching formula.

Research Question Two

How do teachers address twice exceptionality?

Ten teachers' answers are different from different setting of teaching. First, teachers address mathematical creativity when they teach twice exceptional students who are gifted but also have disabilities. Teachers modify their expectation, collaborate with other teacher, address social and emotional needs, and support disorganization issues.

General education teachers and mathematics coaches provide modified support and admit their struggling. Enrichment program teachers encourage small group or partner activities. Special education teachers strengthen individual support that student need.

Research Question Three

How do teachers perceive relationship between mathematics, creativity and giftedness?

From question 11 to 14 and 16, teachers respond about mathematical creativity and giftedness. Question 16 is conducted at the last part of each interview. Because this is about teacher's image which takes time to express relationship between mathematics, creativity and giftedness. This question includes teachers' explanation of the image.

Beauty of mixed area between math, giftedness, creativity. G02 thinks when mathematics mixed with creativity, giftedness grows exponentially. This assumes that there are growth levels of giftedness. S09 thinks math, creativity, and giftedness are similar to three rivers converge before cascading over the falls. Creating maximum potential energy, falling water creates excitement and beauty at the bottom.

Difference and common area between math, giftedness, creativity. G01 expressed creative students appear gifted in math, but may not necessarily be gifted. Mathematically-talented students belonged to mathematically creative students. M03 suggested relationship

between math, creativity, and giftedness can be each exists on their own or with each other. They can all be together in a student, too. E07 also expresses unclear border line overlapping between these three as well as domain-specific concepts. Similar to M03 and E07, S10 insists that both creativity and giftedness can play a role in mathematical thinking either separately or concurrently. They each have an impact on each other whether negative or positive.

M04 asserts that giftedness can be shown within traditional methods of assessment; also being able to show multiple levels of understanding on any standards. This shows developmental progress of Domain specific model. E05 shows how gifted learners and regular education learners are the same and different based on motivation. But, it did not mention math and creativity.

Math knowledge and mathematical creativity. E06 focuses on mathematics knowledge. Creativity is part of a sequence that leads students to math knowledge. S08 also focus on math knowledge since all three components require foundational and basic knowledge, pushed past that and questioning more and allowing creating and solving own problems. This position is within same context as Karp (2010) suggested that teacher should deliver mathematical knowledge.

Recommendations

First, further research could suggest authentic activities maximize creativity in each classroom setting since this research reveals different perceptions from different teacher groups.

A second recommendation is to ensure reliability of results would be strengthened with similar teaching years of teachers. Because of different teaching years from 1.5 years to 27 years, perceptions of teachers could be various that they have seen in the classroom.

Third, it is difficult with teachers experience involving gifted education because of limited chance to meet gifted students in general education. In addition to this, mathematically-talented students are taught in enrichment program.

Finally, the time to conduct interviews for this study was 30 minutes. Allowing enough time to respond would generate enough time to complete thoughtful responses for most teachers bring more ideas.

Conclusion

In conclusion, results gathered from this study gave insight to the four groups of teachers. Also this revealed the perceptions of mathematics, creativity and giftedness accepted differently from each teacher group. All teacher groups admitted that they pursue to keep learning creativity related resources. Some teachers pointed out limited time and strict standards are barrier to encourage creative activities in classroom.

Even if teachers' responses and perception vary, general education teachers focused on instructional technology and curricular support. Mathematics coaches tried to support teachers think outside the box and provide various activities. Since mathematics coaches experienced general education teaching, their responses were similar to general education teachers.

Enrichment teachers encourage small group activities and challenge above level experiences. Special education teachers agreed that finding individual strength and building trustful relationship to support different type of mathematical creativity.

On the other hand, twice exceptional students are receiving modified curriculum in inclusive classroom, but special education teachers focused more on individual strength.

As researchers observe ways for teachers to succeed in mathematical creativity toward gifted students, teachers were proudly delivered their teaching experiences and stories. Indeed, by providing appropriate lessons for each student, teachers feel big reward from them and also keep pursuing to learn about creativity by themselves or as a team. One recommendation for the future research to support teachers is that creativity related project or activities should be allocated in standards. Trying to support students whether they have hardship or not, teachers provide more opportunities to buttress creativity progress with a larger degree of ideas. This research shows the differences between teacher groups and relationship between creativity, math, and giftedness.

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Appendix A: Consent Form

You are invited to participate in a research study about interpretation frame of mathematical creativity definitions from different teachers' group. If you agree to be part of the research study, you will be asked about mathematical creativity definition. Benefits of the research define how teachers address mathematical creativity to teach mathematically-talented students, and the potential positive impacts for teachers are supporting mathematically-talented students effectively.

The procedures you are being asked to participate are writing consent form, reading interview guide, interviewing, drawing your Venn diagram or image. It will take about 30 minutes. Interview questions are like below.

1. How do you address creativity?
2. How do you define mathematical creativity?
3. How do you address mathematical creativity with regard to gifted students?
4. How do you address mathematical creativity when you teach twice exceptional students who are gifted but also have disabilities?
5. Could you draw a diagram or image to shows the relationship between creativity, giftedness, and mathematics?

Risks and discomforts can be caused that you would feel compromise to answer or you may feel not familiar with several concepts toward mathematically-talented students.

Data collected will remain confidential. Your responses will be kept strictly confidential; your name will not be disclosed nor will identified direct quotes be used. During the interview, you may refuse to answer any questions. After the completion of the interviews,

you will receive your transcribed interviews. At this point, if you wish to make expand responses or note omissions to the transcription, you may.

Participating in this study is completely voluntary. Your decision whether or not to participate will not affect your current or future relations with St. Cloud State University, or the researcher. If you decide to participate, you are free to withdraw at any time without penalty.

If you have questions about this research study, you may contact Dr. Martin Lo, Dr. Bradley Kaffar, or Dr. Susan Haller. Results of the study can be published at the St. Cloud State University Repository. After interpretation, the research which includes your responses will be published via online forum from May 5th 2017. <http://repository.stcloudstate.edu/> Your signature indicates that you are at least 18 years of age, you have read the information provided above, and you have a consent to participate.

Signature

Date

Your completion of the survey indicates that you are at least 18 years of age and your consent to participation in the study.

Contact Information

Principal Investigator: Yewon Sung ysung@stcloudstate.edu, (320) 282-1553 | EB A120D

Faculty Mentor1: Dr. Martin Lo hlo@stcloudstate.edu , (320) 308-2406 | EB B125

Faculty Mentor2: Dr. Bradley Kaffar bjkaffar@stcloudstate.edu (320) 308-3267| EB B133

Faculty Mentor3: Dr. Susan Haller skhaller@stcloudstate.edu (320) 308-4836 | ECC 242

Appendix B: IRB Approval Letter



Institutional Review Board (IRB)

720 4th Avenue South AS 210, St. Cloud, MN 56301-4498

Name: Yewon Sung

Address

USA

Email: ysung@stcloudstate.edu

IRB PROTOCOL DETERMINATION: Exempt Review

Project Title: Teachers' Creativity Perceptions for Mathematically Gifted Student

Advisor Martin Lo

The Institutional Review Board has reviewed your protocol to conduct research involving human subjects. Your project has been: **APPROVED**

Please note the following important information concerning IRB projects:

- The principal investigator assumes the responsibilities for the protection of participants in this project. Any adverse events must be reported to the IRB as soon as possible (ex. research related injuries, harmful outcomes, significant withdrawal of subject population, etc.).

- For expedited or full board review, the principal investigator must submit a Continuing Review/Final Report form in advance of the expiration date indicated on this letter to report conclusion of the research or request an extension.

- Exempt review only requires the submission of a Continuing Review/Final Report form in advance of the expiration date indicated in this letter if an extension of time is needed.

- Approved consent forms display the official IRB stamp which documents approval and expiration dates. If a renewal is requested and approved, new consent forms will be officially stamped and reflect the new approval and expiration dates.

- The principal investigator must seek approval for any changes to the study (ex. research design, consent process, survey/interview instruments, funding source, etc.). The IRB reserves the right to review the research at any time.

If we can be of further assistance, feel free to contact the IRB at 320-308-3290 or email ri@stcloudstate.edu and please reference the SCSU IRB number when corresponding.

IRB Institutional Official:

Dr. Latha Ramakrishnan
Interim Associate Provost for Research
Dean of Graduate Studies

OFFICE USE ONLY

SCSU IRB# 1693 - 2116	Type: Exempt Review	Today's Date: 2/28/2017
1st Year Approval Date: 2/27/2017	2nd Year Approval Date:	3rd Year Approval Date:
1st Year Expiration Date:	2nd Year Expiration Date:	3rd Year Expiration Date:



Institutional Review Board (IRB)

720 4th Avenue South MC 204K, St. Cloud, MN 56301-4498

Continuing Review / Final Report

Principal Investigator: **Yewon Sung**

Co-Investigator:

Project Title: **Teachers' Creativity Perceptions for Mathematically Gifted Student**

If the project has been completed (no longer collecting data on human subjects) please indicate your projects status under Final Report and complete questions 1 through 5. If you have completed collecting data on human subjects but continue to analyze the data, as long as no new data is being obtained, your project would be considered completed.

If the project has not been completed (you are collecting data on human subjects) please indicate the status of your project under Continuing Review/Project Continuation and answer questions 1 through 5.

Final Report

- The Project has been completed.
 Project has not and will not be conducted. Explain:

Continuing Review/Project Continuation

- Data collection continues with enrolled participants.
 Participant recruitment continues following approved IRB protocol.

Have any changes been made to your research project (changes in subject recruitment, informed consent documents, design, methodology, procedures, etc.) since it was approved by the IRB?

- No
 Yes, explain:

Final Report and Continuing Review/Project Continuation, please answer the following:

1. How many participants have participated in your study _____
2. Have any adverse events (complaints, unexpected reactions, discomfort, or problems) occurred during this research project
 No
 Yes, explain:
3. Have any participants withdrawn from the research, either voluntarily or at the researcher's request?
 No
 Yes, explain:
4. Has any new information been identified that may affect the willingness of subjects to participate in this research project?
 No
 Yes, explain:
5. Have any changes been made to your research project (changes in subject recruitment, informed consent documents, design, methodology, and procedures, etc.) since it was approved by the IRB?
 No
 Yes, explain:

 Principal Investigator's Signature

 Date

SCSU IRB#: 1693 - 2116

Appendix C: Interview Responses

Q1	How do you address creativity?
G01	I think just provide different activities that I do in the classroom. When I heard the word creativity, I thought that it like how to I keep interesting in the classroom.
G02	I think the biggest things of creativity is giving students choice, academic choice, leveled ability choice, letting them have a voice, have creative things to, be part of designing project, during the project, or problem solving, we do things called number talks. “What are your strategies? What are you thinking so opened?” Opening discussions to all kinds of different perspectives. There is always more than one way to look at something.
M03	I try to encourage creativity; makes sure to have positive experience, having different ways of problem solving, letting kids collaborate to get an idea from each other. Classroom assignment should reflect that creative is important, not having all worksheets or multiple choices questions, having some open-ended questions, and problem solving within the assignments that the student do. Also, encouraging curiosity, so when students are asking questions, not just cross over them and ignore them. Take the time to talk about them and see if anyone else knows and learn from each other. I think also having them space helps, too. If you have a space in your room, if they are done with something, they can go there and can be creative whether that is creative. Creative manipulative, problems to work on, it can be a lot of different things or even in makerspace, students can invent. I think the teachers that have a creative space that helps to foster that, too.
M04	<p>When I think of creativity, giving students choices, tune into their best learning style. Some loves to get something in front of the class, others couldn't pay them. It depends on where they are. Creativity is allowing them choice to come out.</p> <p>When I think of creativity in math, I think of differentiation first of all. When I both have a classroom and now I work with teachers to be stronger math instructors, with creativity really comes with differentiation, how student going to show what they know. Their choice what they learning, and how we can give them options, so every tiered student accomplishes standard, all other projects or extension, or those type of things students can choose. So, one students may choose a poem about a topic, and another student may choose make some sort of anchor chart, graphic, or posters. We just finished pi day, it means students do art projects, some kids did rap, commercials about it. So, those are big project, we do not do that every day.</p>
E05	I tried to find out of students, their skills and what they are interested in. Obviously, I look at their test scores where they are gifted, and what strands are gifted in different things like that. I talk to teachers what they are doing their classroom, and I try to extend what they are doing in their classroom to gifted kids. We allow them problem solving within real life situation.
E06	Usually math, everything has driven by standard, but we are trying to allowing them options. And, we offer many extension as we can, we use menus, Tic-Tac-Toe board to

	students, kind of being charged of proving their knowledge whether they are strong at picture, graphic, making video, or using of technology. A lot of students are more creative and they are use of how they do some of the projects. (Allowing student options.)
E07	I stress there are more than one way. Do things in life. Offer choice as much as I can to often their own. I use their creative ideas, and celebrate new ideas when there is something unique or original to make that child feel proud from that idea.
S08	Creativity is the concept of pushing yourself pass what you know and coming up with your own questions. You want to come back for more and go further with it. So, it is taking concepts in foundations and things that you've learned, and pushing you to ask questions and find out more. And, doing that what you are comfortable with, but also showing your strengths in the process.
S09	I address everyday creativity in classroom, it is a challenge. Because I can be creative enough to make the lesson one student can relate to in a personal level. Then, everyone ahead especially to the student. I am always testing myself, I am always reflecting, I am always asking myself, "How can I do?" I am not where I want to be there, but I continue to work on them.
S10	Every student is unique and each individual bring their creativity to the table, I try to bring them, I can through their learning their minds are so creative and they learn differently. For example, I have a student who loves comics, and he is very creative, and coming up with stories about comics. So, I try to incorporate his learning into the creativity and how he can show me what he knows that creative side through that comic piece.

Q2	Creativity is (sufficient, necessary, or necessary and sufficient) condition for giftedness. Could you tell me your reason?
G01	Creativity is necessary and sufficient condition for giftedness. I just think children loves do different things. I think that gifted students are interested in learning and for those creative thinkers; it is different ways of doing things rather than just sitting in a desk.
G02	Creativity is necessary condition for giftedness. I do not think that there is always sufficient condition. Because some gifted students are very linear thinkers, so you have to teach them how to think outside of boxes and be flexible thinkers.
M03	Creativity is necessary and sufficient condition for giftedness. If you have some gifted skills, you need the creativity to be able to process to whatever the skills whether it be acting or writing or reading, or math problems, so I think they go hand and hand.
M04	Creativity is necessary and sufficient condition for giftedness. When I think of math giftedness, it is topic specific or standard specific. We do some students are struggle with algebra, but geometry works for them, but we have vice versa, some students are struggle with geometry, but they really get algebra. So, when I think of giftedness in math, we have students who are truly learning disability isn't that math everything is kind of difficult for.

	But I think with math, there are such a variety of things of they are doing that giftedness comes out all of the time, in different way. I would say it is both necessary and sufficient condition, just because you have to know your students use the formative assessment to figure out where they are. And, go from there. Because we have a student who struggle with this topic, but next you move onto that really clicks for them.
E05	Creativity is necessary condition for giftedness. You have got to find out their interest and where they are creative to be getting into individually because I am individualized my education as much as possible. It is very necessary condition.
E06	Creativity is necessary and sufficient condition for giftedness. So often, we are trying go so fast and just pace kids through, say faster, faster and faster. That accelerated piece, but really dig deeper into that, there has to be some creativity to prove the knowledge. That just not we are going sharing information given back to you. So, there has to be some level of students being able to show what they know. Sometimes, they need to be creative to prove their knowledge.
E07	Creativity is necessary and sufficient condition for giftedness. Part of this giftedness is being able to be very fluent with ideas and process those ideas, and being a flexible thinker where they are jumping out of the lots and thinking about, things from different point of view and sharing those ideas.
S08	Creativity is necessary and sufficient condition for giftedness. I think when you are looking at kids that they have giftedness, you need to remember that a lot of time that they are gifted in certain area, and they are cross the board. I think that it is necessary that you need to provide activities and instructions that giving them the opportunity to be creative, but you also need to be sufficient in what you are teaching them. Because there are our areas that they are making the same growth as other kids. I think both.
S09	Creativity is always necessary condition for giftedness. I don't think it is sufficient condition.
S10	Creativity is necessary and sufficient condition for giftedness. I think creativity is too unique to the individual, especially with giftedness. Everyone learns in a different way. I think it is so important their learning that have creative side come out.

Q3	Could you give me some examples of words which represent creativity?
G01	Variety, create, adapt concept of different things, collaborate, change, make choices, apply, draw, write, color, think, plan
G02	Flexible, mindful, open-minded, adaptable.
M03	Create, make, discuss, dialogue, solve

M04	In math, I would say explanation. A lot of times, kids just know. Our highest math students, they struggle most of explanation. They cannot explain that they just know that. Math masters level, very mathematically gifted students, they do not know how to explain that. Explain to other people to understand push them to be creative. They say “I know that”, but they cannot explain that a lot of times. I think explanation is huge part of creativity.
E05	Growth mindset, extend
E06	Able to think about things differently in your own, able to take your knowledge and find the way to show your understanding without being given specific directions, looking to say working out find surface area, drawing net and using formula
E07	Flexibility, fluency, originality, elaborating their ideas, different activities, a long list of ideas and categorizing ideas, look for different viewpoint.
S08	Investigate, question, multi-sensory; doing things with your hands and eyes and what you are hear and what you feel, collaborate, work with others, share ideas with other people around you.
S09	relieve, think outside the box, have a good sense of humor, compassion, pull them engage, let them know they are safe, enjoy learning, get deeper, encourage to have high self-esteem when it comes to pre-puberty, be bullied, or sarcasm, re-discover the joy of learning.
S10	unique, different, positive, successful

Q4	As a teacher, what do you think about the requirements to stimulate creativity?
G01	I think constantly change your lessons, and making things different, offering variety. Teachers are not doing checking. Sometimes some of higher kids they get done early. And, I provide my manual to them and say “Check how you are doing.” and they look at the answers within the manuals and see how they are doing. I would not do that probably for everyone and all the time, but that works.
G02	A lot of people are feeling there are not flexibility in their curriculum. A lot of people thinks that you cannot stray them, they just follow page 9, page 10. But, we are currently hard to put it in there, we are bringing all from different resources. And, knowing that the one program we have called my math is only one resource we usually use 6 or 7 resources. We look and spend the time, but there is no set to requirement to stimulate creativity. Our new math person for the district is really going to push that we have a lot more creativity in our math classes. So, I work on the BCR (Building Content Representatives) team. So, I am working with her to integrate more projects more creative things.
M03	I think that teacher can encourage curiosity, collaboration, problem solving, open-minded, and growth mindset.

M04	I think that the biggest what we have is teachers are continuing to provide options. We want them just do the worksheets. But, when we give that way to Schoology assignments, students want to do it electronically, “We want I-Pads.” So, it is easier just have them multiple choices, have them figure it out, and take a picture of their work and submit that. So, I think for teachers to continue to push that creativity is to provide options that I-Pad Schoology assignments has a role for sure, I mean math moves very fast day-to-day thing. But, we think of those unit topics, we need to continue to give options. Because when we get flat, students just lose their interest.
E05	As a teacher, there are a lot of different types of students. I extended all of my lesson even when I was a regular classroom teachers. I never wanted to students be bored. I put them in leveled groups.
E06	Sometimes it is limited little bit because of standards, and I wish we could slow down and encourage creativity a lot more than. Sometimes I feel that we do what the standard so push, push, and push. Sometimes it is easier to do just “Let’s do this workbook page 9, and move on.” Allowing students really dig deep into what can you do with this information. Sometimes we finished units early, we just finished coordinate playing, and students are able to play around and create pictures with something to see their creativity was great. Sometimes we lose this chance just because of the pressure of standardized tests.
E07	I think for lessons to have in their embedded writing, because it helps problem solving and critical thinking, it helps kids evaluate own thinking and own productivity.
S08	<p>Teacher should know their kids. And, what makes them have stronger. All kids have their strength and barriers that they struggle with, and being able to pull out those moments, those skills that they are really good at. Allow them to be creative, and allow them to come up with ways to show what they know that is really important.</p> <p>I also think giving them a lot of opportunity to do student-led instructions. So, I am getting students work with other students, providing them manipulatives, and providing them hands-on activities. So, they can see concepts, but then I also take steps further and create some their own activities to show them the teacher that they are understanding that concept. I also think that creating a responsive classroom, culturally responsive classroom, getting knows kids, giving the opportunity to express them. It is really important.</p>
S09	It is getting to know students, like or dislike background, culture really helps to stimulate creativity because I know where I would go with it. Frankly, I have always been interested in this, any this form can stimulate creativity. It is just a car door broken of my van when I was giving gas lecture, and I used it for as an attention getter as a part of my lesson. It is just having a sense of peace which comes with feeling like you're in control. I need to know I am in control my time because I am not doing more quickly. When that happens, creativity goes right down. For me, personally, it is having enough time to feel peaceful, then I am getting things done. And, I know that sounds way philosophical. Probably, no one else truly say like this, but this is how it is for me.

S10	<p>I think it is always to bring out creativity, I don't think every student learns in that way, I don't think that every student necessarily benefits from it. Having be kind of curious how it would be requirements to have something like that. All the students are creative in their own way.</p> <p>As a teacher, bring their passion, their strength with their learning. I think they are bringing their passion, and taking that passion and showing them how they apply that to their learning and how to show they are learning through their passion.</p> <p>Having students explore new thing kind of helps. Giving students pieces of things and letting they figure out how to finish that or that is shown many different ways. There is not always one way to solve something. And, I have flipped classroom sometimes, and I have a student teach me how they are seeing something. And, I think that they bring out their creativity. Because I did not see that way that is interesting. That is showing how your brain is working but we are going to get the same answer. But, they get to use their creativity to show what they know and how they learn.</p>
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Q5	<p>Could you explain your teaching experiences about creativity? How would you plan to encourage students' creativity?</p>
G01	<p>We do various activities like SCOOT which is like a Scavenger hunt. We do some online activities like Quizziz, which is online assessment where I put problems up. And, children can answer on their iPads. Kahoot is another online one that we do, that similar to where you put the questions up. And, children submit their answers on their iPad. Children could check how many they are right or wrong. It is a great way of review. I am just allowing kids to do Math talk, where they share their way of doing a problem. I am having children to do buddy-check verse the teacher is always checking, sometimes working in partners or in groups. Another thing, we do to be creative is to use QR codes. And, they use those to check their answers. I give them a problem, and then I hang the QR code up, so they can check their answers with that. This is another way of checking verses always having teachers correct their answers.</p> <p>We do math projects, right not they are making a Geometry town. We've got one hanging out on the wall over there. You can see the project. They had to use parallel lines, Perpendicular lines, and different shapes for the buildings. That is the teacher's example, but we are working on that right now. Also, there are Million-dollar project, where they receive million dollars. Then, students had to create a budget with the million dollars. That was kind of fun. We did four activities.</p>
G02	<p>I challenge students to learn frustration, "Don't be afraid of taking risk." You can watch the children through the year, and the first start of your math class they are may not very creative thinkers. They have been trained to be robots and memorizing you only get to do this. So, by the end of the year, teaching them creatively, they get more frustration. Also, teaching them to deal with frustration, "I cannot do this. How are you going to problem</p>

	<p>solve?" It is the biggest thing of creativity. Because they do not know how to look at it. And they would shut down, so it is just building the confidence and them to take a risk.</p>
M03	<p>My teaching experiences had been kind of all over the board, so I have done classroom teaching for five years, and I was a reading specialist, and I was interventionist for reading and math, and I was an academic coach. So, I have taught whole classes, small groups, co-taught with teachers, I have done with all the combination of all. I have been 4 different districts, they all did little bit differently.</p> <p>And, I think that collaborating, keeping open-minded and having the growth mindset is very important. I think that some of teachers to forget to have creativity in their classroom. They are being close-minded, and looking at the standard, this is what I need to do, not thinking what I could do, what could kids think of. We should use more imagination.</p>
M04	<p>For me, I always use math menu type thing, try 'Tic-Tac-Toe board', 'Can do', 'Must do' those types of things, lots of choices. Because I wanted them to show what they knew, and they could pursue personalized learning, I would know more. I mean task appropriate math, homework practice those types of things, but we need to have options for kids to that worksheet maybe isn't the best way to show that I understood something.</p>
E05	<p>I have enriched everything from teaching from art history to robotics. I do a lot of technology based activities. They are doing a lot of project based activities, researching online, using iMovie, google slides.</p>
E06	<p>One of the thing, I did my master's project was the flipped class and in that we allowed students to show their knowledge before, so they were watching the lesson at home, and when they got to class, so we were able to have different activities are ready for the students when they came in instead of standing here and teaching the lesson. We were able to group them and <u>have</u> different activities set up based on their understanding, which was great and kind the start of what we have been able to do. Because now we are able to let student make the video, instead of watching videos made by us, or able to watch students makes those videos to show their knowledge in the word problems and were able to create and how they solve them is maybe different. Sometimes I grab other students' attention get something about differently.</p>
E07	<p>In math, I like to have kids have choices in which problem they are going to work, 1st, 2nd, 3rd I like to compare strategy being used. I try to use problem solving in multiple ways. We did burble activities, our kids had to look at the sheet of bubbles, and they thought how many different things they can make the bubbles into. Some kids do the clock, the sun, the cookie, the planet, everything is just round. Some kids combined the bubbles, makes glasses, snowman, tractor tires, and build the tractor around it. Some kids look from different perspective draw the toilet bowl as you look down this way. I have a kid who draw like the bubbles being irrigated farmland and draw the barns stuff in between. I just liked activity; I loved to get them thinking from different perspectives and different ways to think about a sheet of bubbles. (Have choices and try them to find different way of thinking)</p>

S08	We do a lot with technology; I think that you can more cooperate with technology. We are doing a lot of things with like the app, SESA. With the classes, we do a lot of social skills and interactions. I do have those in classrooms this year. It is more interactive bulletin board. Getting students posting bulletin boards, there could be movies, there could be pictures. And, they have to explain to the rest of the groups why they upload it that. And, I just think we do a lot with cultural responsiveness is very creative, how you manage classroom even before you start teaching. Academics are really important. Changing the way that you respond to kids the way get kids to come back from an activity. The more creative and the more unique way, you can make your classroom feel, the more kids feel like they are part of it. They are much more willing to express some other ways.
S09	We are doing main idea and details activities. I brought my footstool from my rocker, and the legs screwed off. I put them all here. Without the legs, we talked about how tools comfortable without support. How the main idea is the comfort, what we are look for in the stool, just like we look for in a paragraph. But it is not as comfortable without support, so it doesn't mean as much as without support of its legs. And, so then I put detailed signs on the legs of my stool. We went around the table, and one kids screwed in one leg, and he try to stand and fell over. Well, it is higher of the ground, but it is certainly very useful with just one detail. And the other student put it in opposite because it is square, and they go ahead. They put into two details and that is great, I am just going to lie, sturdier is better, what if we had three legs, after four legs. I had graphic organizer and cut it out and bent it to make a stool. And, I just put it up on the wall. This is maybe one way of creativity.
S10	I do a lot of activities in math, we have a big portion our district for a number sense, and learning about the number sense, so something that I have done is kind of made a chart for a group of my kids. And, we pick a number of the day and I tell them you show me that number and any kind of representation you want to. They can be very creative about how they want to show it. And, I had a kid who drew 20 hearts. Some kids see it differently, so I let them being creative moment how they are going to show me that number and represent things in their own ways without my saying. "You need to do tally, or you need to do 10 blocks", they get to figure it out themselves, and things that they come up with is very creative sometimes, so it is pretty impressive.

Q6	Do you pursue to learn about creativity by yourself?
G01	Yes. I am learning diverse technologies to integrate activities.
G02	Yes. We spend a lot of time to learn about creativity, how can we make it real world, how can we make it hands-on, how can we make it active. I work with STEAM a lot, when we look at projects with the gifted students. You need to have more open-ended, it teaches more about life skills, and how to be a good student than not just good mathematician. I look a lot of times to look about.

M03	Yes. I pursue to learn about creativity related things.
M04	I try to do. I do more of that in the summer than I do during the school year. I really think that it is kind of one of those things, again that same with kids. the more you do it, and find time for it, and they get more important. When you are middle of crazy, kind of this time of a year. That sort of learning gets push to side. That is a good reminder.
E05	Yes. I think so. I am also looking at to Rubric cubes, how them I can use in the classroom. I did it last year and this year in my classroom. I am always looking at new things such as google classroom for my homework.
E06	Yes. I would say as a team we do that. I work with 5 other 5th grade teachers as a team. We I think we push each other to be the best. We all have different strength, sometimes their creativity makes my classroom better and I hope vice versa, I can share an idea “Hey let’s try this, we went through talking about before we got this. How we are going to use lateral symmetry tomorrow, so we are just talking about always willing to change and flexible. None of us are set in one way and try to be flexible. Students are willing to be flexible and they receive that very well. They are very be reflective on their own.
E07	Yes. I read about journals that I see come across my Facebook, I have been to gifted conference that have creativity session that I attend.
S08	Yes. I am always trying to find ways to engage kids in the classroom. I am always trying to find additional ways of how to we get kids engage that I think. Sometimes, school, and standards, and things that we are teaching kids, can get really redundant, or unsystematic. So, I think we can support how kids to be self- motivating, self-starters, and problem solvers. Because, when they get into the real-world, they are going to have to do that a lot. When I see, I thinks about engaging students and being creative in the classroom.
S09	Yes. I absolutely do. Because I truly lifelong learner, little postings on Facebook, some science. I think “That’s cool.” There is no way to stop learning.
S10	Yes. I always try to find ways to be creative in my teaching and into bring creativity in my students. It is important their learning. I tried to be creative about how I teach lessons, not just lecturing, not just doing, paper handout, pencils try to be really creative, instead of writing these words, drawing them and sand bucket. I try to learn more about creativity, it is like a journey to learn more about creativity.

Q7	How do you define mathematical creativity?
G01	Basically, using a variety of strategy is to solve problems. I guess variety of strategy is to solve problems to complete the assignments. That is why it is great to allow kids to how they did it not only how the teacher does the problem.

G02	I think that it is just being flexible thinkers, looking at all the different ways you could do something.
M03	I would think that mathematical creativity could be using numbers, or spatial relationships, maybe engineering concept, but I think that same ideas behind that no matter which kind of creativity you are talking about. As far as the curiosity, open-ended, collaborating with each other. I think the differences would be more focus on the math skills.
M04	I think it is important for kids to be able to explain in multiple ways. Now, there are few things that kind of multiple things to do. But, I really think that whole mathematical creativity comes from being able to explain multiple ways, or show someone else, If I can teach someone else my own understanding, it gets deeper. Sometimes, like especially in elementary, I don't talk 3rd grade students, but 3rd grade who can explain 3rd grade who doesn't get it, like a language that they speak, so those kids know that. I don't speak 3rd grader, creativity is being able to explain to somebody else. I think this is a huge piece for creativity for students. That doesn't mean that they have to do that all the time. But, those kids who struggle in math and find same age who can explain it, it helps.
E05	I could see students are black or white. Everything in their head, they process everything in their brain. I feel it is really creative. I think a lot of visual things like rubric cube, different types of patterns, children could figure out.
E06	Especially for the enriched or gifted students are often do in their head. But when you ask to slow down and explain their process to someone else whether they are using words or picture, they have a hard time doing that. So, to force that issue to open outside the box, so "You are able to solve with this way, today we are finding the surface area of pyramids." We are talking about "Are there any shortcut we could find the area all of the faces do you see anything else?" If you are dividing by 2, and you are multiplying by 4? Did you really wanted to do that or other ways, so sometimes I felt doing fewer problems and talking about more extension really allow students to be creative and how they solve the problems. So, I think our curriculum itself does really nice job of providing a lot of options and showing students with multiplication and division ways outside of the traditional algorithm to solve. Sometimes, students get solve to use the area method for a while, and then they end up switching that because I made them to the traditional algorithm because they understand multiplication better itself, that is a nice thing where they are able to experiment with that and see when they do switch over. Because at this part, have anyone using those, they understand traditional algorithm better, but it is not because they are memorized the multiplication or division.
E07	See in multiple ways that arrive at solution.
S08	I think it is taking those ideas and those foundational skills of math. Applying them to the point where you are wanting more, you are asking more. So, it is more than just figuring out how to solve the problem or learning the concept of multiplication, and it is getting pass that point and actually wanting to they given to dig into more asking yourself questions about that you are creating your own questions about that concepts that you want to go further, kind of the whole concept of STEM. They are so interested and self-motivated to do more.

S09	If I am a creative mathematical teacher, I have mastered relating that math to the students and convincing them as useful. Because so often students think “How is that going to help my future life?” and in any way that I can do, I think that they take certain amount of creativity to do that. To have it make sense to them, and for them to think that is useful. That is good.
S10	I think mathematical creativity is a great thing. Mathematical creativity is something that can be applied so many things that you really can't get creative with math. It is about how you represent, number is one to one correspond that representation. We do all sorts of things to represent now. Rather than, just standard with paper and pencil, expanding their mind to think in a different way than the standard.

Q8	Could you explain the relationship between mathematics and creativity?
G01	Because of the exact mass of math, you can really look at the final product, but maybe, how you get to the final product can be creative. And, especially certain things of higher level of thinkers can do a lot of work in their head. That is creative. I allow them to be creative as long as they get the right answer. I allow them to be creative in the way that they solve the problems as long as they get the right answer. Like when we did multiplication, 3 digits by 3 digits, I showed them 3 different ways to do that. I think I had only one child not do it the traditional way. Most of them do end up doing traditional way, but I think just offering them as an option, and maybe later life. I know when I did 3 by 3-digit multiplication; I always started at the back. Well, sometimes I started from the front with the hundreds, so I think it is just good for them to know that information.
G02	I think that go hand in hand. Math has never been looked at something creative, numbers and answers. But, there is a lot of thinking, there is a lot of problem solving, there is a lot of ways to explain you in math. If there could be different perspectives, and different ways you could do something. We do a lot of things, like breaking numbers, composing and decomposing things. They can be a lot of different things. Makes students a lot better mathematicians. You can look at it that way.
M03	I do think that they go a lot of times hand and hand. People who are good at math, many times are creative. I have been seen students, that don't necessarily always a way. I think that people who are creative will do better the higher math, yet. I think if you are not creative, you can get basic math. As it gets higher and higher and you have to think outside the box. I think you are not creative, it gets to be tough.
M04	I think being able to communicate what you know in math. For example, pi day project, there are something that students did. In my head, it didn't make sense, but when they explain that they got that. I think creativity in math it will reach somebody else. Your way make sense to me, and maybe make sense to him.

E05	Doing different coding and different things are like the relationship between mathematics and creativity. All the way from looking at an array, 3 multiply 3 is 9 to being able to code a robot. Students can see the pattern. When I think creativity in mathematics, it is always patterning to me.
E06	Math is traditionally black and white subject. There is not a lot of a grey in there which is interesting with creativity. Left- right brain argument little bit was, math kind of forces students, to some point, the process is very important. But at some point, you have to be able to arrive at a solution or answers to the question you are get into our creativity. Sometimes that is free there is no right or wrong. I think that is one of the things with the standardized test we are run into where students are judged always on their answers they don't see the process all of the time. They could be creative and show how they know this is not one question that could be another as well.
E07	I think the being able to see a variety of strategy that would be handy to solve a certain type of word problem or even in today in math expressions our curriculum we use here teaches kids multiple strategies for even computation kind of problems and then they use what works for them.
S08	I think that mathematics in order for you to be successful; you have to be able to questions. You have to be able to questions yourself further. What it is they are looking at, what it is that they want to solve? I think even when you start with very basic math concept, you should to teach students how to question, not just teaching memorizing and solving the problem. Because, ultimately, we want them to be able to solve problems. We want them to be able to look at something, and to be able to know what they need to work through that. So, I think that the whole concept of questioning and problem solving and using multi-sensory approaches to solve problems goes hand and hand with math. And, when you look at creativity even in regardless to art, your questioning is needed 'how you are going to be creative to be in the art piece', you are just starting with the basic, starting with numbers, paper, they go hand and hand. If you want to go through higher level of math, you definitely need to question and build from those skills.
S09	I hope they go hand in hand, because math is such a foundational objective science. If you can interject enough creativity to make it interesting, relatable, and fun. You got it made. And, I don't think a lot of people realize that. But, I personally feel the relationship should be intertwined absolutely.
S10	I think math can be represented in different ways, you can be really creative how you carry out problem, how you show problem and numbers, how you represent it. It is really related.

Q9	Are there differences between creativity and mathematical creativity?
G01	I think that the difference would be final products. In math, it is pretty exact, it is not changing. But, math projects, all of their products are going to be different. It is nice that to have. Not just say right or wrong, some of math projects it has been creative. Creative final

	results I would say. But most of time, math is black or white. Every time it is either right or wrong. I would say that is how they different between regular creativity and mathematical creativity.
G02	You might be physically creative, you can be artistic dancer, or you can be mathematically creative. But, if you can put creativity and math together, you feel much stronger mathematician. And, they can get to something that they do not know, then they have a better tool box. They do not know, they just have one way to look at it.
M03	I think the essence of them are same. But, we are just using either numbers or engineering, just different context.
M04	Creative activity supports mathematical creativity. Some of their projects that we do show kids to have always done with paper and pencil type of math. But, now my teacher make me poster that is my creativity comes out. That change math identity which is huge thing especially upper level elementary and middle school. If they don't feel wordy or smart enough? You got a combat that fix that attitude. So, creativity can help with that. Because sometimes our kids, they may not have the ability to be as creative as somebody else who maybe the art speaks more of them, drama speaks more of them. And, they can be topped dog. I think that is good for everybody in the class. Because kids know who are good at math, even if you never tell them.
E05	I think when students do not know their times tables, then it really limits creativity in math. When they can't see the multiplication pattern. That could be a stumbling block between creativity and mathematics. They can't see number patterns and different things, keep bringing up their patterns, but when they don't know their multiplication facts, until they do, they cannot be creative.
E06	I see creativity is more art piece of things, where students can create a piece of art or music. With math, sometimes it is limited how you are creative or solving solution. Sometimes creativity is more open ended where this is not necessarily end goal on time in math, at some point, you are trying to prove your understanding or solve the problem.
E07	I want to say yes, but I also can see somebody is real visual learner, they could see problem like a diagram or a map kind of draw a picture, whereas visual creativity in art might help in mathematics also. The ability to come up with lots of different ideas when you are stuck, now what things there up, now what posters when you are stuck, write down what you know, try a new strategy or new idea, try a different idea.
S08	I think the concepts are same between creativity and mathematical creativity. I really do think, even when you are look into the concept of STEAM approaches, all of those things are interrelated. When you look at science, and when you look at the arts, they all have creative component to them. And, there are always things that you are building from those things. I do think mathematics, the foundational component of building, and those foundations so kids can become creative. Creativity may look a little bit different. However, creativity can still be put in the place that you are using multi-sensory approaches, you are using hands-on activities, you are allowing kids to be more than just

	memorizing facts, and you are allowing using manipulatives. So, I think that the creativity even if that the basic could look different, but there are a lot of similarities when you look at the very foundation. Thus, I think that there are more similarities than differences.
S09	It comes together between creativity and mathematical creativity. I suppose there are all kinds of creativity, there are social creativity, relational creativity, creativity in teaching each different subject matter. But, if you really want to get hot and heavy and deep, the more you learn about math, and the more you learn about art, they more come together. Even to the chaos theory in beyond, there is mathematical foundations for that. So, to me, the epitome of art is creativity. Once you are able to explore those two disciplines so far enough, they really come together. I mean, that is philosophical approach of mine.
S10	I think that there are differences; mathematical creativity is driven more towards to mathematical side while you are trying to represent something showing how you got to something. But, creativity you can be anything. I think that they can be correlated but at the same time they are not. Creativity can be different things.

Q10	What students' characteristics can be expressed in mathematical creativity?
G01	I would say different ways of solving problems. Sometimes, they are messy. It seems like they are kind of messy and not organized. Some of the highest kids are not well organized.
G02	I think giving them a chance to be individual to build their confidence. "I can be different, but I am still right."
M03	I think being able to talk about what they are doing, and talk with each other. To be able to help each other in a group project to get better. Those kids are usually persistent and do not give up easily.
M04	Students' characteristics come out a lot in math classes. I think their attitude around their perceived math ability, especially upper elementary and middle school students have developed what they feel is their mathematical ability, whether that is over inflated or under inflated, or right on, you never know.
E05	Students are having everything in their head, so they can figure out everything in their brain, and good at using computer and I-Excel, things that we do online. Students know multiplication at this age; you can see the differences and tell those students are ahead.
E06	Perseverance, I have to be one of the characteristics that students have to have for creativity. Because so many times, we practice "Here is the skill, do your problem is just like it." We focus on problem solving skills. We teach a strategy, so students just turned in a problem solving that focus on writing in the equation. We have worked in equation all year long, put the ten questions, we were given, we are probably above their level where they had to try and come up with a solution whether the situational solution equation to solve the problems. Persistence is definitely a big one, sometimes being willing to ask for

	help, and seek out help. I think it is another characteristic, especially developmentally in 5th grade, students aren't very good advocates for themselves to admit that I don't know. They are trying to internalize it. We're trying get student to realize some math isn't just by yourself activity have to reach out and problem solve. That's another characteristic. Sometimes involves seeking out help from others. It is a big piece as well.
E07	Willing to try different things, use the perseverance to move on different idea or different strategy at the younger ages I see that needs to be taught, especially like my second grade when I first introduced the stuck now what, they laugh and say "We can't sit down there and cry, so what do we do?" To be able to get around that break the wall that they are against having to get around.
S08	With technology, to show what they have known, mathematical reasoning, spatial reasoning even when you look at that are gifted or having learning disabilities, even in general education. There are many components in math. When you looking at the geometry, you looking at the abstract thinking of algebra, you are looking at the spatial reasoning when it comes to geography. There are so many different components, and some kids are maybe really good and maybe some of them are really strong at one of those areas. But different are could be difficult for them. I do think that math skills really show you where students struggle and where they do not. I think when it comes to the creativity; it is interesting to watch how they learn. And, I think as a creative teacher, if you are using teach creative concept, it is really interesting to watch students if you are giving them choices what they pick to how they solve of problems. Some kids like to draw a picture because they are very spatial. They can tell the problem for you. Other kids are multi-sensory learner they would like to touch manipulatives. The characteristics of students, when you are being mindful of what you are giving students as tools to solve problems, and you can definitely see those characteristics of students and how they learned. And, you could understand your students even more.
S09	Their voice can be expressed mathematical creativity; they learn self-expression the right kind of creativity, humor, usefulness, self-esteem, curiosity, a sense of belonging. The risk goes on and on and thinks about it.
S10	Anything can be expressed who they are such as humor; all things can be all applied.

Q11	How do you address mathematical creativity with regard to gifted students?
G01	We have a gifted and talented program coach, and she pulls kids out. She does small group. She has 12 students about 20 minutes. She does things with a group. A math method, math masters one of the thing she takes a test, and they go to math master's competition. She also sometimes does with Fermi math. Fermi is just a real-world problem that is ongoing. They take the long time to solve not just a quick. Sometimes they create something, she also mentioned math dice, but she uses dices they do different, higher level thinking problems depending what they share. And, we do continental math athletic within classroom. They can take test five times it is five different tests through of the year, and

	<p>then they total their scores. And, then kids are given the highest. Kids do the best, so that kind creates. I have an enrichment or extra credit worksheet that I offer to kids that is kind of how I give them extra credits. And I think, offering the above level of math is the next steps. We encourage those kids who we know gifted or higher to do above the work. I will show you one of the worksheet, like geometry town, this was the grade level, but the enrichment or higher level, the above grade level they had to do little bit more complex about math. We are just allowing them to do the problems.</p>
G02	<p>A lot of it, it is just putting it into the context about problem, that is real-world, or situational, and how do you solve it. And, sometimes those students are creating their own problems. Here is the set of numbers, what could you do, or how can you write a story that matches this.</p> <p>We are going to stretch students' brain, we call it "growing your brain" this way to them. "Here is the problem context. Here are your ranges about you've got to do. And then, we left them of pile of ways to solve it. You can use number tiles, you can use linking tools, you can use cubes, you can use maker boards." But, we are giving them the chance to create the problems in their own way to solve it. First thing, they do not love, but then they start to like it.</p>
M03	<p>Whether it is mathematical or other creativity, pretty much same aspects as I said in the beginning. I think that having the growth mindset, and even if you think you are only given do this. You have to know your mind can grow, just like your body, so just let them know that they can go as high as they want to go.</p>
M04	<p>Helping them really push their ability to give right answer a lot of times, that explanation. Mathematical creativity take different skills set than just answering question. I think whether it is gifted students or any students helping them really push themselves to explain. And, interpret things maybe in a non-literal way or in a way that they haven't thought about yet. That is the way that is the traditional algorithm, how could you apply that to everyday life. Because sometimes students really struggle with area. I will tell you area. Allowing those to come into pi.</p>
E05	<p>I address mathematical creativity with regard to gifted students by doing various activities. For instance, I have a group of 5th grade students who are doing a geometry activity. And, we are doing Geo-Metro city which had 2 by 6 grid, and they had to put a 3D dimensional city on there. It had several requirements. We are learning in geometry, we did volume; we did area, different things like that. And, to do the angles, we do the robotics. They have to code with different angles like obtuse, acute, or right angles. Every robot has to go to visit city. That is mathematical creativity to me along with coding and robotics.</p>
E06	<p>I teach one of the 2 sessions of enriched math in 5th grade, just because the content comes typically a little bit easier, we were able let student little be more creative just because of the time element, not that I don't think other students are not able to be creative, like I mentioned before, recently had a tic tac toe activity, for students prove what they knew about area and surface area. Students who were able to find create cereal boxes and create a project instead of just doing traditional worksheets which makes them think about things</p>

	differently. It makes some slow down because it sometimes enabled to go quickly through problem when they are given tasks and choices. They fully understand the concept.
E07	It is important to acknowledge multiple methods. Teachers might have how to solve it, but there might be many other answers that you didn't think of. Because those kids are figured out.
S08	It is important to know what their areas are gifted in, making sure that you are providing a lot of opportunity for them to express themselves, ask questions to be creative and showing what they know in that specific category. But, being mindful that there are other areas that they are learning at the same pace, or maybe even slower pace more than the other students. Just because you are working with students who are given that labeled as gifted but they are not gifted cross the board. It is really important to know them in what area is gifted and then provide that those creative opportunities for them.
S09	You have got to be able to be creative enough to make them want to learn more. Because often times, gifted students think they have done that. And, I think with gifted students, you need to make creative enough to have them invest time to learn more. So, they realize that they don't know at all. And, I think that is kind of a tap dance, but just let them have a cardboard box and some masking tapes, and let them go add it. I think the maker stations that they are doing now are really great idea. But I think they can be a little bit too programmed, sometimes. This is what we want to do kind of things, but not all of them. But, that would be something that a gifted student might do. One of the best things my kids did when they were in talented and gifted was a marble learns. They did that in 4th grade, they also did that in 8th grade as a regular class assignments. They were kind of doing 8th grade work in their 4th grade. Rube Goldberg, he is wonderful of machines that would make something else is going, that is very open-ended. But, I think get to find a way to get gifted students by having a little fun, and make them want to learn more.
S10	I don't have gifted student this year, but I always look into see their strength. Even gifted students have their strength; they can bring that out mathematical creativity. I had a student last year who was not labeled with giftedness, but her brain work was very different from the way of others brains worked in. We did a lot of flipped classroom. I could see that she has the right answer, but she couldn't show me how she got there. She would come up to white board; she just drew me a picture. "This is how I see it in my brain." You give us step-by-step how you see it and how you got here. I think bringing out their strength, letting them show how they see it, rather than just teaching formula. I think being them kind of power little bit to control their own learning.

Q12	How do you perceive giftedness?
G01	They know without thinking with real hard. They know how to do without working hard. They are beyond the level of the group. They just automatically know the stuff without being taught. They prefer to their company of peers that are at their level. And, I do see that. One of my classes that I teach math, they are very gifted. Those kids are hanging

	together. They really enjoy math projects. They enjoy that their self-directed learning. I think that they are able to connect two other concepts kind of alike. Make inferences about problems before they are being told to do it as far as I see.
G02	There is a big debate, because we have a gifted and talented program. It is hard to necessarily make a whole group of gifted kids. They all have their high points; they have all their low points. They have all their holes to fill. Truly, if we were to labeled kids gifted, we probably have only seen 3 kids in my teaching experiences of 16 years with gifted. Definition where everything is natural. But, I think giftedness has to do with what is your strength that is and what you are willing to push yourself, too. Because, sometimes we have kids who are very average or low average in our class. But because they learn new strategies, they are given more time to think at the end of the year they have grown exponentially, and they fit in with the group. So, it is hard to just say what is giftedness.
M03	I perceive giftedness as being certain one specific skill or several, or someone is above the norms or above their peers. So, they are born with it, they can be somewhat cultivated, too. But, I think that there is innate giftedness.
M04	For me, it is not only ability piece, that whole package of attitude and perseverance with students who persevere. And, I think our kids to come a lot of middle school, things have been always easy for, but now they are not. Then, what happens? Do I avoid it? Or, I do think I like. Because, then I don't have to face to something hard for me. So, that perseverance piece with students comes in a lot like "This is hard, I am going to research this, and figure this out more." And, learn it. Those kids to have that giftedness, a little bit of time, and they get it. But we see a lot of times of avoidance something like that when it gets hard, so perseverance is huge piece for me.
E05	Students who wants to learn more and who wants to challenge more. They want to enrich and extend. They do well if they follow through. They follow through what they are doing.
E06	That's a great question. If you had that answer, teaching will be a lot easier. We are actually as a district kind a going through that right now, what is gifted look like and what does good student look like. Because right now we have 2 sections of enriched, roughly 360 students and 60 students, we kind of believe that not all of them are actually gifted. Some of them are just good students who do well and good support system at home so they are able to accelerate on school may not be gifted. But, when you look at the truly gifted students, they are seeking out knowledge; they are not waiting for knowledge. They are interested in main topic, and they need to be more of a mentor and a coach to try to obtain the knowledge that they are looking forward. Because they have already shown that the basic level. They exceeded level of the standards we are looking for.
E07	I identify by strong curiosity, and questions, isn't satisfied hasn't figured out. Perseverance, sometimes kids just give up on you, and you just know that they are struggling with getting around that break wall but they got large bank of skills.
S08	I think it times of misunderstood. When the student is gifted, teachers expect that they are not struggling with the components, and forgetting that the gifted students are developing

	<p>at the same rate and matured level as other 3rd graders. We have a student who are considered gifted a variety of math, but teachers are extremely frustrated that the student is not organized. Just because they are gifted, it doesn't mean that he has everything else figured out. He still is at the 3rd grade kid. So, I think the whole concept of giftedness can be perceived as misunderstood times. I think that students are gifted, from my personal opinions, really need to have teachers who understand them and give them a lot of opportunities to express what they are gifted in. Because even though they are gifted in one area, they are not always confident with every other area. I think that we really make sure your programming is sufficient and it is right for that child. Because I do think sometimes those kids are hard to figure out what is the best for them.</p>
S09	<p>I am not sure I do the same way as everybody else because I think there are many different ways to be gifted. So, are you gifted in math, are you gifted in reading, are you gifted in languages, are you gifted in drama and self-expression, are you gifted in noting nuances with people and relating to people. So, I think giftedness is really if I were to define and perceive it, it would be beyond the norm and average, stand out accomplishment, but not necessarily just in math or reading.</p>
S10	<p>I perceive giftedness as a significant strength in an area of learning. In the past when I worked with gifted students, they just learn differently than others. As what I have noticed, they are often going unnoticed because they don't do the formula the way that typical students learn it from teachers. That doesn't mean that they are not getting it. They are getting in a different way. I perceive it as strength often goes unnoticed and not visibly outside, often negative towards them because people don't recognize that.</p>

Q13	<p>Is there a relationship between creativity and giftedness? If so, how?</p>
G01	<p>I would say in some situations, there is relationship, but I do know some students who are gifted but they just want worksheet. Tell me what I should do, when I get it done. Whereas, with math projects. Maybe, they are not truly gifted. They just want to receive worksheet.</p>
G02	<p>Yes. Sometimes, they have been no relationship between creativity and giftedness since some of gifted students are very rigid and pursue one way.</p>
M03	<p>Yes, I think that they usually they go hand and hand. Gifted kids are creative, most of them are creative.</p>
M04	<p>Maybe there is a relationship between creativity and giftedness; I think the abstract thinking comes in a lot more with kids who are gifted. They are able to not only think abstractly, they are also able to apply to different situations, and they are not as literal maybe when I am looking for. Kids who struggle just do it this way. Then, when I get to the next thing, I will apply the same rule whether apply or not. Kids who really have mathematical giftedness can take situation and apply them in a different way. I think that something that helps.</p>

E05	Yes, there are relationship between creativity and giftedness. I mean, kids are good at art and different things like, they are good at math and everything like that. Things are go together.
E06	If there is a relationship, I don't think there are strong relationship between creativity and giftedness. Be more creative, some students are more programmed go through the equation, or process or the algorithm. I think sometimes are able to show it in different ways in finish product might be more tension to detail because it deals with some of students who are more type A and people who using that. But sometimes, I also have a class that I teach with students some struggling math, but their creativity sometimes it is much. I don't think there is necessarily a direct correlation between the creativity and giftedness. But, sometimes it able to show it differently than students who struggle.
E07	Yes. There is relationship between creativity and giftedness. I think that bank of ideas and that ability to have fluent ideas to keep walking from solve problems to come up with responses that they do come up with be at language art, math, social. They need to have that constant river of ideas going by and that is part of creativity.
S08	Yes. I think those areas where students are considered gifted in; you need to think outside of the box. You need to think that they are past the level of what you are teaching in your classroom. A lot of the times, once we get to a level of students have mastered the 3rd grade level or 4th grade level of concept, we are done our job. These kids have already mastered that. If we are doing best practice, we need to make sure that we are thinking outside the box. "What can we do for these children when I am teaching that this components knowing that they are already passed that?" I do think there is a creativity level with regard to teachers. What we can do for these students, so we are always pushing that students strive more? But, I also think that there is a level of creativity for that student, because they are sometimes doing something that is completely different than from the rest of the class. There has to be balanced there with we want them to learned all of the things, and they need to learn for that grade level but what can we push so that child is continuing to ask questions and wanting to grow and, verse sitting and being bored because the child has already mastered with that skills. I do think that we really need to look more at the kid in the gifted category, that we are doing something in that classroom in order to continue to ask them questions of concepts.
S09	Yes. In the true sense of the word giftedness, I would say yes. I think that is kind of a trap we fall into with giftedness and math especially. "Go and do this, and go and do this", and it kind of restricts what the student to the person could otherwise be doing. I absolutely think that there is a relationship between creativity and giftedness. Hopefully, gifted people are comfortable with being wrong and wanting to know why, and going down a different road or different path being comfortable with that. To me, that is the part of giftedness definition, but I am not sure everybody. I think some people get stuck in. "It is going to be right or it is going to be wrong." And, I think being comfortable with learning from being wrong is a gift. And, being able to be creative enough to look at other avenue is for answers. I absolutely think there is strong relationship to the true sense of giftedness.

S10	Yes. I think definitely I will just go to the way they think. I think they are very creative in their thinking. That is why they are different from other students. But, I think their creative mind can bring out their giftedness.
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Q14	What factors can affect the creativity of mathematically-talented students?
G01	Teachers are giving them different choices that the bottom after we are done our work. We play games to reinforce the skills that we are done.
G02	<p>Giving them the confidence, and giving them to be risk takers. Because a lot of times, gifted students can only be right, they are perfectionists. "I can only do with this way." So, pushing them out and letting them to know "You are going to be okay. It is just a math problem; you are going to live at the end of this." I think it is the biggest factor.</p> <p>And, another factor is letting your class go. And then, I talk a lot of times if somebody came in here and saw our class. They are not sitting down, they are not quiet, they are moving around. But being able to let go, some of the control is not always easy. Walking them through and having them walk you through to what they are seeing; let them know that they can take risks. Creativity of mathematically-talented students can be activated. A lot of things are building the child. We let the kids tell their way of thinking us.</p>
M03	Teachers' teaching strategies, teachers' philosophy, peers how making fun of them, being supportive, social pressure, difficulty and their special needs. (Teachers' factor)
M04	Boredom is huge thing that impacts creativity. If they are bored, we start to lose them. They need to be pushed just like everybody else. I work a lot with teachers. I say, "Let the student don't get boredom, "No, we push them, we push them, we push them", So, our kids the top we need to push, too. I think that boredom is huge thing that impacts their creativity. Playing into their one right answer. I think stifles creativity, "Because I can give the right answer because I am smart with math whatever, so, that wouldn't there." Ask to think like how you could solve that those types of things push to creativity. I would say boredom, and you have to be right piece. I would rather kids be able to think to get a problem right, being able to think. Then, they are able to say "That's not right." I think encouraging thinking is a big piece. (Students' mental factor)
E05	Home life, friendship, any sort of emotional things can handle kids, not worry about everything.
E06	I think sometimes just brain development, now I am working with 10 year-old, sometimes you get into abstract concept, and their brains are just not ready. Because they are not able to understand that concepts. They are still stuck in concrete mindset; we are trying to through abstract, extremely large, extremely small. They can't fully comprehend. That is the one of the biggest factor, so we run into. Two, time is a huge factor, we don't have enough time to really elaborate let them just run with the topic that they are really interested in.

E07	Perseverance, perfectionism. I have couple of student they don't want to get the wrong answer. They are really hesitant to try something different. Because they know "This way will work, so why are you making me think of this way?" They are unwillingness to take risks.
S08	<p>I think the lack of knowledge that can come from teachers. It could be the lack of knowledge that coming from administration. With regard to gifted students, being able to support, kids in the classroom, even district wide what we do with these kids that are already passed. We know and need to push more what we can do these students to be settling.</p> <p>I also think that there is a big increase in regards to when you are looking at demographics of schools. There are a lot more students, especially when I am looking at my school districts than just districts. In general locally, there are peers to be much higher rate of students they are coming in that they actually need additional intervention verse being other end. Classroom dynamics, how you are planning instruction can greatly impact how a student that is talented making huge progress in a specific area can be affected. Because when you are working with 32 kids in a classroom, and 25 of them need additional interventions to get to understand the concept what they do, or two or three that are making games and doing well.</p> <p>We focus a lot, teachers have to focus a lot, and administrators focus a lot right now how can we get the kids that are lower up to where they need to be. And, sometimes those kids we need to push and do more with, sometimes we do less in the background. So, I do think the lack of knowledge of teachers and administrators can have huge impacts on un-programming those students.</p>
S09	Environment has a big thing to do with it. Who is their leader is? Is there a leader of nurturing? Supportive, condescending or restrictive.
S10	I think a lot of things can affect both positively and negatively. Positively, giving them opportunities to express creativity with their mathematical thinking. Negatively, not allowing them that space, that time to use their creativeness, mathematically just very logistical, "This is the formula you need to know, you need to know these many facts within one minute." I think that takes creativity out of that. So, I think, unfortunately, some teachers feel this is the only way to teach math. That fact fluency, those time tests, it just doesn't give them creativity. I think, just giving them that free time, that confidence just explores their own creativity, and explore how they think it should be solved.

Q15	How do you address mathematical creativity when you teach twice exceptional students who are gifted but also have disabilities?
G01	I think just modifying the expectation of that student. So, that there is still able to show. Basically, they are able to show what they know. But, maybe, not expecting them to do all the problems or we have some kids who refuse to show their work. If they get the right

	<p>answer, and I say that is fine. So, I think that there could be modifying, be flexible that they do as long as they understand the concept.</p>
G02	<p>I think all different things we do accommodate. I went through that whether they are gifted or twice exceptional children. They are all kids. So, I think that there are multiple steps of expectation. We email to parents back and forth, here is your kids organizational skills is usually a big hole for gifted and talented or twice exceptional students. Sometimes we make them sitting who moves around, once we gave them assignments, our room is opened whatever. We provide alternative testing, some students are getting test with small groups, some students are getting test here, or some students are doing project.</p> <p>Again, we do a lot of academic choice, make sure them challenges, regress they get bored. There is a period always a closure, or always a review of today's learning targets. What are their assignments, and then I think part of using words when it come up to the kid who is in that situational stuck, when they are frustrated, and they need time. Ask them "Do you need help?"</p> <p>We do a lot of goal settings to help them, our routine is pretty strong. There are multi emotional and frustrations go take a break, we give them a path. They can move around. Schedules chunked. We have chunks a day, there are nothing get to 45 minutes of lecture.</p> <p>We do a lot of collaboration, students get to partner talk, they get to talk in a group, and they get to talk to teachers. We also have a third teacher, Steve, and pull them to the entire different situation. We are giving them a lot of feedback. I think, we all the different things to accommodate. I think that scratches the surface.</p> <p>I think that we are having high expectations, they know. In the end, we care. You can do well we are going to push you to it, or you will do accountable for it. And, I think one thing that really helped in our class. We do 'Mind-up curriculum' at the beginning of the year with our math kids do, we bring that conversation in. But that helps them to understand, so if they are worked up. You can't blame it on, you are mingled us, how do I call paragraph? That helps kids to know that everybody is different. That is a good way to teach it. So, everybody accepts and understands the difference. You don't have to be offended by whatever is happening.</p>
M03	<p>I think the main thing with all of them, especially, the twice exceptional students' importance of first focusing on their social, emotional needs. Because, those kids many times are going to have a tough time with that aspects of social and emotional parts. Getting along with other kids, maybe being included, just in addressing that part is really important. And then, making sure that they are getting a combination for whatever they are needed so they can be at the level of their peers.</p>
M04	<p>Yes, they are interesting population. We struggle a lot with that group. Because things like organization, homework, and can't find things, often times get teachers to feel as those opportunities shouldn't be there. Like "Why should we put him in there, when he is bring his stuff, he can't find his calculator, he can't find his permission", those come into. With our twice exceptional students, they are really smart, but disorganization is probably the</p>

	<p>most frequent issue with kids who are what we called twice exceptional students. So, I think kids who we need to be more patient with them, when in middle school or elementary school at this point we have a responsibility to give them a lot of choices. But, high school is little bit different, because they are earning graduation credits. For twice exceptional students at elementary and middle school level needs a lot of support. They need to be taught the skills to continue to grow. And, not be denied opportunities because they got a lot of organizational issue which is big with twice exceptional students. Because their brain moves so fast over here, they are very detailed a lot, and just get lost. So, I would say we have three of in this building. We frequently have conversation about this because a lot of times they are often to be freaked out. Because when teachers think of someone gifted, they often think of it isn't easy package. But, students can often be very creative, maybe go down the wrong path. They are talking about this and that; they are over here, so teachers try to bring them back.</p>
E05	<p>I have had few students who are having EBD, emotional issues things like that. I have a small group, be able to work with that type of students. I try them to trust teacher.</p>
E06	<p>We are trying to do a lot of small group work trying to set those students up for the real world. I have got couple students who do have learning disabilities in my enrichment class. They do struggle with. I guess with my experience, I thought a lot of students who are ASD spectrum whether it is Asperger or autism. Even though they are great number kudos, when we put them in a group, social piece is hard for him to be creative in a group, and express their understanding. So, we know going to the real world, group work is kind of be essential for them. We kind of have to guide them through a little bit the whole starting small and having understanding and an individual level. And then kind of building into the small groups, and then to the large class. To kind of structure, how you do for any other student because they have just fewer than all the other enriched. We talk about they are sometimes more afraid to make mistakes. Because someone might perceive them not to be as smart, or things like that. So, turn to put them those situations that they are going to make more uncomfortable, but have the support therefore they need to be successful as well.</p>
E07	<p>Just for organizing. I have daily check in just for organizing "Do you have your planner done, filled out?" Just have some extra support for those of things, those of end of the day organizing, end of class organizing. Socializing, I typically look for, avoid pick your own partner, pick your own partner usually has one or two or three or four five. Kids are just standing and I don't know who I am going to work with. I usually try to pick a partner type of activities that have comfortable personality, comparable intellectual levels where they would find a way on that particular assignment.</p>
S08	<p>Our students are individual; teachers should get to know "What is their strength, what are their areas that I need to work on." Twice exceptional students are tough because there are a lot of things especially with organizing, socializing or some of those things can go hand and hand. And, at times those students appear by their actually below grade level, or struggling academically in certain areas within truly they are not. I do think it is really important to know what they need regardless to their disability, what is that we really need to focus and practice and make sure we are providing those interventions. But, on the other</p>

	<p>side, making sure that we are really pushing their strength, and making sure we are giving them a lot of strategies to use those strengths to build their confidence. That is very similar to the student that I referred earlier, a student who is gifted and has another ADHD. It is really important, that student has a check-in and check-out and some help with organization. But, at the same time, we need to be very mindful. He is continental math, and he is getting all the additional services. And, just because he is not organized. That does not mean that we should limit him to be exposure that he needs for the gifted part. Sometimes, what happen are those kids get denied additional activities or services because they appear off tasks or they appear are unable to listen attentively. So, this is not a good fit and this is exactly what they need or what they are comfort. Thus, teachers should know their kids and be mindful of the purpose of their instruction, provide multiple opportunities to have them use manipulatives to use multi-sensory approaches to have them show you what they know, but it does not just a time with piece of paper and pencil, being more comfortable with your instruction being more student-led. It is difficult to more traditional teachers. With having more choices and more opportunities, children have to express more themselves, more engaged, more retained, and learn from that.</p>
S09	<p>I had a quite a little case study last year. There were student who is very gifted in math, but the social piece and home emotional piece were a shot. He was very upsetting. That was a challenge, I failed the creativity task. Because I was not able to progress, we make a little progress and go back, we make a little progress and go back. He has a spectrum, and it was just, I kept reading, I kept asking, and I kept reading, "What could I do? It is in underneath of a desk, instead of doing his work. He could do it, he just didn't want to do it, he did not see need to do it. Because he knew how to do it, "Why should I have to do it?" it was too easy. And, that is a just kind of a snowball, now he does know how to do it. When you get to fifth grade there is a lot of different math involved, it made him embarrassed and shut down. So, we had a great personal relationship as far as getting along, and I think that he thrusted me. But, I just was not able to find to hook for that young man. For a while I did screen time at home, but home life was he ended up losing his mom this summer. So, it is very tragic. But, twice exceptional that was a real big challenge because it was way, and way off the charts of the sky, this young boy.</p> <p>I think when you can find the right kind of humor, especially in the 4th or 5th grades; I think the kids love it even in the spectrum. They love jokes that don't have to make sense, they just love jokes. I think those twice exceptional I do try to use a whole lot of humor, because there are a lot of pressures on themselves, they really good at this that they know. They are so smart; they know their deficit and other area. And, they don't know what to do about what bothers them. So, I have tried to convince their errors, "That is okay, trust me, feel safe, let's move on." That's what I try to do</p>
S10	<p>I think the most important thing for the twice exceptional student is giving them to support that they need. So, they may have the ability, but they may need support in another area where they have that disability. So, just supporting them with their needs, so they can express their giftedness in their area.</p> <p>I have one student who is not gifted but he does very well in mathematics, but unfortunately, because of his disability, he receives the small group instruction with me.</p>

	The support that he needs is really just one on one support from a teacher to kind of go through with him. Helping with him confidence of it. "You are doing great, you know that." He is very smart in mathematics, that disability definitely comes into play and he definitely need to support from an adult.
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Q16	Could you draw a diagram or image to show the relationship between creativity, giftedness, and mathematics?
G01	<p> <u>Mathematics</u> </p> <p> <u>Creativity</u> </p> <ul style="list-style-type: none"> - enjoys creating projects - questions everything - is intuitive - wonders - thinks out of the box - thinks differently than most <p> <u>giftedness</u> </p> <ul style="list-style-type: none"> - knows automatically - is beyond the group - prefers peers at their level - infers & connects concepts - enjoys self directed learning <p>Creative students appear gifted in math, but may not necessarily be gifted.</p>
G02	<p> $\text{mathematics} + \text{creativity} = \text{giftedness}^2$ </p> <p>When I think of mathematics mixed with creativity, giftedness grows exponentially.</p>

M03

They can each exist on their own or with each other. They can all be together in a student, too.

M04

TEACHERS' CREATIVITY PERCEPTIONS FOR MATHEMATICALLY GIFTED STUDENT
 Principal Investigator: Yewon Sung (ysung@stcloudstate.edu)

5. Could you draw a diagram or image to show the relationship between creativity, giftedness, and mathematics?

Standards
 Formative & Summative Assessments
 → above, on or below grade level.

Creative - Show what you know

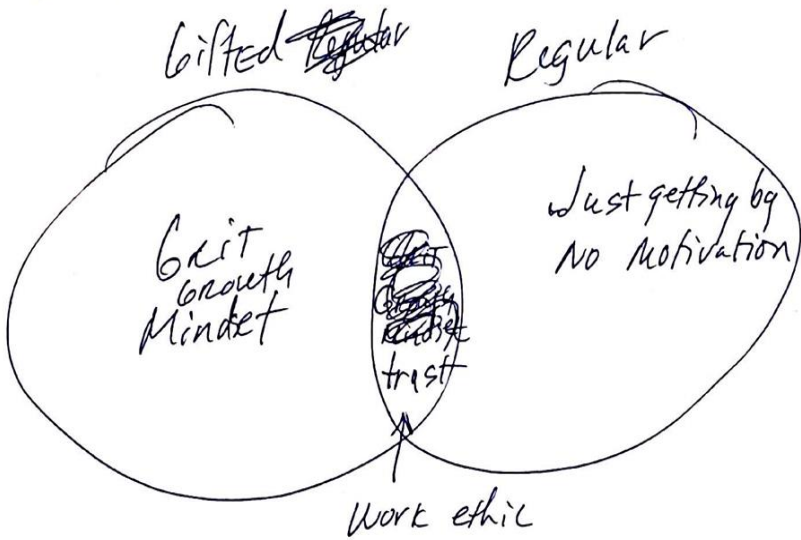
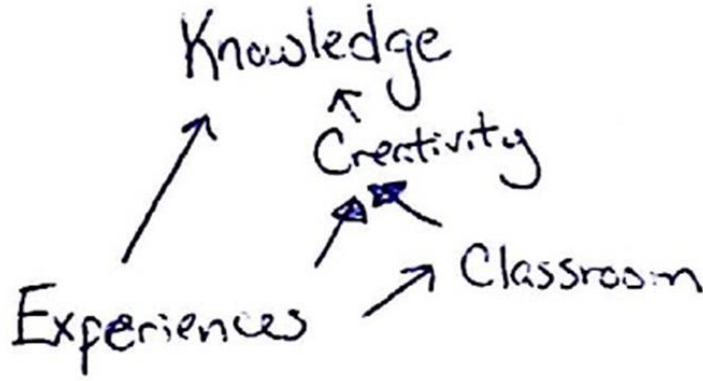
Traditional tests worksheet
 one right answer

Giftedness Options For all students

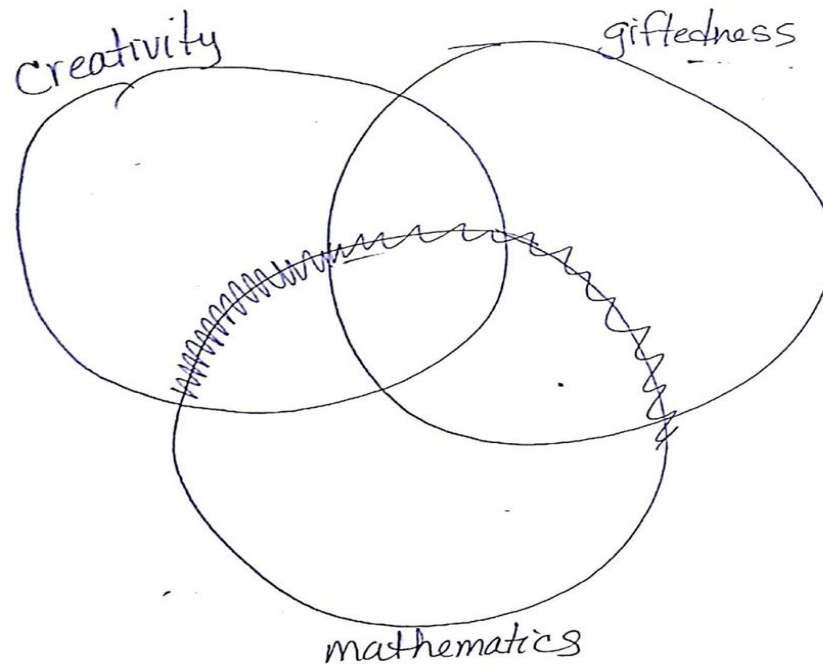
Multiple ways

connection - thinking that can apply to relationships

Giftedness can be shown within traditional methods of assessment; also being able to show multiple levels of understanding on any standards. Often students who are gifted are working outside grade level standards.

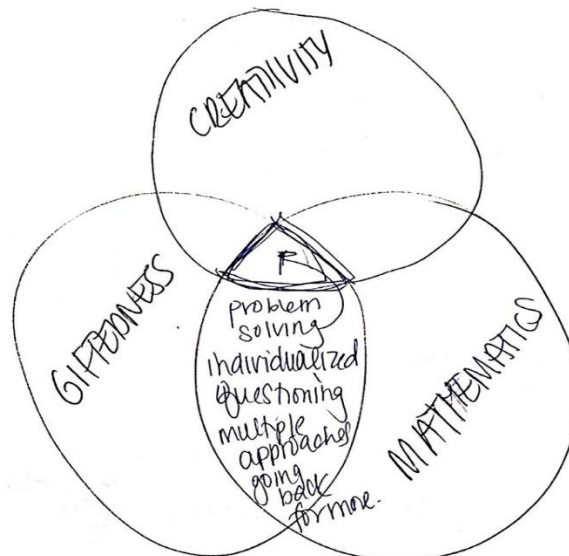
<p>E05</p>	 <p>I am showing how gifted learners and regular education learners are the same and different.</p>
<p>E06</p>	 <p>Creativity is part of a sequence that leads students to math knowledge.</p>

E07



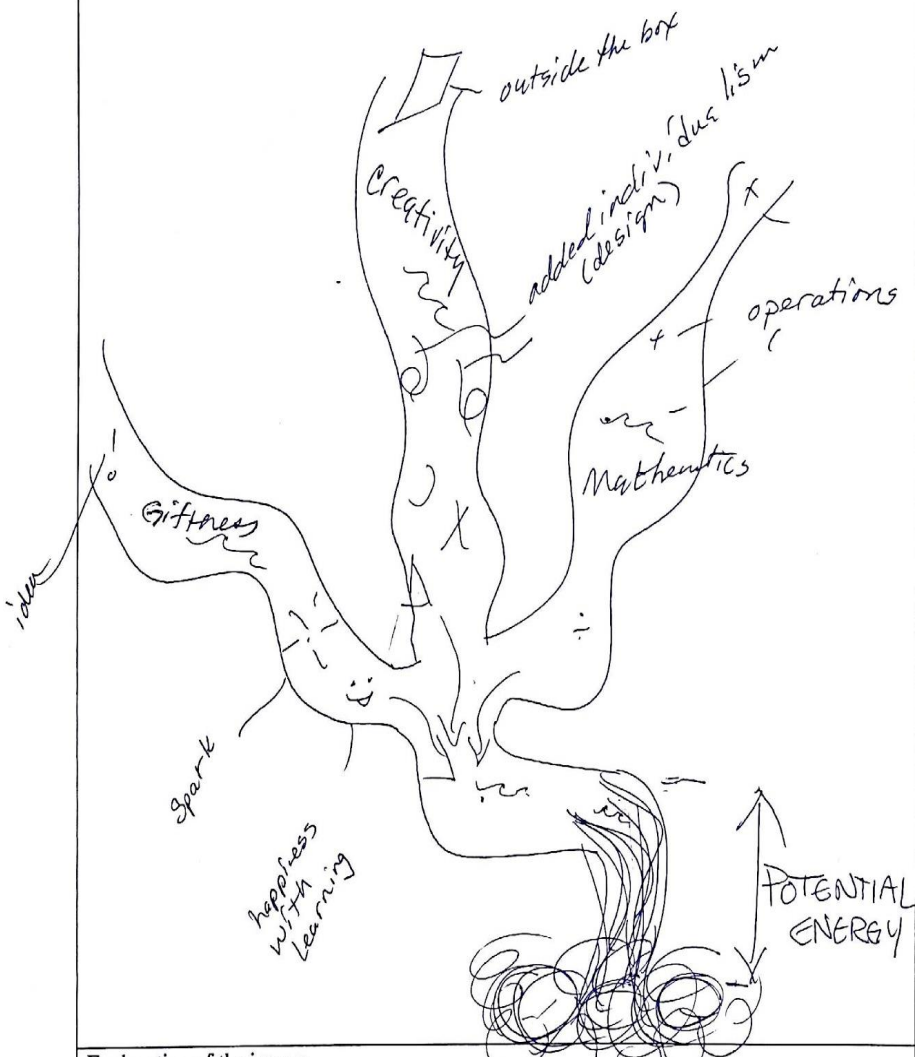
There is some overlap between these 3 as well as domain-specific concepts.

S08



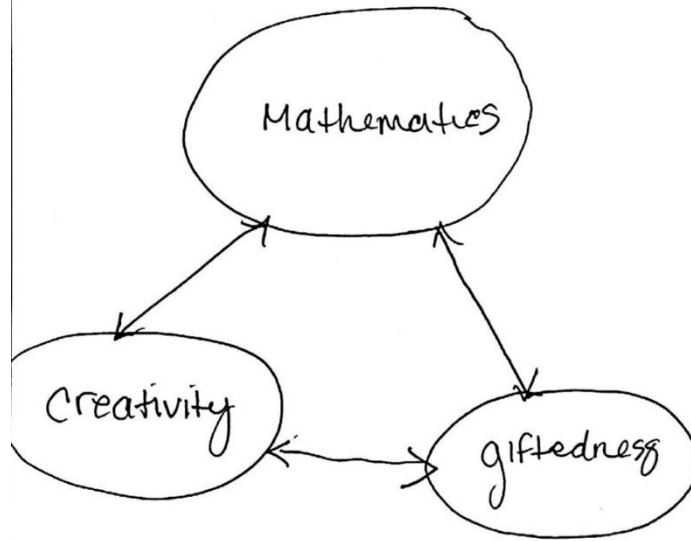
All three components require foundational and basic knowledge, pushed past that and questioning more; creating and solving own problems.

S09



Three rivers converge before cascading over the falls. Creating maximum potential energy-falling. The water creates excitement and beauty at the bottom.

S10



Both creativity and giftedness can play a role in mathematical thinking either separately or concurrently. They each have an impact on each other whether negative or positive.