Spring 5-2018

# Successful Programs and Strategies for Secondary Students Who Are Gifted and in Mathematics Classes: A Qualitative Study

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# SUCCESSFUL PROGRAMS AND STRATEGIES FOR SECONDARY STUDENTS WHO ARE GIFTED AND IN MATHEMATICS CLASSES: A QUALITATIVE STUDY

A Dissertation

Submitted to the School of Graduate Studies and Research

in Partial Fulfillment of the

Requirements for the Degree

Doctor of Education

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May 2018

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Through interview responses, this study examines the perceptions of seven secondary mathematics teachers concerning the programs and methods they incorporate to reach their gifted students. In addition to teacher interviews, four focus groups of teachers, who taught various grade levels, were conducted. All study participants teach or had taught gifted students. To triangulate data, artifacts utilized by interviewees were analyzed.

Participant responses were compared and contrasted to identify patterns and differences. It was found that participants felt they were adequately enriching curriculum for gifted secondary mathematics students. However, in many cases, gifted students were not provided with enrichment activities that extended beyond those received by their entire class. Participants also felt that they were using adequate grouping methods. However, teachers often grouped gifted students with the intention of raising the performance of struggling learners. In such instances, gifted students were not grouped with other high performing students for the advancement of mathematics ability. Participants rarely incorporated acceleration and compacting strategies. However, gifted secondary students routinely took Advanced Placement (AP) courses as a potential form of acceleration.

Despite participants largely feeling that they had not been properly or formerly trained to work with gifted students, participants expressed feelings of adequacy and confidence in their abilities to work with gifted students in the secondary mathematics environment. Participants

expressed both advantages and challenges to working with gifted students. Advantages included the opportunity to utilize the abilities of gifted students to help struggling learners, allowing for teacher and student autonomy within the classroom, and having students in the classroom that the teacher can routinely rely on to provide correct answers. Challenges included lack of gifted student motivation, lack of time to meet the needs of gifted learners, and the problem behaviors of gifted students.

ACKNOWLEDGEMENTS

This study would not have been possible without the expertise, influence, and encouragement of the educators I have been fortunate enough to work with and come to know. I am especially indebted to my committee chair, Edel M. Reilly, D.Ed. of the Mathematics Department at Indiana University of Pennsylvania, who provided extensive professional guidance and taught me a great deal about the research process. I am also grateful for the guidance of committee members Kelli R. Paquette, Ed.D. and Mark Twiest, Ph.D. both of the Professional Studies in Education Department at Indiana University of Pennsylvania.

I am grateful to all the teachers, principals, and superintendents whom I have had the pleasure of working with throughout the course of this study.

Nobody has been more valued in the pursuit of this project than my family. I would like to thank my spouse, Adrienne, for her constant unwavering love and encouragement, and my two children Olivia and Micah for being an ongoing inspiration. I would also like to thank my parents whose love and support are with me in anything I pursue.

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# CHAPTER I

# INTRODUCTION

Gifted students need gifted programming (Hertberg-Davis & Callahan, 2013). This study explores the phenomenon of gifted students in secondary mathematics environments not being adequately provided for in order to reach their potentials. Qualitative phenomenological methodology was employed to illustrate the examination of this phenomenon.General education programming is currently unready to meet the needs of gifted students (Hertberg-Davis & Callahan, 2013). The purpose of this study is to explore and examine the self-perceptions of teachers as they incorporate methods and strategies offered to gifted secondary students in mathematics classes. Participants included a group of seven qualifying secondary mathematics teachers.

To better appreciate the phenomenon being explored, this chapter begins by navigating the context and background framing the study. Next, the problem statement is discussed, as well as the statement of purpose and research questions. Merriam (2009) states that, like the research problem, the research questions must be framed from theory and be utilized to rationally develop the study. Hence, these intrinsically joined building blocks (research questions) form the foundation on which the entire study rests. This chapter also defines the conceptual framework of the study, limitations, and terminology. The chapter concludes with a brief summary.

## Background and Context

Secondary gifted students require special programs to reach their personal mathematics proficiencies. Research has reported that programs are necessary for many reasons such as challenging students in the classroom, influencing students' futures, and positively influencing post-secondary plans (Lubinski, Webb, Morelock, & Benbow, 2001). It is unfair to deny any

student the right to reach her or his potential in mathematics, and providing programs for gifted secondary students to reach their mathematics potentials has become a matter of international competitiveness. The strength of countries and their competitiveness is dependent upon exceptional human capital (Friedman, 2007; National Science Board, 2010).

Concerning international competitiveness, a recent Pew Research Center report (Desilver, 2015) states that only 29 percent of Americans believe the education offered to the United States' science, technology, engineering, and mathematics (STEM) students is above average when compared to STEM educations offered in other countries throughout the world. The views of scientists are even more negative. Only 16 percent of scientists, who are members of the American Association for the Advancement of Science, believe the United States offers an above average STEM education, and 46 percent of these scientists considered it below average (Desilver, 2015). Standardized tests results validate the scientists' contentions.

While overall the United States may find itself in the middle ground of international competitiveness, they are well behind many other advanced industrial nations. The Program for International Student Assessment (PISA) is one of the largest cross-national tests. It measures reading, math, science, literacy, and other key skills of 15-year-old students in dozens of countries both developed and developing. According to Desilver 2015, the 2012 PISA revealed that the United States placed 35$^{th}$ out of 64 counties in mathematics. Singapore, Hong Kong, Taiwan, South Korea, Macao, Japan, Liechtenstein, Switzerland, the Netherlands, Estonia, Finland, Poland, Canada, Belgium, Germany, Vietnam, Austria, Australia, Ireland, Slovenia, New Zealand, Denmark, the Czech Republic, France, the United Kingdom, Iceland, Latvia, and Luxembourg all scored significantly higher than the United States (Desilver, 2015). Desilver (2015) states, "One of the biggest cross-national tests is the PISA which every three years

measures reading ability, math and science literacy and other key skills among 15-year-olds in dozens of developed and developing countries. The most recent PISA results, from 2015, placed the U.S. an unimpressive 38th out of 71 countries in math and 24th in science. Among the 35 members of the Organization for Economic Cooperation and Development, which sponsors the PISA initiative, the U.S. ranked 30th in math and 19th in science"(Desilver, 2015).

As noted, international competitiveness and providing an appropriate means for gifted secondary students to reach their mathematics potentials are the primary justifications for this study. This study advocates and relates to previous research as it attempts to identify and explore effective gifted programs that allow mathematics ability to flourish in our nation's gifted youth at a secondary level. In other words, this study examines and explores gifted methods and strategies offered to secondary students in the mathematics environment. In this way, the research done for this study contributes to the ongoing conversations and practices inherent in the literature on both gifted education and mathematics.

There exists both a lack of teacher training, as well as inept identifying procedures for mathematical giftedness (Lichtenwalter, 2011). Concerning identification procedures, "Of the 32 states with mandates related to gifted and talented education, four states fully funded the mandate at the state level, 20 partially funded the mandate, and eight did not fund the mandate. One respondent with a mandate did not provide the level of funding for at least one of the past three years" (National Association for Gifted Children, 2015, p. 24). Unfortunately, in the United States, gifted education is not considered a discipline and is without an educational-political effort (Persson, 2009). This climate enforces and reinforces the need to examine gifted program offerings, especially within the mathematics environment.

The National Council of Teachers of Mathematics NCTM (2016) believes that the development of the United States' highly talented mathematics students is critical to the future success of our nation. The NCTM informs us that all students, including the gifted, require curriculum designed to foster mathematics skills such as reasoning and problem solving. To help teachers and schools develop mathematics talent the NCTM created the following documents: *Curriculum and Evaluation Standards for School Mathematics* (1989), *Professional Standards for Teaching Mathematics* (1991), *Assessment Standards for School Mathematics* (1995), *Principles and Standards for School Mathematics* (2000), *Curriculum Focal Points* (2008),and*Principles to Actions* (2014).

According to the NCTM, all students who demonstrate the potential for high performance in mathematics should be supplied with an enriched mathematics education. The NCTM's position on students with exceptional mathematical promise states:

> Students with exceptional mathematical promise must be engaged in enriching learning opportunities during and outside the school day to allow them to pursue their interests, develop their talent, and maintain their passion for mathematics. Such opportunities must be open to a wide range of students who express a higher degree of interest in mathematics, not just to those who are identified through traditional assessment instruments. (NCTM, 2016)

Mathematics promise is inclusive of both mathematics potential and interest. The NCTM specifically defines students with exceptional mathematical promise as follows:

> We use the term 'students with exceptional mathematical promise' to include those who are talented or express higher levels of interest in mathematics as well as students who are identified as 'gifted' in mathematics through a battery of standardized assessments.

> We have deliberately chosen this term over the terms ‘gifted’ and ‘talented’ because historically ‘gifted’ and ‘talented’ students have been identified through a single assessment that often is not mathematics-specific. In this position statement we seek to broaden the range of students identified as ‘students with exceptional mathematical promise’ while acknowledging that each and every student has mathematical promise.(NCTM, 2016)

Mathematical promise includes a focused interest in mathematics, an eagerness for mathematics challenge, and creativity in mathematics problem solving. The NCTM further elaborates, and more specifically defines the term “mathematical promise” in the following manner, “Students with exceptional mathematical promise include those who demonstrate patterns of focused interest; are eager to try more difficult problems or extensions or to solve problems in different, creative ways; are particularly good at explaining complex concepts to others or demonstrate in other ways that they understand mathematical material deeply; and/or are strongly interested in the material. Exceptional mathematical promise is not a fixed trait; rather it is fluid, dynamic, and can grow and be developed; it also varies by mathematical topic” (NCTM, 2016).

The NCTM continues to emphasize the need to differentiate instruction for exceptional math learners when they state:

> Students with exceptional mathematical promise must be provided with differentiated instruction in an engaging mathematics learning environment that ignites and enhances their mathematical passions and challenges them to make continuing progress throughout their K–16 schooling and beyond. They must have a variety of opportunities inside and

outside of school to develop and expand their mathematical talents, creativity, and passions. (NCTM, 2016)

The NCTM advocates for professional developments and trainings to work with promising mathematicians. To successfully educate students with "mathematical promise" the NCTM prescribes:

> The preparation and ongoing professional development of teachers of mathematics must address the specific learning needs of these students. Methods of recognizing, nurturing, and challenging students with exceptional mathematical promise must be included in courses and professional development for all preservice and in-service teachers. All teachers must have access to print, electronic, and human resources to support them in meeting the needs of students with exceptional mathematical promise during and outside the school day. (NCTM, 2016)

It should be emphasized that the NCTM specifically mentions professional developments.

The school should be an institution in which instruction is based on a student's capacity for personal growth. Referring to their 2014-2015 State of the States in Gifted Education Report, the NAGC (2015) informs, "The data collected for and represented in this report reflect the policies, practices, and their resulting effects for the estimated three million academically gifted and talented U. S. students in grades PreK-12" (NAGC, 2015, p. 11). To adequately educate this number of students, teachers, administrators, and policy makers must be educated and informed. Students with gifted mathematics ability must be appropriately challenged with well developed programs that meet their needs. "The U.S. is largely neglecting the estimated 3 million academically gifted and talented students who represent diverse experiences, skills, ethnicity,

and cultural and economic backgrounds. All of them require a responsive and challenging educational system if they are to achieve to their highest potential" (NAGC, 2009, p. 2).

Good instruction for gifted learners begins with good curriculum. The NAGC points out that it is exceptionally difficult to incorporate gifted programs into schools where standardization is the norm. According to NAGC (2017), appropriate curriculum for gifted students originates with many practices beneficial to all learners but extends beyond.For the gifted student, good curriculum encompasses educational experiences that are organized by key concepts, principles, and disciplines as opposed to facts. Gifted students must understand the relevancy of what they are learning through high level activities that enable processing of information, grappling with meaningful problems, and proposing and defending solutions. Adequate programs provide the gifted student with structure and choice, as well as being respectful of her or his natural abilities (NAGC, 2017). Once curriculum for the gifted student has met these standards, appropriate teaching becomes the focus.

The Talent Identification Program (TIP) at Duke University identified 259 gifted adolescents and followed them to age 40. The students' accomplishments were exceptional. "Thirty-seven percent had earned doctorates, 7.5% had achieved academic tenure (4.3% at research-intensive universities), and 9% held patents; many were high-level leaders in major organizations" (Makel, Kell, Lubinski, Putallaz, & Benbow, 2016, p. 1). Makel et al. (2016) also found that ability level paired with commitment determined the extent and potential for accomplishment. In 2007, Park, Lubinski, and Benbow reported on 25 years of following 2,409 students who scored in the top 1% on their SATs at age thirteen. They found that ability patterns identified at age thirteen paralleled forms of creative expression in middle age. In adulthood,

these students demonstrated exceptional accomplishments in literary achievement and scientific and technical innovation.

In 2009, the NAGC confirmed that the federal government spends just two cents per every one-hundred dollars of American's education budget on educating gifted students. The NAGC (2009) explained the ramifications stating, "According to the 'State of the States' report, there is a markedly insufficient national commitment to gifted and talented students, which, if left unchecked, will ultimately leave our nation ill-prepared to field the next generation of innovators and to compete in the global economy" (p.2). The federal government's support for gifted students now stands at only 2 cents of every $100 dollars it invests in K-12 education. At the state level, 26 percent of states provide no funding support to gifted education" (NAGC, 2009, p. 2). Since funding determines the extent to which gifted students receive adequate help (Lichtenwalter, 2011), it is justifiable to spend tax dollars to develop specialized programs for gifted students.

The current process for educating gifted students is the result of flawed educational policy (Hymes, 2014). No Child Left Behind (NCLB) has made cuts to gifted education programs seem justifiable by perpetuating the myth that gifted students can thrive when appropriate programs are absent. However, like all students, gifted students need curriculum that caters to their individual needs and abilities. Cuts continue to occur across the board in all aspects of education, and gifted students suffer from these cuts as do all students. More than a decade of data demonstrate that gifted students suffer from the program cuts that were allowable under NCLB. These cuts have resulted in limited access to gifted programs, lowered academic performance and achievement, and minimized postsecondary and lifelong learning opportunities. The lack of appropriate programming for gifted students has even resulted in some parents

removing their students from public schools and placing them in private and charter schools (Brulles&Winebrenner, 2012).

Parents make enrollment decisions based on how content they feel about their child's academic growth and school (Abdulkadiroglu, Angrist, Dynarsky, Kane & Pathak, 2011). "As of January 2017, 17 states have scholarship tax credit programs. These programs allow individuals and corporations to allocate a portion of their owed state taxes to private nonprofit scholarship-granting organizations that issue scholarships to K-12 students. The scholarship allows a student to choose among a list of private schools, and sometimes public schools outside of the district, approved by the scholarship organization. The scholarship is used to pay tuition, fees, and other related expenses. As a result, the state does not have to appropriate per-pupil education funding for those students that receive scholarships" (National Conference of State Legislators, 2017, para. 1). One of these states is Pennsylvania.The tax credits allow parents and businesses to use state taxes for private schools. McKay Scholarships can assist students who are both gifted and identified as having a disability. The McKay Scholarships fall under section 504 accommodations. Gifted and disabled students can use these funds for private school placements.

Exceptional accomplishment is only possible when opportunity is present. Research reports that innovation, economy, and giftedness are related; tomorrow's innovators are today's gifted students (Shavinina, 2013). In other words, properly educating our gifted youth today will result in brighter futures, not just for the students themselves, but, for society.

## Problem Statement

A research problem is driven by incomplete knowledge or flawed understanding (Booth, Colomb, &Williams, 2008). This study confronted an unsatisfactory situation in which a

discrepancy existed between what is currently known about the secondary mathematics settings for gifted students and what needs to be known about the lack or misuse of gifted programs in such settings. A more thorough understanding of why research indicates that gifted students are not being adequately provided for in secondary mathematics settings is important. Programs necessary to enable our nation's gifted students to flourish in mathematics are not being appropriately created, funded, or utilized. Our nation's gifted students are not well served by our public education system (Colangelo, Assouline, & Gross, 2004).

Gifted secondary mathematics students are negatively and consistently impacted by the problem this study addresses. This study investigated the specific problem of lacking gifted program implementation for secondary mathematics students. Gifted students are not being adequately provided for in secondary mathematics settings, and thus will be unable to experience a proper mathematics education or the brighter future this education may enable.

## Statement of Purpose

This study explored and examined the effectiveness, implementation, and availability of gifted programs made available to gifted secondary students in the mathematics environment. "The difficulty of meeting the needs of mathematically gifted and talented students in regular classrooms is not new to researchers and teachers. Teachers should implement differentiated instruction inside the regular classroom" (Manuel &Freiman, 2017, p. 79). Renzulli and Renzulli (2010) reported it is a mistake to decide gifted students do not need instruction that is differentiated. The purpose of this study was to explore and examine the self-perceptions of teachers as they incorporate methods and strategies offered to gifted secondary students in mathematics classes. Through a better understanding of gifted programs incorporated into secondary mathematics environments, it is anticipated that a more thorough understanding of

these programs will emerge, as well as the potential for transferability amongst similar settings. In addition, teachers and administrators can use information from this study to make more informed decisions regarding program options.

## Research Questions

This study focused on three main research questions. The questions were designed to yield answers that shed light on the research problem. All research questions were interconnected, and shared a meaningful relationship. The research questions were designed with a clear and strong alignment to the research problem and purpose of the study.

1. What specialized methods do mathematics teachers report using when working with students who are gifted, and how do they feel about these methods?
2. How prepared do secondary mathematics teachers feel they are to teach gifted students?
3. What are the advantages and challenges mathematics teachers perceive when working with gifted students?

## Research Approach

After receiving approval from the university's institutional review board (IRB), the researcher interviewed seven secondary mathematics instructors. Prior to exploring the instructors' experiences, the researcher examined various methodologies of data analysis, and qualitative phenomenological methodology was determined to be the best fit for the study. Qualitative phenomenological methodology is concerned with perceptions and perspectives. It explores the understanding of a phenomenon. The features of qualitative phenomenological methodology complemented the study's research approach of utilizing multiple data sources. These sources included secondary mathematics teachers,exploring a phenomenon, and the

production of descriptions of contexts and participants. Overall, this study sought a rich description of a complex phenomenon.

Data collection primarily consisted of teacher interviews. The interviews formed the study's basis and consisted of information gathered through seven individual interviews. Interviews were electronically recorded and transcribed. Interview questions asked teachers to focus upon gifted methods and strategies utilized in the secondary mathematics environment. Interview questions can be found in Appendix A. During data analysis, the methods' and strategies' relationships to the Renzulli Model of Giftedness (Renzulli, 1978), the study's conceptual framework, were considered. Prior to the interviews, four focus groups consisting of five participants in each group were utilized as data collection tools. Focus group questions can be found in Appendix B. The focus group element was incorporated into the study to enable triangulation of data by addressing the same issues in a group setting. Focus groups were not limited by subject area or grade level. However, the criterion of teaching gifted students was critical and thus remained. The third element, enabling triangulation, was the collection of relevant artifacts provided by teacher interviewees. Artifacts can be found in appendices C thru F. These included, lesson plans, modified student lessons, visual data, and written records. The researcher requested artifacts from each interviewee. It should be noted that if an interviewee was unable to provide artifacts this too was relevant to the study. Absence of materials could potentially indicate the absence and/or misuse of appropriate methods and/or strategies. Artifacts were collected to further explore ways teachers educate their gifted students, and were considered tangible evidence of pedagogy for the gifted. Artifacts were categorized and grouped using the same criteria as the individual interviews and focus groups. The researcher sought ways the artifacts related to creativity, task commitment, and the study's research questions.

Methods explored were inclusive of gifted program options. This study hoped to identify best practices when working with gifted education students in the secondary mathematics curriculum. By identifying and expanding upon best practices, this study hoped to make valuable contributions to current literature concerning gifted programs utilized in secondary mathematics environments. In addition, this study hoped to further inform school districts and administrators when making selections for gifted program offerings and teacher trainings. Overall, by exploring gifted program offerings made available to secondary mathematics students, this study was intended to generate a deep rich understanding of teachers' self-perceptions concerning gifted program delivery in the secondary mathematics environment.

It should be noted that since this study was concerned with the degree to which gifted programs were being implemented in secondary mathematics environments, it was relevant to the study if a secondary mathematics teacher never utilized a method or strategy to educate a gifted student. Never using a method or strategy to educate a gifted student or students may be indicative of improper usage simply by denying an appropriate opportunity to a gifted student or students in a secondary mathematics setting. Not utilizing methods or strategies and/or methods or strategies not being available to gifted secondary students in mathematics environments was critical information.

To seek answers, five prominent programs offered to gifted secondary mathematics students were chosen for examination. These program offerings were enrichment, acceleration, cluster grouping, compacting, and AP courses. Each program was examined in terms of its relationship to two of the three rings of Renzulli's model of giftedness. These rings were mathematics creativity and commitment to mathematics tasks. The overlap allowed the researcher to examine ways each program affected both rings simultaneously, as well as

individually. In other words, each program had the potential to enhance one or both of the characteristics represented by the rings.

## Conceptual Framework

Researchers use conceptual frameworks to define choices and match research questions and analytical tools to those choices (Ravitch&Riggan, 2012). According to Marshall and Rossman (2015), without a conceptual framework, a researcher would lack the ability to make reasonable decisions during the process of research. This study's conceptual framework, the Renzulli Model of Giftedness, framed the problem and purpose of the study. It was chosen to provide a scaffolding to support the study and provide a new perspective to an existing problem. In addition, the Renzulli framework linked the research problem, literature review, and research methodology.

All aspects of this study including research methods, data analysis, data collecting, and research design are tied to the conceptual framework. There was no need to create an original conceptual framework for this study. The Renzulli framework fit the study's purpose and was not too reductionistic or deterministic. It was open enough not to force data into predetermined categories, and it allowed the researcher to explore a potentially complex phenomenon without unintentionally simplifying or over-simplifying it.

The framework for this study aided when categorizing topics that arose from the literature during research and that are expressed in the next chapter's literature review. Categories guided findings during data analysis. A visual display illustrating Renzulli's theory follows. Renzulli preferred a systemic identification system represented by three intersecting and interactive rings. Each ring contains a specific characteristic. These characteristics are: well-above average ability, creativity, and task commitment.


*Figure 1.* Renzulli's three-ring conception of giftedness.

The rings of the Renzulli model represent aspects of giftedness. This study focuses on how programs incorporated by secondary gifted mathematics teachers cater to these aspects. This study sought data that either confirmed that secondary mathematics teachers are or revealed that secondary mathematics teachers are not using methods that allow for the creative problem solving of gifted students. Creativity involves solving mathematics problems in various ways. Likewise, this study sought data that indicated task commitment by determining if a method used by a teacher increased a gifted student's likelihood of engaging in mathematics problem solving. Task commitment involves the gifted students' dedication to their mathematics tasks as well as their motivation to complete such tasks.

As noted, this study examined the methods and strategies teachers used when educating gifted students in the secondary mathematics environment by exploring each method's or strategy's relationship to two of the rings of Renzulli's model.These rings were task commitment and creativity. Methods or strategieswere inclusive of the programs of enrichment, acceleration, cluster grouping, compacting, and AP courses. For example, if a teacher responded that they used enrichment activities to educate their secondary gifted mathematics students, this study

asked how enrichment enhanced a well-above average secondary student's creativity and commit to mathematics tasks. Since the rings of Renzulli's model intersect and overlap, this study addressed ways enrichment could potentially affect the two rings (task commitment and creativity) simultaneously. In reference to Renzulli's model, it should be noted that a student's ability level, according to Renzulli, is well-above average if they perform in the top 15-20% in any domain (Kaufman & Sternberg, 2008).

The concept of creativity in mathematics has been evolving for several years. Generally, in the past, creativity in mathematics was considered to encompass the elements of fluency, originality, and flexibility (Kim, Cho, &Ahn, 2003). In addition, Imai (2000) noted that the concept of elaboration was connected to creativity in mathematics. A gifted student may possess elaborative skills that expand upon the intricacies of a solution beyond the capacities of her or his peers (Mann, Chamberlin, &Graefe, 2016).

In reference to the Renzulli model, task commitment is motivation. The two terms are interchangeable. To briefly review, students who are gifted are characterized by creativity, above-age ability, and high task commitment. This study focuses upon creativity and task commitment. Encompassing task commitment, Renzulli reports that gifted subjects show high levels of perseverance, interest, dedicated practice, and fascination (Navas-Sanchez, Carmona, Aleman-Gomez, Sanchez-Gonzalez, Guzman-de-Villoria, Franco, Robles, Arango, &Desco, 2016). Therefore, gifted programs in the secondary mathematics setting must cater to these characteristics. This study sought data revealing methods and strategies secondary mathematics teachers used that allowed for perseverance, interest, dedication, and fascination as their gifted students engaged in mathematics tasks.

The study's research questions were derived from the conceptual framework. The first research question seeks to determine what specific methods or strategies secondary mathematics teachers use to educate gifted students and how the teachers feel about these methods or strategies.The first research question also seeks to determine how these methods or strategies cater to gifted students' creativity and commitment to mathematics tasks. Possible methods or strategies include combining multiple lessons, enriching curriculum, teaching AP courses, and the use of specific curriculum. The second research question seeks to explore how adequately prepared secondary mathematics teachers feel they are to work with gifted students, as well as what training they received, techniques they have learned, and the effects of the training. The second research question also seeks to determine if the training teachers received lent itself to the potential for creativity and task commitment of gifted students. The third research question explores the challenges secondary mathematics teachers may have faced when working with the gifted, as well as the success they have experienced and their recommendations for other teachers. The third research question also seeks to determine if these advantages and challenges were related to gifted students' creativity and commitment to mathematics tasks.

## Limitations

There are certain design elements of this study that may have influenced findings. It is possible that these factors may have weakened the study. Further research may be guided and aided by acknowledging these elements. It was possible that these potential issues did not matter. It was not possible to predict how these issues may have influenced the methods and trustworthiness of the study.

For the purposes of this study, instructors of gifted students in secondary mathematics classes were given in-depth interviews. These instructors were contacted by their respective

administrators concerning the study, as well as the researcher. Administrators were the initial contact either by phone, direct mail, or email to ask for permission to interview the teachers of gifted secondary students in mathematics classes. Interview questions targeted methods and strategies teachers had found successful. Limitations of this study took two forms. The limitations were either general limitations of qualitative research or limitations pertaining to the study's design. The researcher attempted to limit both to the fullest extent possible.

Concerning qualitative limitations, researcher subjectivity is inherent in qualitative design. Therefore, bias is a potential limiting factor. Participant subjectivity may also be a factor. Interviewees and focus group participants may have offered responses they assumed the researcher was looking for or responses that suited their own purposes. Interviewed teachers also may not have been fully candid during the interview process. To help thwart the potential for subjectivity, the interviewer strived to maintain an environment conducive to openness and honesty during interviews and focus groups.

Concerning study design, restriction of sample size may have posed a limiting factor upon the study, negatively impacting the study by narrowing its generalizability to similar settings. In addition, research bias may have occurred when teachers responded to the interview and focus group questions. Since the interview was voluntary, teachers responding may have felt strongly about gifted education and believed the methods or strategies identified work well. The adverse may also be true. Since the interview was voluntary, teachers may have been motivated to respond based on a personally held negative view of gifted education. It is also possible that teachers who had not experienced success teaching gifted students may have opted not to be interviewed or participate in a focus group. It should be noted that the interviews and focus groups only provided a snapshot measurement, and that the participants' current emotional state

may have factored into their responses causing the responses to be unique at the given time. A final limiting factor is that only secondary students were studied during individual interview data collection. The study did not address transferability to grade levels outside of the high school mathematics setting.

## Definitions of Terms

Acceleration: Acceleration involves the supplying of curricular content that matches the pace at which a gifted student learns.

> Access to higher level learning activities and skill development than typically provided in regular education to students of the same age. The pacing, complexity and depth of planned coursework are modified as indicated by individual needs. Acceleration may include: planned course compacting/telescoping, subject acceleration, specially designed instruction, credit by examination or performance, interdisciplinary planned courses, distance learning courses, higher education level courses, independent or self-directed study. (Pennsylvania Department of Education, 2014, p. 40)
>
> Presenting content to match the accelerated rate at which gifted and advanced students learn (Winebrenner&Brulles, 2008).

AP Courses: Classes offered to high school students that enable them to earn college credits.

> These courses are also used as acceleration opportunities for gifted students (Colangelo et al., 2004).

Cluster Grouping: "Ability grouping within a heterogeneous classroom" (PDE, 2014, p. 40).

> Grouping students by ability and achievement levels (Brulles, Cohn, & Saunders, 2010; Gentry & MacDougall, 2009; Tieso, 2005).

Compacting: - “Elimination of content that the student has already mastered allowing a faster paced learning progression based on the student's rate of acquisition/retention of new materials and skills” (PDE, 2014, p. 41). Giving students full credit for previously mastered standards (Winebrenner, 2003). After academic material is mastered and the requiredskills are identified, a student is permitted to skip content (Manyowa&Ncube, 2013).

Creativity: - The elements of fluency, originality, and flexibility (Kim, Cho, &Ahn, 2003).

Enrichment: - “In-depth learning experiences that provide interaction with new ideas, skills and topics that enhance the curriculum. These experiences are based upon individual student strengths, interests, and needs” (PDE, 2014, p. 41). A form of differentiating instruction for talented learners that presents daily intellectual challenges (Gagné, 2011). Enrichmentinvolves presenting material with more depth, breath, complexity, and abstractness thanis found in a regular education curriculum (Manyowa&Ncube, 2013).

Gifted Education: -

> Specially designed instruction to meet the needs of a gifted student that is conducted in an instructional setting, provided in an instructional or skill area, provided atno cost to the parents, provided under the authority of a school district, directly, by referral or by contract, provided by an agency, individualized to meet the educational needs of thestudent, reasonably calculated to yield meaningful educational benefit and studentprogress and provided in conformity with a Gifted Individualized Education Plan. (PDE, 2014, p. 42)

Gifted Student: - “A student who is exceptional under section 1371 of the School Code (24 P.S. § 13-1371) because the student meets the definition of "mentally gifted" and needs

specially designed instruction beyond that required in Chapter 4 (relating to academic standards and assessment). This term applies only to students who are of "school age" as defined under §11.12 (relating to school age)" (PDE, 2014, p. 42). When one possesses and usesoutstanding natural abilities in at least one domain, placing them in the top 10% of their same age peers (Gagné, 2011).

Program: - Any pedagogical technique used by a teacher. In this study, pedagogical techniques are inclusive of, but not limited to, gifted program options such as acceleration, AP courses, cluster grouping, compacting, and enrichment.

Task Commitment: - In reference to the Renzulli model, task commitment is motivation. Components of motivation include perseverance, determination, dedication, high levels of interest, enthusiasm, and fascination (Renzulli, 1998).

## Summary

This chapterbegan by introducing the problem of an existing discrepancy between what is currently known about the secondary mathematics settings for gifted students and what needs to be known about the lack or misuse of programs for gifted students in such settings. Next, the chapter presented the study's purpose, which was to conduct a detailed exploration of the effectiveness, implementation, and availability of gifted programs offered to secondary gifted students in the mathematics environment.Research questions and the approach taken to address the questions were explained. The Renzulli Model of Giftedness, this study's conceptual framework, was presented. The chapter closed by noting limitations to the study and defining terms commonly used throughout the study.

# CHAPTER II

## REVIEW OF THE RELATED LITERATURE

The Renzulli Model of Giftedness was used as a theoretical overview that informed the research process and is included in this literature review. It should be noted that the researcher agrees with the literature supported contention that the talents of the United States' potentially gifted mathematicians are not being fully developed due to inappropriate educational opportunities. The review will initially provide the reader with a comprehensive perspective by summarizing current and historical knowledge on the topic of gifted methods and strategies used in secondary mathematics environments then shift to material more closely related to gifted program options. This review is inclusive of the ongoing conversations held by theorists and authors who explore current issues and trends in both gifted and mathematics education. To adequately prepare for this study, it was necessary to review, summarize, and synthesize the existing discoveries concerning the topic of gifted methods and strategies utilized in secondary mathematics settings.

It was also necessary to consult historical overviews of methods and strategies used in gifted environments, as well as historical overviews of other issues pertinent to the study. First-hand information and source material were gathered and explored to identify gaps in the literature. Seminal works and landmark studies were consulted when possible. Each method and strategy, explored in this literature review, was researched until a point of saturation occurred.

The topic of gifted methods and strategies utilized in secondary mathematics classrooms needs to be more deeply explored to move important conversations in the literature forward. This literature review attempts to take a critical, analytic, and evaluative stance. As it reviews,

synthesizes, and summarizes information, the review situates the study as the next logical step in furthering information on the topic.

The development of this dissertation was grounded within a conceptual framework. This framework was Renzulli's model of giftedness. The Renzulli framework was considered acceptable based on a thorough review of published study in gifted education. The following review of literature combined with the Renzuilli model informed the research questions addressed by this study.

At a very basic level, this study was based on how to improve gifted secondary students' mathematics educations. The study examined methods and strategies teachers have found successful when teaching gifted students mathematics. The success of a method or strategy was determined by how well it fit within two of the three rings of the three-ring conception of giftedness developed by Joseph Renzulli. A successful method or strategy was characterized by its effect on a gifted student's creativity and how well it positively affected their mathematics task commitment.

This literature review will detail successful methods, strategies, and programs repeatedly noted in the literature. Amongst these are the program options of acceleration, enrichment, compacting, cluster-grouping, and advanced placement (AP) programs. "It is important for teachers, as the main mediators in schools, to work with emotion and knowledge and to enable gifted students to share their high abilities with their peers, undertaking activities that are both challenging and also develop sensitivity, within a stimulating environment that responds to their special educational needs, which are not only intellectual but also affective and social" (Stoltz, Piske, Freitas, D'Aroz, & Machado, 2015, p. 68).

All aspects of this literature review will relate to program options for gifted secondary students in the mathematics environment. However, at times, the review's focus will narrow to strategies, both general and mathematical, that can be utilized within the programs studied. The literature review will begin by defining "giftedness."

## Defining Giftedness

A federal definition of giftedness was provided by the Commissioner of Education in the 1972 Marland Report to Congress. The report described gifted students as those who give evidence of high achievement capability in areas such as intellectual, creative, artistic, leadership capacity, and specific academic fields. The report emphasized a need for services and activities not ordinarily provided by schools to develop the students' capacities. The Marland Report defined gifted students as,"those identified by professionally qualified persons who by virtue of outstanding abilities are capable of high performance."

The federal definition of giftedness is as follows "The term 'gifted and talented,' when used with respect to students, children, or youth, means students, children, or youth who give evidence of high achievement capability in such areas as intellectual, creative, artistic, or leadership capacity, or in specific academic fields, and who need services or activities not ordinarily provided by the school in order to fully develop those capabilities" (No Child Left Behind [NCLB], 2001).

Definitions can be and are used by schools to determine which students belong in gifted programs. The definition of giftedness to which this study ascribes is provided by the NAGC. In their position statement titled *Redefining Giftedness for a New Century: Shifting the Paradigm*, the NAGC defines gifted students as "those who demonstrate outstanding levels of aptitude (defined as an exceptional ability to reason and learn) or competence (documented

performance or achievement in the top 10% or rarer) in one or more domains. Domains include any structured area of activity with its own symbol system (e.g., mathematics, music, language) and/or set of sensorimotor skills (e.g., painting, dance, sports)" (NAGC, 2010, p. 1). This definition of giftedness was approved by the NAGC board in 2010, and is their most current stance. However, it should be noted that definitions of giftedness vary across states. While varying definitions of giftedness creates a climate in which there is no single definition of mathematical giftedness, each state is working to benefit the gifted student.

Krutetski (1968) described mathematically gifted, or mathematically capable students, as those who generally strive for the simplest and most elegant path when solving a math problem. Students, who are not mathematically inclined, according to Krutetski, were not as concerned with the aesthetics involved in finding a solution.Within the confines of defining giftedness, a definition will inevitably be incumbent upon current political influences, notions and theories of student development, and currently available programs. Still, while varied, definitions do share common traits such as outstanding levels of aptitude, exceptional abilities, and creativity. The National Association for Gifted Children does not subscribe to a single theory of the nature of human ability. Instead it recognizes that some students are capable of high performance. However, high performance should not be confused with students who work hard and achieve. Differentiating the two are the innate abilities and aptitudes of the gifted student. The NAGC believes that the nation's schools are responsible for providing these high performers with an optimal and appropriate education that enables them to develop their talents (NAGC, 2015). The NAGC views definitions of giftedness as frameworks to be utilized for the development of gifted education programs. Renzulli's three-ring conception of giftedness, the conceptual framework for this study, is one example.

The Renzulli model frames this study. Recently, detailing the three parts of the Renzulli model of giftedness as characteristics of gifted students, Mann, Chamberlin, and Graefe (2016) stated:

> Mathematical problemsolving, has many conceptions. A commonly accepted conception of giftedness is Renzulli's(1978) Three-Ring Conception of Giftedness in which he defined it as being comprised of above average ability, task commitment, and creativity. Regarding task commitment, Renzulli (1998) uses the terms perseverance, determination, dedication, high levels of interest, enthusiasm, and fascination, all of which are components of motivation. Subsequently, Renzulli added co-cognitive traits through his Operation Houndstooth (Renzulli, 2002) research. Each of the six areas outlined by Renzulli in Operation Houndstooth (i.e., optimism, courage, romance with a discipline, sensitivity to human concerns, vision, and physical/mental energy) has a strong connection to the affective domain and adds fuel to the discussion of why problem solvers seek solutions. (p. 5)

Giftedness models generally include performance, creativity, referrals and nominations, rating scales, behavioral checklists, IQ tests, and achievement tests. Howard Gardner (1993) may be the most identifiable name among the creators of models of giftedness, particularly in the field of psychology, and many schools have developed curriculum based on his theory of domain specific multiple intelligences. Gardner believes that all individuals possess eight signs of intelligence, but some may excel in one or more of these areas. Yeager (2016) explains, "Howard Gardner was a professor of cognition and education at Harvard University's Graduate School of Education who developed his theory of multiple intelligences in the late 1970s and early 1980s. *The Theory of Multiple 'Intelligences* states that, '…individuals possess eight or

more relatively autonomous intelligences. Individuals draw on these intelligences, individually and corporately, to create products and solve problems that are relevant to the societies in which they live.' Gardner has determined that there are currently eight signs of intelligence; spatial, bodily kinesthetic, musical, linguistic, logical-mathematical, interpersonal, intrapersonal, and naturalistic" (p. 12).

"Gardner is not the only researcher to have considered abilities in a more domain specific way. Julian Stanley's experiences with precocious youth also led him to develop a domain-specific conception of giftedness. Stanley established the Study of Mathematically Precocious Youth (SMPY) at Johns Hopkins University in 1971 with the purpose of identifying youths with precocious specific abilities, especially in mathematics, and of supplying them with the educational resources they need to achieve their full potential." (Kaufman & Sternberg, 2008, p. 75).

François Gagné separates his work from the systemic approach in support of the notion that giftedness is developmental. He believes that even the terms "gifted" and "talented" should not be confused. To aide in the development of gifted abilities Gagné created the Differentiated Model of Gifted and Talented (DMGT). Gagné (2004) states, "The Differentiated Model of Giftedness and Talent (DMGT) presents the talent development process (P) as the transformation of outstanding natural abilities, or gifts (G), into outstanding systematically developed skills which define expertise, or talent (T) 3 in a particular occupational field" (p. 119).

It is necessary to understand what Gagné means by both gifted and talented. Per Gagné (2004), "*Giftedness* designates the possession and use of untrained and spontaneously expressed natural abilities (called outstanding aptitudes or gifts), in at least one ability domain, to a degree that places an individual at least among the top 10 per cent of age peers. *Talent* designates the

outstanding mastery of systematically developed abilities (or skills) and knowledge in at least one field of human activity to a degree that places an individual at least among the top 10 percent of age peers who are or have been active in that field or fields" (p. 220). For further clarity a simplified version of Gagné's model follows.

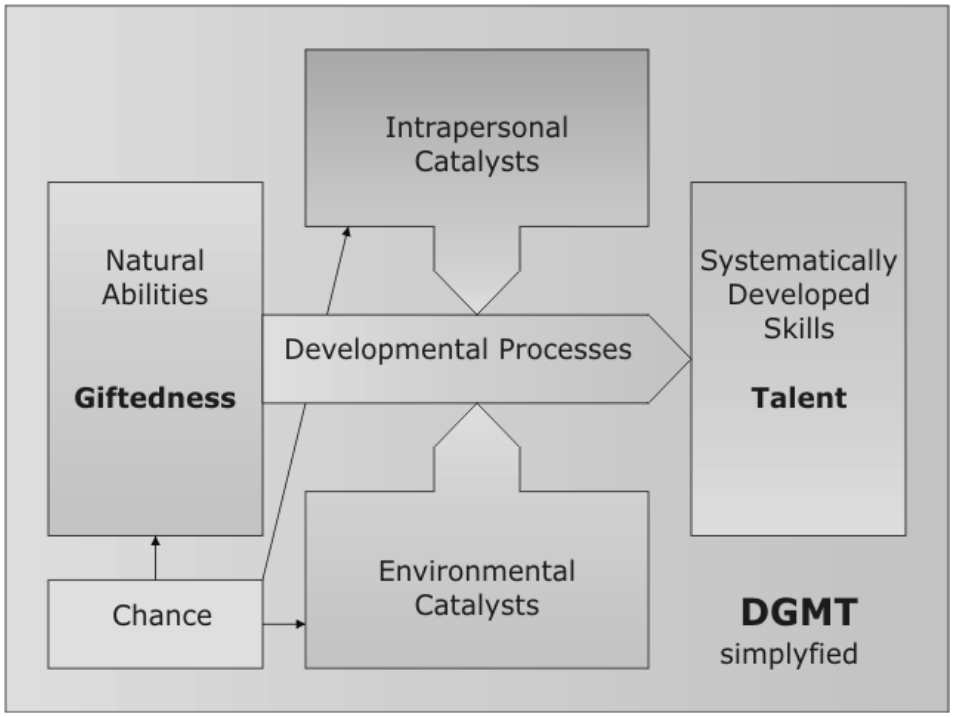


*Figure 2.* Gagné's differentiated model of giftedness and talent

For decades, researchers were content to follow the lead of Lewis Terman and define "giftedness" in terms of IQ (Terman, 1925), but "The need for precise definitions is especially critical when dealing with constructs such as creativity, intelligence, and talent, given the wide range of commonly used definitions for these terms" (Sternberg & Davidson, 2005, p. 201). "All definitions of giftedness imply the necessity of a social context because such a context is requisite for determining whether (and how) a person, action, or product will be defined or judged as gifted" (Sternberg & Davidson, 2005, p. 202). "Definitions of giftedness vary widely from a study to another. Although the most widespread definition is based on a Full Scale IQ

[FSIQ] score, many authors include creativity, school performance, leadership or any combination of these in their definition. Those who based their definition of giftedness on IQ have chosen several thresholds: 120, 125, 130, 145 or even 160, even if the most frequent choice remains 130 (i.e., 2 standard deviations above the population mean)" (Peyre, Ramus, Melchior, Forhan, Heude, &Gauvrit, 2016, p. 366).

Still other lead researchers, such as Nancy Robinson (2005), advocate for conceptual approaches to giftedness. While Robinson believes achievement measures are valuable for identifying gifted youth, Robinson supports a psychometric approach rather than a systemic or developmental one. A psychometric approach is traditionally recognized as an IQ approach, and it is a popular means of identifying gifted students in the United States.

It should be noted that IQ scores are accompanied by a standard error of measurement. This error of measurement may not be considered when a student is placed based on a predetermined yet variable "cut-off" score. Students missing the score by just one or two points may be excluded. Once excluded, the students could be denied necessary programs and never reach their true mathematics potential. In addition, testing takes time. The student may be subjected to waiting for testing results to be challenged or accelerated through an already mastered curriculum.

Concerning state definitions of giftedness, McClain and Pfeiffer (2012) report:

> 90% include intelligence as an area or category of giftedness. Thirty-nine state definitions include high achievement (78%), and 27 state definitions include creativity (54%). In addition, 28 states (56%) include a specific category of giftedness (e.g., artistic talent), 15 states (30%) include the category leadership or leadership ability in their definition, and 3 states list motivation (6%). (p. 66)

The state of Pennsylvania defines mental giftedness in the following manner. "Mentally gifted is defined as outstanding intellectual and creative ability the development of which requires specially designed programs or support services, or both, not ordinarily provided in the regular education program (22 Pa. Code §16.1)" (PDE, 2014, p. 7). PDE (2014) further defines a gifted student as, "A student who is exceptional under section 1371 of the School Code (24 P.S. § 13-1371) because the student meets the definition of "mentally gifted" and needs specially designed instruction beyond that required in Chapter 4 (relating to academic standards and assessment). This term applies only to students who are of 'school age' as defined under §11.12 (relating to school age)" (p. 42).

Both the Marland Report and Pennsylvania's definitions of giftedness include the concept of creativity, as does Renzulli's three-ring conception of giftedness which frames this study. However, there are different levels of gifted ability, and defining "giftedness" becomes more difficult when one considers the immense differences between being moderately and highly gifted (Donovan& Cross, 2002). Research has determined that factors such as home, school, environment, and personality intertwine to determine whether a student's innate giftedness will develop (Renzulli, 2006; Sternberg & Davidson, 2005). There is great diversity within the gifted population and it is not easy to definitively find a singular definition of "giftedness." Yet, "In the absence of a clear and definable definition of what it means to be gifted, school districts typically set local criteria for inclusion" (Clark, Moore, & Slate, 2012, p. 8).

## Identifying Gifted Students

Before discussing program options to implement in a mathematics class, an understanding of how gifted students are currently identified is necessary.

> Sixteen states (32%) mandate that schools use intelligence tests when identifying gifted students, whereas 17 states (34%) mandate the use of achievement tests, the two most widely required gifted identification methods/domains. In addition, 13 states (26%) require the use of nominations and teacher and/or parent referrals. Nine states (18%) require the use of a teacher-completed behavior rating scale, whereas seven states (14%) require the use of a behavioral checklist. However, it is likely that there is overlap in terms of these two categories of identification methods. Last, nine states (18%) require the use of creativity tests, whereas eight states (16%) stipulate the inclusion of performance measures to identify giftedness. (McClain & Pfeifer, 2012, p. 68)

In Pennsylvania, PDE (2014) dictates, "The local school district is primarily responsible for identifying all 'children with exceptionalities' which means 'children of school age who have a disability or who are gifted and who, by reason thereof, need specially designed instruction exceptional children and developing educational programs to meet their needs (24 P.S. §13-1371(1))'" (p. 4). PDE (2014) recognizes and accepts the decisions school districts make concerning the identification of their gifted students stating, "The student is thought to be gifted because the school district's screening of the student indicates high potential consistent with the definition of mentally gifted or a performance level which exceeds that of other students in the regular classroom" (22 Pa. Code §16.22) (p. 4).

## Need for Teacher Training and Appropriate Programs for the Gifted

"Teachers often lack the essential knowledge, skills and confidence to identify and meet the needs of gifted and talented students. Evidence suggests this lack of preparation may be related to teachers' professional development" (Fraser-Seeto, Howard, & Woodcock, 2015, p. 1). "A patchwork system of teacher training, availability of services, and the lack of reporting and

accountability has real consequences for high-ability students who may not succeed without specialized and rigorous instruction" (NAGC, 2009, p. 2). In Bégin and Gagné's 1994(a) study, teacher training in gifted education was associated with greater support of gifted programs. In-service teacher trainings tend to mold teachers' attitudes and perceptions of gifted education (Berman, Schultz & Weber, 2012). Teachers who participate in professional development activities demonstrate improved attitudes toward gifted education (Kronborg& Plunkett, 2012).

"The ultimate goal of special education programs for gifted students should be to foster excellence. Quality of learning experiences is a key for these programs to achieve this goal" (Sak&Eristi, 2012, p. 1). As already established, students who are gifted learn differently. Gifted students may benefit from enrichment, or may best be served in an advanced placement (AP) course. Perhaps the student may benefit from a combination of programs. As with all students, instruction for gifted students must match the ways they process concepts and develop skills. To accommodate gifted students, teachers must differentiate instruction (Gagné, 2011). PDE (2014) requires school districts to, "Provide opportunities to participate in acceleration or enrichment, or both, as appropriate for the student's needs. These opportunities must go beyond the program that the student would receive as part of a general education (22 Pa. Code §16.41) (p. 23)."

In Pennsylvania, the Pennsylvania Department of Education (PDE) provides guidelines for the qualities of effective gifted mathematics programs. Referring to their guidelines, they state:

> The purpose of these guidelines is to assist local education agencies in meeting the requirements of the State Board's regulations set forth at 22 Pa. Code Chapter 16 - Special Education for Gifted Students. The regulations recognize that gifted students are

> considered to be “children with exceptionalities” under the Public School Code of 1949 and in need of specially designed instruction. The guidelines are an overview of both acceptable and best practices, procedures and policies designed to meet the learning needs of gifted students. These guidelines reflect Pennsylvania’s continuing commitment to providing educational services appropriate for mentally gifted students that are consistent with their individual needs, outstanding abilities and potential for performing at high levels of accomplishment. (PDE, 2014, p. 3)

PDE (2014) requires, “Gifted education programming must be an integral part of the instructional school day.”“Districts may use administrative and instructional strategies and techniques in the provision of gifted education for gifted students which do not require, but which may include, categorical grouping of students” (22 Pa. Code §16.41). A combination of acceleration and enrichment provides the greatest opportunity for flexible programming to meet the needs of the gifted. Even if a pullout option is present in the school district, an individualized plan must be provided. The individualized plan must establish learning opportunities to insure meaningful progress (22 Pa. Code §§16.1(viii), 16.41(2)).Minimal or trivial progress is not meaningful progress. The gifted student must be provided instruction at an appropriate level of challenge and with adjustments that accommodate individual needs. The instruction must be reasonably calculated to yield meaningful educational benefit and student progress” (p. 5).

PDE (2014) further details these qualities:

> School districts are free to group gifted students in ways that best serve the needs of each gifted student. However, the service delivery options chosen for each gifted student are developed based on the strengths and needs identified within the Gifted Individualized Education Plan and must be agreed to by the Gifted Individualized Education Plan team.

Options for gifted students may be offered through a variety of settings and selections such as:

- Early entrance to kindergarten based on mental age and individual readiness.
- Cluster grouping based on instructional level.
- Open-ended compacted curriculum with flexible pacing.
- Level, grade and/or subject acceleration with flexible pacing.
- Grade or subject "skipping."
- Advanced placement and honors courses with earlier-than-normal access.
- Permission to receive credit for demonstrated mastery in required courses by recommendation of the Gifted Individualized Education Plan team (credit by examination).
- Permission to submit proposals to replace requirements for which the student has demonstrated mastery as recommended by the Gifted Individualized Education Plan team (college courses).
- Independent study designed to meet a gifted student's long-term interests and expertise in a given area.
- Specialized curriculum for gifted learners based on validated research in gifted education.
- Distance learning.
- Consortium, collaborative or cooperative arrangements with other school districts.
- Online courses.
- Opportunities for gifted students to work with their peers in a resource room.
- Alternative scheduling (block, alternating days, etc.).

- School within a school.
- Arrangement of school schedules in order that gifted students can access the fine arts.
- Incorporation of appropriate outside-of-school educational experiences.
- Enrichment in content areas.
- Independent learning contracts.
- Mentorships, apprenticeships, internships and field experiences designed to meet gifted students' performance level and career interests. (p. 27-28)

## Programming and Instructional Options

To enable gifted students to reach their potential, research supports the programming and instructional options of acceleration, enrichment, cluster grouping, and compacting. "The preponderance of existing evidence accumulated over the past century suggests that academic acceleration can greatly improve K–12 students' academic achievement" (Steenbergen, Makel, &Olszewski-Kubilius, 2016, p. 893). When curriculum is enriched, material is presented with more depth, breath, complexity, and abstractness than what is offered in regular education classrooms (Manyowa&Ncube, 2013). Gagné (2011) found that curriculum must be enriched to meet the needs of exceptional learners. Cluster grouping enables higher levels of performance by separating gifted learners according to ability and achievement (Brulles, Cohn, & Saunders, 2010; Gentry & MacDougall, 2009; Tieso, 2005), and curriculum compacting builds appropriate rigor into the gifted student's curriculum (Reis & Morales-Taylor, 2010). Each of these programs will be explored in more detail in the remainder of this chapter.

### Acceleration

Colangelo, Assouline, and Lupkowski-Shoplik (2004) have concluded that, "Acceleration has been well researched and documented. Acceleration is the best educational intervention for

highability (gifted) students. Acceleration is consistently effective with gifted students. Acceleration is highly effective for academic achievement. Acceleration is usually effective in terms of social-emotional adjustment" (p. 2). Two forms of acceleration show prominence: grade-based acceleration or grade skipping and grade telescoping. Both forms involve exposing gifted learners to content earlier than their same age peers. The two prominent forms of acceleration will be individually discussed in the following paragraphs.

The first form of acceleration noted, grade-based acceleration or grade skipping, "Shortens the number of years a learner remains in the K–12 school system before entering a college or university or other post-secondary training" (Colangelo, Assouline, &Lupkowski-Shoplik, 2004, p. 48). For example, a student may progress from first to third grade skipping second. The *Iowa Acceleration Scale* is one tool that can be used to make decisions about grade-based acceleration. This tool provides guidelines for implementing acceleration (Assouline, Colangelo, Lupkowski-Shoplik, Lipscomb, &Forstadt, 2009).

> Grade-accelerated students generally outperform their chronologically older classmates academically. Accelerated students should be expected to achieve, relative to their new grade peers, at a high level that is generally comparable to their performance in the previous grade. Such students are typically among the top 10% in a class, and they should be expected to remain in the top 10% throughout their academic careers. To be clear, there is no evidence that acceleration has a negative effect on a student's social-emotional development. (Colangelo, Assouline, Marron, Castellano, Clinkenbeard, Rogers, & Smith, 2010, p. 181)

Data gathered during a 40-year longitudinal study by Park, Lubinski, &Benbow, (2013) revealed that,

> grade skippers (a) were more likely to pursue advanced degrees in STEM and author peer-reviewed publications in STEM, (b) earned their degrees and authored their 1st publication earlier, and (c) accrued more total citations and highly cited publications by age 50 years. These patterns were consistent among male participants but less so among female participants (who had a greater tendency to pursue advanced degrees in medicine or law). Findings suggest that grade skipping may enhance STEM accomplishments among the mathematically talented. (p. 176)

Rather than skipping a grade, a student may also enter kindergarten or first grade early. The student does not skip a grade or finish a grade in less time than is typical; they simply begin school at a younger age. Colangelo, Assouline, and Gross (2004) define early entrance as, "Early Admission to Kindergarten: Students enter kindergarten or first grade prior to achieving the minimum age for school entry as set by district or state policy. Early Admission to First Grade: This practice can result from either the skipping of kindergarten, or from accelerating a student from kindergarten in what would be the student's first year of school" (p. 5). Differentiating early entrance from typical grade skipping, Colangelo, Assouline, and Gross (2004) define grade skipping as, "Grade-Skipping: A student is considered to have grade skipped if he or she is given a grade-level placement ahead of chronological-age peers. Grade-skipping may be done at the beginning or during the school year" (p. 5).

Concerning the second form noted, grade telescoping, "Little research has been conducted on this particular form of accelerated learning in the last two decades, with most studies occurring in either the 1930s or the 1960s in North America" (Plunkett &Kronborg, 2007, p. 81). Grade telescoping or "moving through the required curriculum in a shorter period" (Plunkett &Kronborg, 2007, p. 81), allows a student, or group of students who are the same age,

to complete a school's curriculum in less time. The student or students are telescoped through curriculum. For example, students who are grade telescoped may be permitted to complete two years of content in one year.

Acceleration can take many forms. For example, in addition to the two prominent forms of acceleration just discussed, content-based acceleration exists and may take various forms. "Single-subject acceleration, dual enrollment, and Advanced Placement coursework are all forms of content-based acceleration" (Colangelo et al., 2010, p. 183). A discussion of all the forms of acceleration would be too exhaustive for the purposes of this review.

"A long history of research shows the effectiveness of most types of acceleration, the question of why it is not more universally implemented looms large for educators, parents, and policy makers" (Steenbergen, Makel, &Olszewski-Kubilius, 2016, p. 891). Acceleration matches content to the accelerated rate at which gifted and advanced students learn (Winebrenner&Brulles, 2008), and involves presenting content at the pace a gifted student learns (Winebrenner&Brulles, 2008).

The term "acceleration" can be misleading. A teacher may say they "accelerated" a student who skipped a grade, but would never say they "decelerated" a student who has failed a grade. When a student is placed in an acceleration program they have demonstrated an ability to move ahead. The quickened curricular pace is not burdensome to the student, nor is the student given any additional work. The student is simply afforded the opportunity to accelerate through course material at a rate and pace that matches their ability. The student is placed at a more appropriate level of instruction. In other words, the term "acceleration" is a reference to the gifted student's progress. The curriculum is not accelerated. The curriculum is refined to meet the gifted learner's needs. The student is "accelerating." The curriculum is not. When

accelerating a student, a primary consideration is meeting the student's emotional needs and avoiding social maladjustment (Manyowa&Ncube, 2013). Gifted students need expedited pacing due to their ability to grasp meaning and make connections faster than their peers (Winebrenner&Brulles, 2008).

Per Colangelo et al. (2010), "Many states and school districts have no formal policies that address the desirability of acceleration or specify the procedures to be followed in making decisions about acceleration for particular students" (p. 180). The researchers call for every school district to implement a written acceleration policy. "The policy should be characterized by accessibility, equity, and openness. It should provide guidelines for the implementation of acceleration, including administrative matters, to ensure fair and systematic use of accelerative opportunities and recognition for participation in those accelerative opportunities. Finally, the policy should provide guidelines for preventing nonacademic barriers to the use of acceleration as an educational intervention and include features that prevent unintended consequences of acceleration" (Colangelo et al., 2010, p. 181). "Acceleration decisions should be made by child study teams, not individuals. A child study team, which should include experts in gifted education, should consider individual acceleration cases, and with the use of valid and reliable instruments to guide the discussion, decide on the form of acceleration needed" (Colangelo et al., 2010, p. 191). It should be noted that a plan for accelerating a student should not be confused with an Individualized Education Plan (IEP) or a Gifted Individualized Education Plan (GIEP), though the written acceleration plan may be a part of the GIEP.

**Enrichment**

"Gifted education and mathematics literature suggest support for curriculum that is both enriched and accelerated with a focus on developing conceptual understanding and mathematical

thinking" (Gavin, Casa, Adelson, Carroll, Sheffield, & Spinelli, 2007, p. 567). A curriculum is enriched by allowing for more abstractness, complexity, depth, and breath (Manyowa&Ncube, 2013). Manyowa and Ncube (2013) identified some ways in which curriculum is enriched within primary schooling. These ways are instruction from a teacher other than the student's regular daily instructors and who is an expert in giftedness, withdrawal for enriched instruction, being placed in a special class setting for part of the day, and placement in a resource room with other students who are gifted.

Gagné (2011) considers enrichment programs to be the most effective means for the development of gifted ability. Gagné (2011) informs us that curriculum must be enriched to meet the pace of talented learners. Gagné's research has demonstrated that gifted students learn at entirely different rates than average students. An enriched curriculum, according to Gagné, is necessary to provide exceptional learners with daily intellectual challenges.

A 1993 survey revealed that there were two predominant methods used in the enrichment programs offered to our nation's gifted learners. "The Classroom Practices Survey was conducted to determine the extent to which gifted and talented students receive differentiated education in regular classrooms. Survey samples were third and fourth grade teachers, including a general sample of teachers in public schools" (Archambault, Westberg, Browns, Hallmark, Emmons, & Zhang, 1993, p. 1). The two predominant methods revealed were enrichment of curriculum content within the regular education classroom, and pull-out courses (Archambault et al., 1993). Another national survey was conducted during the 1990s by the National Research Center of the Gifted and Talented (NRCGT). This survey concerned the longevity of differing enrichment practices found in the United States' schools. Findings indicated enrichment programs were offered just two to three times a month (Gagné, 2011).

To differentiate instruction for talented learners, the curriculum must present daily intellectual challenges (Gagné, 2011). Gifted students in mathematics classes need extra challenging material, from a regular education or gifted education teacher, to flourish. Murray (2009) demonstrated that enrichment programs are necessary to allow gifted students to meet their specific excellence goals. Per Gagné (2011), "Intellectually Gifted and Academically Talented in U.S. elementary and middle schools rarely have access to even the most basic forms of enrichment" (p. 18). An effective enrichment program, according to Gagné (2007), is diverse and emphasizes depth rather than difficulty.

Reis, Burns, and Renzulli (1992) found that effective and appropriate gifted programs have enrichment at their core. With enrichment comes consistent intellectual challenge for exceptional learners. Gagné (2011), Reis, Burns, and Renzulli (1992) deem enrichment to be the most relevant adaptation for students who are gifted. Gagné (2007) reports that when a student can master curriculum at an accelerated pace, there is room for enrichment within their curriculum. Enrichment enables exceptional learners to reach their educational goals faster while experiencing significant challenge. Allowing gifted students in mathematics classes to experience greater challenges than their peers is appropriate since Gagné and St. Père (2001) found that gifted students demonstrate high levels of perseverance. A discussion on compacting the curriculumof gifted students follows.

**Compacting the Curriculum**

When a curriculum is compacted, a student is given full credit for previously mastered content (Winebrenner, 2003). The student therefore avoids unnecessarily repeating this content. For example, if a student is fluent in dividing fractions and a new unit or course asks the student

to complete a section on dividing fractions, the student may be permitted to skip the section and move onto a lesson offering appropriate challenge and rigor.

Curriculum compacting is used to maximize instructional time by building appropriate rigor into the gifted student's curriculum (Reis & Morales-Taylor, 2010). When curriculum is compacted, material must first be mastered and the desired skills must be identified before a student is permitted to skip content (Manyowa&Ncube, 2013). In mathematics, compacted curriculum involves more challenging math work that is substituted for regular education math content. Unnecessarily repetitious content is eliminated. The gifted student may move ahead once mastery of content occurs.

While accelerating through a curriculum involves skipping topics, compacting curriculum offers more challenging alternatives to topics once mastery of the regular content is demonstrated. Yet, in both, certain topics are skipped. These topics are skipped only when gifted math learners demonstrate the ability to comprehend higher level math concepts. A compacted curriculum enables an active use of knowledge (Resnick & Hall, 2005).

"Compacting is used to document the content areas that have been compacted and the alternative work that has been substituted" (Reis & Morales-Taylor, 2010, p. 30). In other words, students are permitted to move ahead after mastery through a compacted curriculum. In Reis, Westberg, Kulikowich, and Purcell's 1998 study, it was determined that when a gifted student masters content and this content was consequently replaced with more challenging material, higher achievement was the result. Compacting seems to guarantee mastery while enabling appropriate challenge (Reis, Westberg, Kulikowich, & Purcell, 1998).

**Cluster Grouping**

Cluster grouping entails grouping students into, "clusters in a classroom so that they may receive differentiated instruction" (Ibdah, 2017, p. 113). Recently, Ibdah (2017) explored the results of fourteen studies on cluster grouping and reported, "unanimous support for cluster grouping by the authors" (p. 113). Ibdah (2017) also reported that, "The key trend was that cluster grouping had a positive effect on the academic and social achievements of all students" (p. 117). While the practice of cluster grouping has the potential to enable students with similar mathematics ability to collaborate while being exposed to appropriately challenging math work, grouping alone has little to no impact on academic gains (Gentry, Paul, McIntosh, Fugate, & Jen, 2014). The teacher must group and differentiate with acceleration activities and strategies (Gentry, Paul, McIntosh, Fugate, & Jen, 2014). In doing so, cluster grouping can allow like-minded students to grow independently and share cooperatively.

The practice of cluster grouping enables instructors of gifted students in mathematics classes to understand and embrace the inherent needs of their students (Brulles&Winebrenner, 2011). Teachers tend to more readily allow for compacting and content acceleration when students are cluster grouped (Brulles&Winebrenner, 2011). Cluster grouping allows gifted students to feel more accepted since they are working with students of similar ability and achievement (Delisle & Galbraith, 2002; Webb, Amend, Webb, Goerss, Beljan, &Olenchak, 2005).

Cluster grouping has been utilized to educate mathematically gifted students for decades (Gentry & MacDougall, 2009). Cluster grouping enables higher levels of mathematical performance by separating gifted learners from an otherwise heterogeneous classroom (Brulles,

Cohn, & Saunders, 2010; Gentry & MacDougall, 2009; Tieso, 2005) and teaching them at an appropriate level and pace within the same class.

Brullesand Winebrenner (2011) report, “Flexible grouping allows students to work with others who share similar interests, are ready for more challenging levels of complexity, or share similar learning preferences. Groupings should change according to the content or targeted objectives” (p. 3). Kulik’s (1992) meta-analysis demonstrated that, “Meta-analytic reviews have shown that the effects of grouping programs depend on their features. Programs that entail only minor adjustment of course content for ability groups usually have little or no effect on student achievement” (p. 1). However, “Programs of enrichment and acceleration, which usually involve the greatest amount of curricular adjustment, have the largest effects on student learning, with talented students from accelerated classes outperforming nonaccelerates of the same age and intelligence quotient by almost 1 full year on achievement tests” (Kulik, 1992, p. 8).

Rogers' (1991) meta-analysis results were like Kulik's. Rogers showed that when gifted students were cluster grouped and the curriculum was differentiated, the students’ achievement improved. However, “If the "cluster" curriculum is not appropriately differentiated, then the academic results will be lackluster” (Rogers,1991, p. 27). Improvements were in the areas of critical thinking, creativity, and academics (Rogers,1991).

Rogers (1991) demonstrated that when gifted students were cluster grouped for mathematics, they scored substantially higher and outperformed control groups. Both Roger’s 1991 study and Kulik’s 1992 study strongly support cluster grouping’s efficacy, demonstrating cluster grouping to be an effective strategy for challenging our nation's gifted youth. However, “Although experts in gifted education widely promote cluster grouping gifted students, little

empirical evidence is available attesting to its effectiveness" (Brulles, Cohn, & Saunders , 2010, p.327).

Benefits of cluster grouping include full attention to the needs of exceptional learners, appropriate pacing of learning, an inclusionary setting, facilitating effective teaching, rises in achievement, more easily managed differentiated instruction, and students who are more likely to become academic leaders (Brulles&Winebrenner, 2011). In addition, cluster grouped students feel more comfortable and confident than when grouped by age (Delisle & Galbraith, 2002; Webb, et al., 2005). Winebrenner and Brulles (2008) note that for cluster groups to be optimally effective gifted services must start immediately after the student is identified. The services should then be delivered as a continuum throughout the student's education. When gifted students remain within regular education math classrooms, they can still be cluster grouped and their work can be appropriately adapted. It is possible for regular education teachers to learn strategies that enable gifted students to learn while at the same time benefit from regular education students (Gentry & MacDougall, 2009; Tieso, 2005; Winebrenner&Brulles, 2008).

**Advanced Placement Courses**

Advanced Placement (AP) courses are considered one form of content-based acceleration. Colangelo, Assouline, & Gross (2004) inform, "Students who had taken AP courses had significantly higher grade-point averages in the subjects in which they had accelerated than did their non-AP matches" (p. 53). In addition, AP courses offer college credits when taken by high school students. In the 1950s, the Ford Foundation began the Advanced Placement (AP) program, which consisted of seven schools and eleven subject areas (Callahan, 2003; Colangelo, Assouline, & Gross, 2004). Students who participated in the program were permitted to earn college credits when they were in high school. In 2008, in the United States,

1.5 million students completed 2.7 million AP exams and were afforded the opportunity to earn credits in thirty-seven courses across twenty-two subject areas (College Board, 2008).

Rather than incorporating teaching strategies and programs geared specifically for gifted learners, many school districts have used the College Board's Advanced Placement program to serve their gifted students on a secondary level (Callahan, 2003; Feldhusen, 1995; Hertberg-Davis & Callahan, 2008; Vanderbrook, 2006). VanTassel-Baska (2001) found that AP courses: were opportunities for acceleration, emphasized higher thinking skills, exposed gifted learners to advanced concepts, grouped gifted learners together, and gave gifted students choices to match their talents and course work. However, "No empirical data are available which suggests that exceptional learners in these courses benefit any more or less than the rest of the student body enrolled in them" (Clark, Moore, & Slate, 2012, p. 2). Still, in a study conducted by Hertberg-Davis and Callahan (2008) the researchers demonstrated that gifted students felt appropriately challenged while enrolled in AP courses. In another study, Vanderbrook (2006) conducted interviews with gifted female students taking AP courses. The interviewees reported receiving academic and emotional support from teachers and peers that was not present in other areas of their academics.

> Given the growing number of districts that have adopted the Advanced Placement program as the sole means for serving their Gifted students at the secondary level, it was surprising that no published empirical quantitative studies were located in which the effectiveness of Advanced Placement (AP) courses in meeting the learning needs of exceptional studies was examined. (Clark, Moore, & Slate, 2012, p. 2)

In 2003, Callahan found that the rise in popularity of AP courses for gifted students was due to a lack of program options made available to gifted students. Despite being a choice

chosen due to a lack of options, AP courses were considered the most reliable indicator of high school and future college success (Kaye, 2006). AP courses in mathematics may benefit a gifted student. When a gifted student is placed in an AP course it may be due to other program options not being made available.

## Summary

This chapter presented information detailing why appropriate methods and strategies for educating gifted students in mathematics classes are necessary. The chapter opened byexploring howthe term giftedness is defined and gifted students identified. Next, the chapter examined the need for teacher training to work with the gifted. Gifted programming options,that have demonstrated themselves to be beneficial, were examined.These options included acceleration, enrichment, compacting the curriculum, cluster grouping, and advanced placement courses.

# CHAPTER III

# METHODOLOGY

The purpose of this study was to explore and examine, with a sample of secondary mathematics teachers, programs offered to gifted secondary students in mathematics classes. This chapter documents the necessary steps taken during the study's design throughout its implementation. Research questions, factors and features of the study, study objectives, time-period, location, and teacher interviewee sample are discussed.

This study did not intend to cover or explore content or subject areas outside of the secondary mathematics environment. Within this environment, this study only intended to explore gifted programs and strategies and their impact. This chapter remained flexible and open as the study developed and preceded. This study was designed based upon principles of qualitative research. Qualitative methodology was considered to be the best method for evaluating teacher response data. This decision was made in part because the method enabled a thorough analysis of qualifying teachers' answers to open-ended interview questions. In addition, qualitative methodology enabled the researcher to arrive at conclusions by reflecting upon the teachers' work with gifted students in secondary mathematics classes.

This qualitative study did not seek to make changes to programs. It sought to explore and understand gifted programs and strategies utilized in secondary mathematics environments to make the environments better. This study had a conceptual base, as well as both theoretical and practical importance. The study was situated within a specific conceptual framework, the Renzulli Model of Giftedness. As noted, this study employed qualitative methodology. This choice was made primarily for data analysis and justification, which will be expressed in the basic design of the study.

Subjectivity and objectivity hold no meaning in qualitative research (Roulston & Shelton, 2015). Qualitative research seeks answers to "what" questions (Bloomberg& Volpe, 2016). This study, at a basic level, is descriptively asking "what" methods and strategies work and what programs are made available to secondary gifted students in mathematics classes. Wertz, Charmaz, McMullen, Josselson, Anderson, and McSpadden (2011) tells us that the "what" asked in qualitative research may be acquired formally or informally, explicitly or implicitly, and established or assumed. In addition, this study asks "why" teachers feel these methods and strategies are successful, as well as where and when these methods and strategies are put into practice.

It was anticipated that through a better understanding of gifted methods and strategies utilized in secondary mathematics environments a more thorough understanding of these methods and strategies would emerge, as well as the potential for transferability amongst similar settings and information which secondary mathematics teachers and school administrators could use to make more informed decisions regarding program options. To better understand this phenomenon the study focused on 3 main research questions.

1. What specialized methods do mathematics teachers report using when working with students who are gifted, and how do they feel about these methods?
2. How prepared do secondary mathematics teachers feel they are to teach gifted students?
3. What are the advantages and challenges mathematics teachers perceive when working with gifted students?

Chapter III describes the study's research methodology. It is inclusive of discussions pertaining to qualitative research rationale, research design, trustworthiness, participants, study site, instrument, data collection, and method of analysis. The chapter concludes with a summary.

It is important to reemphasize that this study is an exploration of teachers' self-reported experiences teaching gifted secondary youth the subject of mathematics, and that the review of literature has demonstrated that much can be gained from such an exploration.

## Rationale for Qualitative Research Design

In the social science fields, qualitative research is quickly advancing as an important research strategy (Merriam, 2009). This section will briefly explain why a qualitative design was chosen. The primary reason is that this study explored a social phenomenon occurring in secondary mathematics classrooms. This study is a qualitative phenomenology. Phenomenological qualitative research design is well-suited to explore such a phenomenon. "The purpose of phenomenological research is to investigate the meaning of the *lived experience* of people to identify the core essence of human experience or phenomena as described by research participants" (Bloomberg& Volpe, 2016, p. 48). In the case of this study, these human experiences are the self-perceptions of the methods and strategies secondary mathematics teachers incorporate for their gifted students. In other words, this study utilized phenomenological qualitative design-based research methodology to explore the complex social situations of what occurs in secondary mathematics classrooms when instructors incorporate methods and strategies to teach their gifted students.

Overall, this study sought to understand methods and strategies incorporated into the secondary mathematics environment through the perspectives of the teachers incorporating them. The researcher sought to explore and understand, as well as present, the participating teachers' perspectives (Creswell, 2013). The methods and strategies this study explored were complex and occurred within a context – the secondary mathematics classroom. At a basic level, this study was concerned with the instructors' experiences of success or failure when teaching

secondary students who are gifted and in mathematics classes. The study sought a holistic understanding and sought to extrapolate deep meanings from the phenomena under study.

Qualitative research is naturalistic and draws on multiple methods (Merriam, 2009). It calls attention to different ways of collecting, viewing, and reviewing data – all necessary components of this study. Further, the qualitative approach utilized in this study enabled the researcher to theme, code, and categorize his data. Again, this study sought content-rich description. The choice to use qualitative methodology enabled possibilities for blending artistic, expository, and social scientific information as the examiner analyzed and represented research (Jones, Torres,&Arminio, 2014).

The qualitative nature of the study created an opportunity to research, assess, and evaluate teacher responses. Qualitative research allows for the evaluation and examination of the teachers' experiences as well as the discoveries and findings concerning method and strategy options for the gifted in secondary mathematics environments. At the same time, the researcher's interpretations and perceptions become a part of the research. This results in a subjective flow during inquiry (Creswell, 2014). "Researchers must continually ask themselves where they are at any given moment in relation to what they study and what are the potential ramifications of this position on their research" (Berger, 2015, p. 231); choosing a qualitative study helped ensure the perceptions and influences of the participants were considered and appreciated within their correct contexts. The choice to utilize qualitative research also helped the researcher remain cognizant of the study's intended outcome while evaluating responses.

The qualitative approach to research is uniquely suited to uncovering the unexpected and exploring new avenues (Marshall & Rossman, 2015). By choosing a qualitative approach, contemplation on the nature of teacher responses was enabled while simultaneously situating

these responses within the interviewed teachers' worldviews and the teachers' individual perspectives. In other words, a qualitative approach allowed the research to both analyze responses provided by the teachers and appreciate the contexts from which their responses originated.

As noted, this study is concerned with the experiences of secondary mathematics instructors who have taught or teach gifted students. A relevant qualitative tradition was necessary to analyze these experiences. As this study seeks the essence of phenomena as they were perceived by individual teachers, the phenomenological tradition was chosen. "Phenomenologists focus on what all participants have in common. The researcher analyzes data by reducing information to significant statements or quotes and combines these into thematic categories" (Bloomberg& Volpe, 2016, p. 49).

This phenomenological study sought an understanding of the real-world experiences of teacher participants, and was committed to understanding the experiences as they occurred (Smith, Flowers, & Larkin, 2009). The phenomenological tradition of qualitative inquiry facilitates deep descriptive insights (Smith, Flowers, & Larkin, 2009). Using a phenomenological approach aided the researcher in detailing what teacher interviewees had in common, and aided the researcher as he reduced experiences described by the teacher participants. In other words, this study utilized a phenomenological approach to capture the essential characteristics of the phenomena under study (Bloomberg& Volpe, 2016).

The phenomenological tradition enabled the researcher as he took a reflexive stance, and as he examined the experiences reported by teacher participants resulting in a unified description of the phenomena. The writing of this description relied on the researcher's interpretations of experiences reported by the teachers (Bloomberg& Volpe, 2016). This process began as the

researcher analyzed and reduced data into specific and relevant quotes which were then combined into thematic categories. The written description arose from the thematic categories. This description both textually and structurally presented the phenomena experienced by the teachers (Bloomberg& Volpe, 2016).

## Instrumentation

The instrumentation utilized in this study included interviews, focus groups, and an additional data source (artifacts collected from participants). In addition to discussing the three data sources, the following sections of this chapter will detail the research site, research participants, data collection methods, and the methods for data analysis and synthesis. Protection for human subjects and permissions will also be discussed.

## Interviews

Interviews were the primary means of data collection for this research study. Interviews were chosen because they could enable deep descriptive feedback concerning the gifted methods and strategies being explored. The interview process also enabled the researcher to clarify and ask for further elaboration of participant responses.

According to Brinkmann and Kvale (2015), in qualitative research, interviews are a fundamental tool. The interviews in this study were semi-structured. Questions were designed to allow for interactivity between the teacher interviewee and researcher. The teachers were given opportunities to detail their individual personal experiences. The interviews were used to gain an understanding of the interviewee's points of view, and assumed that these points of view were meaningful and worthy of study. This study used the interview tool to represent the teachers' experiences in words. However, though a valuable tool, interviews can have certain

limitations. Interviewees may have been unable to adequately verbally express themselves. Interviews also assume a level of skillfulness on behalf of the researcher.

The study's three research questions guided the creation of interview questions which can be found in Appendix A. The interview questions concerned methods and strategies secondary teachers used when teaching gifted students mathematics, how prepared these teachers felt they were to teach gifted students, and the challenges the teachers faced when teaching mathematics to gifted students.

The interview questions were created by the researcher to gather information on gifted methods and strategies teachers have felt demonstrated effectiveness. The interview questions created for this study sought information pertaining to (a) how methods and strategies offered catered to the well-above average ability of gifted students, (b) how methods and strategies offered affected creativity in mathematics problems solving, (c) how methods and strategies offered affected students' commitment to task in mathematics classes, (d) most common methods and strategies offered, (e) differences between methods and strategies, (f) preparation for future math classes, (g) preparation for problem solving, reasoning, and critical thinking, (h) teacher preparedness, (i) pre-service teacher training, and (j) in-service teacher training.

Though the interview questions were open-ended, a clear focus and continuity were kept throughout. It was determined that too much variation in responses could result in a data analysis that was too varied which would negatively impact the study's purpose. During the individual interviews, questions one through five focused on specialized methods teachers used when working with students who are gifted. Questions six through ten focused on how prepared teachers felt they were to work with gifted students in the secondary mathematics environment.

Questions 11 - 15 focused on challenges secondary mathematics teachers had faced when working with gifted students.

## Focus Groups

Focus groups were also utilized as a means of data collection for this research study. Focus groups occurred prior to the interviews. Like interviews, focus groups were chosen to enable deep descriptive feedback concerning the gifted methods and strategies secondary mathematics teachers utilized in their classrooms. Focus group questions, which can be found in Appendix B, were similar to interview questions and were created by the researcher to seek relevant and appropriate responses for each category. Each focus group was asked an identical series of questions. The focus groups were restricted to ten questions to limit possible responses within the chosen research categories and to ensure a clear topical focus.

During the focus groups, the same topics were addressed. However, questioning was structured to cater to a group dynamic. Questions one through five were introductory questions focused on the training participants received to teach gifted students. Questions five and six focused on specific techniques used to teach gifted students. Questions seven through 10 were core questions and focused on methods and strategies the teachers had used to teach gifted students as well as the teachers' successes and failures when incorporating these methods and strategies. Focus group questions can be found in Appendix B.

## Interviews and Focus Groups

During both interviews and focus groups consistent data were sought. During both, questioning was standardized with identical phrasing and ordering of questions. All questions were created prior to the interviews and focus groups. Focus group questions were written to supplement the interview questions. All interviews were given on an individual basis. No

interviews were completed in groups. During both interviews and focus groups, the researcher remained neutral and did not interject his opinions or beliefs.

The following table contains the research questions and their corresponding open-ended interview questions, as well as the measurement tool used to analyze each research area. In addition, the complete set of interview questions can be found in Appendix A. Table 2 contains the research questions and their corresponding focus group questions.

Table 1

*Research Questions and Measurement Tool*

| Research Questions | Interview Questions | Statistical Analysis Used |
|---|---|---|
| 1. What specialized methods do mathematics teachers use when working with students who are gifted? | Interview Questions: 1,2,3,4,5 | Initial Coding, Focused Coding, Thematic Coding |
| 2. How prepared are secondary mathematics teachers to teach gifted students? | Interview Questions: 6,7,8,9,10 | Initial Coding, Focused Coding, Thematic Coding |
| 3. What are the challenges mathematics teachers face when working with gifted students? | Interview Questions: 11,12,13,14,15 | Initial Coding, Focused Coding, Thematic Coding |

Table 2

*Focus Group Questions and Measurement Tool*

| Research Questions | Interview Questions | Statistical Analysis Used |
|---|---|---|
| 1. What specialized methods do mathematics teachers use when working with students who are gifted? | Focus Group Questions: 5,6,7,8 | Initial Coding, Focused Coding, Thematic Coding |
| 2. How prepared are secondary mathematics teachers to teach gifted students? | Focus Group Questions: 2,3,4 | Initial Coding, Focused Coding, Thematic Coding |
| 3. What are the challenges mathematics teachers face when working with gifted students? | Focus Group Questions: 1,9,10 | Initial Coding, Focused Coding, Thematic Coding |

## Research Site

There were no barriers in locating sites for this research study. Individual interview data were collected from high school settings. Focus group data were collected from high school, middle school, and elementary school settings. All schools were in Southwestern Pennsylvania. Sites were located by the researcher. Access was granted by district leadership and building-level school principals.

## Research Participants

To obtain the target population, the researcher contacted the superintendents of chosen school districts and asked for permission to contact secondary mathematics instructors to request interviews. A contact letter can be found in Appendix G. For focus group participation, the researcher contacted school principals to request permission to contact teachers of varying grade levels who have taught gifted students.The permission request can be found in Appendix H. To collect data, the researcher scheduled mutually agreed upon dates, places, and times with the

participating teachers to conduct their interviews and focus groups. Interviews and focus groups sessions took place in schools.

To protect the identity of the voluntary participants, the researcher does not identify them or their employing schools by name. For individual interviews, data were collected from secondary mathematics teachers who teach or have taught students who are gifted. For focus groups, data were collected from teachers of varying grade-levels and subject areas who teach or have taught gifted students.

The interviews and focus groups were conducted as open-ended questions were orally dictated by the researcher. Responses were electronically recorded using a tape recorder. The interviews and focus groups could take from approximately half an hour to forty-five minutes to complete depending on the level of detail the participating teachers used to express their perspectives, beliefs, experiences, and opinions.

## Data Collection Methods

Data collection methods were decided upon in consideration of the study's overall research design and conceptual framework. The data collection section of this study attempts to give a solid rationale for the study's selected data collection methods. In addition, this section attempts to demonstrate the study's methodological congruence - the coherence amongst the parts of the research study, such as the study's goals and research questions.

Triangulation enhances the quality of multiple data sources. In qualitative studies, it is common for multiple data gathering methods to be employed. Multiple data are necessary since, generally, the phenomena being studied are multifaceted and a complex understanding is being sought. By combing data collection methods, triangulation strengthened this study.

To reach greater depth of understanding and enable triangulation, this study collected data through in-depth teacher interviews, focus group responses, and the collected documents and materials from teachers. The researcher requested that interviewed teachers and focus group participants provide documents including but not limited to visual data, written records, and artifacts. These materials could take the form of texts, worksheets, lesson plans, adaptation materials, samples of accelerated or enriched curriculum, or any other item used to enhance the education of gifted students. These documents, items, and artifacts were collected from the natural setting in which the gifted students received their mathematics educations. Items collected provided the researcher with contextual insights.

## Methods for Data Analysis and Synthesis

The researcher transcribed the teachers' responses to cross examine content and identify trends. This contextual information allowed the researcher to better interpret responses provided by teacher volunteers. During the transcription process, every effort was made to ensure the transcripts adequately reflected the teachers' responses. After transcriptions were produced, an analysis was initiated to look for trends in the data that centered on the aim of the study. When a trend was identified, the area was further explored.

As noted, it was mandatory that all individually interviewed teachers teach or taught mathematics in a secondary setting to students who are gifted, and the purpose of this study was to explore and examine methods and strategies offered to gifted secondary students in mathematics classes. Nelson, McMahan, and Torres, (2012) informs us that when processing qualitative data, we must consider, interpret, and then reconsider the data to enable pattern and theme recognition. Reliability in education research is achieved through minimizing errors and bias (Yin, 2014). The qualitative data gathered for this study were thoroughly considered at each

step of a three-stage data analysis process. These steps or coding stages were initial coding, focused coding, and thematic coding.

Data analysis and data synthesis occurred simultaneously to maintain focus and avoid repetition. During this process, each interview and focus group question response was examined to determine its relationship, if any, to one or both of two of the three rings of the Renzulli framework. In this way, the researcher could determine if, and to what extent, the method or strategy noted in the teacher's response related to one or both aspects of giftedness identified by Renzulli. It was determined that the analytical strategy of initial coding, focused coding, and thematic coding would yield an appropriate analysis of the teacher interview and focus group responses. The data analysis process occurred within the confines of the study's conceptual framework. Coding was thematically enabled by utilizing the Renzulli model of giftedness. The coding process involved an initial stage in which data were coded; a secondary focused coding stage, and a third and final thematic coding stage. Both individual interviews and focus groups were coded the same way.

Stage 1:

During the initial coding stage, recorded teacher responses were transcribed and major concepts were identified. These concepts consisted of the general perceptions, feelings, and opinions of the interviewees concerning the methods and strategies examined, as well as their self-perceived preparedness to work with gifted secondary students. Essentially, this stage was an examination of the data in its entirety. At this point, the data had not yet been generally or thematically categorized utilizing the Renzulli framework or research questions. However, similarities and generalities amongst responses were noted. In the following stage, focused coding, the process of categorization, began.

Stage 2:

At this point the responses were fragmented into categories. This enabled the researcher to look at specific details amongst responses. The researcher was looking for clusters or themes that could be linked. The researcher essentially looked for threads amongst the data. During this process, stage-two, responses were related to the two noted categories of the Renzulli model and research questions. The Renzulli categories were creativity and commitment to task. Possible examples of what the researcher was looking for could include teacher incorporated methods or strategies that enabled students to solve problems in more than one way. This would be considered creative problem solving. If the teacher incorporated an assignment they felt more thoroughly engaged a gifted student, this could be considered a method that increased the student's commitment to task. The researcher also looked for ways findings fit amongst prior research and literature. During this process, themes demonstrating parallels between teachers' perceptions, opinions, and views on like topics, emerged. In the next, and final, stage these themes would be further examined and thematically coded using the Renzulli framework and research questions as guides.

Stage 3:

During the third stage, the researcher considered the broader implications of the study. These considerations took place as data were examined for patterns and as connections were identified. The researcher hoped to identify common methods or strategies teachers used to educate their gifted students, such as grouping, AP courses, combining multiple lesson topics, acceleration, or enrichment. The researcher also hoped to gain insights into teacher preparedness to incorporate such methods or strategies. Preparedness could come in the form of portions of a teacher-training program, in-service training on gifted education, or trainings on gifted education

not provided by the teachers' employing districts. In addition, the researcher hoped to gain insights into the successes and failures study participants experienced while educating their gifted students. During this focused coding stage, conclusions were formed as well as recommendations for further research. It also was during this stage that answers, to the research questions that guided the study, were sought.

Teacher responses were analyzed to identify repetitive keywords and themes that emerged within the responses as well as anything that stood out as unusual. The conceptual meanings and relationships of the focused codes were then considered. Judgments were inferred when analyzing teacher responses.

Using the Renzulli model as a basis, interview and focus group responses were examined to determine each method's or strategy's potential. That is, the researcher analyzed the teachers' perceptions of how their efforts affected their gifted students' creativity in problem solving and commitment to mathematics tasks. Simply put, the researcher looked for evidence that a method or strategy affected student motivation and/or if a method or strategy enabled students to solve the same problem in different ways. In addition, responses were examined to determine if any methods or strategies were consistently misused or neglected, as well as how prepared teachers felt they were to work with gifted secondary students in mathematics. Implications were drawn and data were revisited multiple times to confirm all conclusions.

## Additional Data Source

As mentioned, to further enable a thorough understanding of their positions on topics, participants were encouraged to provide artifacts. These artifacts can be found in appendices C thru F. The researcher requested that participants provide texts, worksheets, lesson plans, adaptation materials, samples of accelerated or enriched curriculum, and any other materials or

items the teacher used to enhance the education of their gifted students. The researcher analyzed all materials provided by the participating teachers with emphasis on how the artifact affected the method or strategy.

Many kinds of documents provided the researcher with information in addition to and that complimented the teachers' interview question responses. Items could include educational materials, adaptive materials, books, photographs, and student work samples. Each was analyzed based on the verbal input provided by the teacher who incorporated the specific item into the curriculum of their gifted students. In other words, it was teacher's opinion or perception, concerning the item that was analyzed. Like all interview and focus group questions, responses were measured against the Renzulli framework and research questions which characterized this study. The researcher explored and categorized ways each item related to a gifted student's creativity and task commitment. Additional relevant evidence of student success was also sought and analyzed in the same fashion. This information could encompass, but was not limited to, daily procedures and daily student work, departmental materials, and websites. To reiterate, when analyzing any additional material provided beyond interview and focus group question responses, the researcher focused on how the material related to the Renzulli model of giftedness and research questions as well as how the material may have affected one or more method or strategy being studied.

## Protecting Human Subjects and Permissions

The researcher was responsible for the protection of participants as well as keeping participants informed concerning the study's purpose. Protecting participants and keeping them informed entailed revealing to participants how information would be treated. Despite no ethical threats being anticipated, the researcher took certain safeguards to protect participating teachers.

First, informed consent was prioritized. Participation in the study was completely voluntary, and the researcher asked each participant to sign a statement of written consent of their voluntary participation. Second, when disseminating data, the rights of participants were considered highly important. Names and identities were kept confidential, as were the names of the schools that employed the participants. A descriptor replaced the participants' names in the demographics section. This descriptor was a word used to denote a study participant. The descriptor was used for indexing purposes. Responses were collected immediately after conducting each interview or focus group. At any time, prior to data analysis, a participant could withdraw without penalty. Third, caution was taken during data storage procedures. Access to data was restricted to the researcher only. Data and transcripts were stored securely in the researcher's home for three years; after which time they will be destroyed in accordance with federal guidelines.

## Summary

This chapter focused on three sections. The first section described the qualitative research to be used. The second section dealt with data collection. The final section explored the data analysis process. In the next chapter, the results of the study will be discussed. These results will be expressed in terms of findings as they emerged from the collected data. Direct quotes from study participants will be explored and related to the study's research questions.

# CHAPTER IV

## DATA PRESENTATION AND ANALYSIS

The purpose of this study was to explore and examine the self-perceptions of teachers as they incorporate programs and strategies offered to gifted secondary students in mathematics classes.The researcher aimed for a better understanding of this phenomenon. The results of this study hoped to provide secondary mathematics educators with a more thorough understanding of programs and methods for gifted students. This chapter presents results on the effectiveness of acceleration, enrichment, compacting, cluster grouping, and advanced placement (AP) courses, as well as results on the effectiveness of teacher preparation to work with gifted students.

Data were collected from the following three sources. Using interviews, primary data were collected from a sample population of seven secondary mathematics teachers who teach or had taught gifted students. Data were also collected from four focus groups. Each group consisted of five teachers. Three of the four focus groups consisted of only elementary school teachers. One focus group was comprised of middle school and high school teachers. All focus group members currently teach or had taught gifted students. The third source was artifacts collected to support the claims of the teachers. Willing participants, from the sample population, provided artifacts to support their comments. Participants believed their artifacts adequately accommodated gifted secondary mathematics students. Artifacts, provided by participants, included logic problems, SAT guides, and exams.

Task commitment, according to Renzulli (1998), is motivation, and the components of motivation include perseverance, determination, dedication, high levels of interest, enthusiasm, and fascination (Renzulli, 1998). Kim, Cho, and Ahn (2003) report that creativity is comprised of the elements of fluency, originality, and flexibility. Though this study is focused on both task

commitment and creativity, during the seven interviews and four focus groups the words "task commitment" and "creativity" were avoided. The researcher felt that if the interview questions contained wording inclusive of the terms "creativity" and "task commitment," interviewee responses could be influenced. The researcher did not mention either term during questioning, and hoped that teachers would provide evidence of both without prompting. Evidence of task commitment and creativity without prompting did occur, though infrequently.

Evidence of task commitment and creativity (two of the three rings of the Renzulli Model of Giftedness) was sought in the following manner. If a teacher indicated that a certain method resulted in students being more likely to complete their mathematics assignment or to delve further into the assignment, this method would be considered to have increased the student's commitment to his or her mathematics task. If the teacher gave a response in which a certain method they used, with their gifted students, resulted in different students solving the same problem in various ways, the response would be indicative of creativity when solving mathematical problems.

## Focus Groups

Responses from focus groups were analyzed to see if they paralleled individual interview responses in any way. Four focus groups were held. Focus group participants were teachers of various subjects and grade levels. Due to teacher schedules, focus groups were held prior to individual interviews. The only criteria for focus group participation was that a participant must have taught or be teaching a gifted student. Focus group participants could teach any subject area or grade level.

At the beginning of each focus group session, participants were told that there would be a total of ten questions, and that each question was to be explored in detail. Focus group questions

can be found in Appendix B. Focus group discussions began with an introductory question. The purpose of this question was to engage participants in a discussion concerning their roles educating gifted students. Next, it was explained to the participants that the remainder of the focus group questions would be separated into three categories. The first category, or group of questions (2 – 4), explored the teachers' perceptions of their preparation to work with gifted students. The second group of questions (5 – 6) explored how the teachers felt about the methods and strategies they used to teach their gifted students. The final group of questions (7 – 10) explored the teachers' perceptions of the gifted students' responses to the methods or strategies used. Focus group participants talked with each other and arrived at group consensuses.

## Interviews

Interview questions can be found in Appendix A. Individual interviews began with two demographic questions. The purpose of these questions was to determine what mathematics subject areas each participant taught and to determine each participant's years of experience. Participants were then told that there would be a total of fifteen questions, and that each question was to be explored in detail. It was explained to the participants that the interview questions would be separated into three five-question categories. The first category, questions 1 – 5, explored the participants' perceptions of the programs and methods they incorporate when working with gifted students. The second group of questions (6 – 10) explored how the participants felt about their preparation to work with gifted students. The final group of questions (11 – 15) asked participants to explore two specific instances of working with an individual gifted student.

All participants taught secondary mathematics. Chris taught the subject areas of Geometry, Algebra I, and Algebra II. Chris had been teaching for 26 years. David taught Honors Algebra II, and had been teaching for sixteen years. Lenny taught the subject areas of Algebra II, Honors Pre-Calculus, and Calculus II. Lenny had been teaching for 27 years. Victoria had taught the subject areas of Pre-Algebra, Algebra I, Algebra II, Geometry, Pre-Calculus, Calculus, and Trigonometry. She had been teaching for 22 years. Clinton taught Algebra II and Geometry. He had been teaching for 11 years. Laurel taught Honors Geometry, Pre-Calculus, and Trigonometry. He had been teaching 17 years. Hal taught Algebra II, AP Calculus, and AP Statistics. Hal also had been teaching for 17 years.

## Additional Data Source

To support their perceptions and comments, participants were encouraged to provide artifacts. Artifacts supplied were utilized as an additional data source. Like participant and focus group responses, artifacts went through a process of coding and analysis. Participants provided logic problems, SAT guides, and exams which complemented their responses. These materials were analyzed with emphasis on how they affected the methods and strategies employed by the participants when educating their gifted students. Another consideration, when analyzing artifacts, was how they affected the creativity and task commitment of gifted students. The analysis of each artifact centered on the comments and perceptions of the participant who provided the artifact. In other words, it was the participants' perception of the artifact that was analyzed. Artifact analysis was guided by research questions and the Renzulli Framework.

## Results

**Answer to Research Question 1:**What specialized methods do mathematics teachers report using when working with students who are gifted, and how do they feel about these methods? Mathematics teachers believe they use grouping, various enrichment activities, AP courses, and compacting lesson topics when working with secondary students who are gifted.

### Cluster Grouping

**Most participants used the method of grouping, but none of the participants indicated that they cluster grouped to benefit gifted students.**

Six teacher interviewees used grouping as a method or program to accommodate their gifted students at some level. Participants found grouping programs useful enough to incorporate into the secondary mathematics environment.However, no participants cluster grouped. In addition, participants' perceptions of the value of grouping varied.

The practice of grouping should be viewed as separate from the practice of cluster grouping. Groups in a classroom can contain students of many different ability levels. In this study, participants' focus, when grouping, was on how gifted students affected other students. This focus was evident in responses such as Laurel's, "It was interesting to see right away how the gifted students will guide the regular education students."

As mentioned, of the four focus groups conducted, three focus groups consisted entirely of elementary school teachers. All three elementary school teacher focus groups indicated that they cluster grouped gifted students with other gifted students. The fourth focus group, which consisted of high school and middle school teachers, stated that they did not use the method of grouping at all. Therefore, no middle school or high school teacher, participating in this study, cluster grouped by ability level.

Based on participant comments and descriptions, there was a perceived necessity for grouping to maximize mathematics task commitment as well as creativity in problem solving. Although most participants appreciated the value of grouping for both gifted and regular students, participating teachers also expressed some shortcomings of grouping. Gifted students were generally described as group leaders or students who were part of a group to help struggling learners. The following is a more detailed description of what participants reported.

Chris and Clinton both grouped to raise the performance of lower performing students. Chris stated, "I may give a higher-level student two lower-level students to work with." Clinton explained, "When I group, what I do is I'll put high ability students with lower ability students." Neither Chris nor Clinton grouped gifted students with other gifted students to advance their mathematics proficiencies. Both Chris and Clinton grouped their gifted students with the intention of raising the mathematics ability levels of struggling learners.

Clinton also noted that he felt groups of three were the most beneficial, "I've been doing threes. With threes, no one gets left out. Sometimes you do groups of four and someone ends up getting left out." When Clinton says, "left out," he means that when a group has too many students the likelihood of a student not being an active member of the group increases. Clinton continued, "I group a lot, especially if I teach something, and I quiz, and the students are struggling. I say, 'Go ahead get in groups,' and they know already who I've assigned to the groups. I pick the groups. Definitely, we do that a lot."

David grouped his students and felt that the practice aided his students' transition from the school to work environment. He described his reasoning, "Individual work is important. But, I think something that is missing is the ability to work with others in today's society. So, I incorporate grouping." Lenny used grouping for the specific purposes of homework review and

projects. Lenny stated, “I use grouping when they are working on their homework assignments, and then I also use grouping in projects.”

Three participants Laurel, Hal, and Victoria provided responses indicatingoccasional grouping. Laurel, referring to grouping, said, “I do at times. Yes, I do.” Laurel recalled a single activity he regularly does with students while they are in groups, “One of the things that I try to do with my students from time-to-time, talking about grouping, what I’ll do is I’ll give them a notecard. I’ll tell them, ‘You have two minutes. Tell me everything you know about the number Pi.’” Participant, Hal, failed to provide verbal evidence that he grouped with purpose and commented that he only grouped, “Occasionally, depending on the topic.”Victoria recalled, referring to how often she grouped students, “Rarely - not formal grouping.”

The grouping methods **Focus Group 1** participants used were more consistent with the data on effectively grouping gifted students. One participant said, “I keep gifted students in group activities. Although they may be able to take it beyond, I find that if they want to move ahead, they can, or they can fall back with the group. For math, if I can, sometimes I like to pull the gifted students out for an activity. Sometimes I show them some higher addition when we’re on addition. So, it’s a little of both.” It should be noted that statements made during focus groups may be influenced by the group dynamic and trying to say the right thing in front of colleagues. Backing up this possibility while also expressing a negative aspect of grouping, one member from **Focus Group 2** commented, “Administration has told us you need to differentiate your small groups. Our teachers are grouping either based on observation or computerized test scores. It’s not truly gifted. It’s grouping all students into categories. The gifted students are just given more work, and that’s not what they need.”

**Focus Group 3** participants stated that they grouped gifted students with other gifted students. Three **Focus Group 3** members grouped gifted students together. One member, referring to her gifted students as extension students, said, "Definitely within a group, you have to put the extension kids within a certain group so that they function together and they take ownership over the group. The teaching staff does different things with them each time. I really try to have a focus. I pull the gifted students back in small groups during math. So, they do have their period of time where I try to meet their needs, differentiation throughout that entire process, and I think the small group really lends itself to trying to work with gifted students." Focusing on scheduling, she continued, "We have intervention time set into our schedule, and I think without that it would be very challenging to be able to pull the gifted students back and try to work with them. So, having that intervention time has been helpful." Another **Focus Group 3** participant, who also groups gifted students with other gifted students, added, "I would say grouping for sure, I can pull small groups and group them by ability level."

**Enrichment**

**All participants believed that they enriched their curriculum for their gifted students.**

One-hundred percent of participating teachers believed that they were enriching their curriculum for their gifted students. The teacher participants provided much data indicating that they were enriching curriculum. However, the methods of enrichment described by the teachers varied significantly. The teachers' ability to describe these methods also varied.

Student creativity when solving math problems was illustrated as teacher participants described their perceptions of how they enriched content. For example, Chris described his method for enabling creative problem solving in terms of relevancy. Chris said, "There are so many options to go further with Geometry. What I've gotten into is that when we have a test,

when we have a test on chapter one or chapter two, I give all the kids a problem-solving question. I don't just give it to the identified gifted students. It's given to everybody. The expectations are much different with the gifted students." Samples of Chris' logic problems can be seen in Appendix C. Chris provided four logic problem artifacts to support his statement. The first logic problem gave students a total dollar amount and asked them to figure out how three brothers, living on a farm, should equitably distribute the total dollar amount to purchase specified seed amounts. The second logic problem required no mathematical processes to figure out, but asked students to use logic to pick a better barber based on given facts. The third logic problem asked students to figure out a way to transport a given amount of liquid using two containers which could hold specified amounts. The fourth logic problem asked students to find an error within the problem itself by identifying a statement that did not logically fit. Chris continued, "The questions also lead into what we are doing in class. I'm hoping that the gifted kids will find the logic problems to be more of a challenge. Hopefully, they are the ones who can explain it, and solve it. The logic problems then lead into if/then statements. I try to find problems that not only challenge the students, but also lead into what's next. If you draw a picture it's easier to solve the problem. I have a problem-solving wall where you can see all the different problems, Pythagorean Theorem problems, three-dimensional problems.I don't put the logic problems on a regular test because I don't expect all the kids to get it. Everybody tries it, and we go through it, and we talk about it, and a lot of times it's a way to reach your kids who are gifted."

Chris considers logic problems, given to all his students, enrichment for his gifted students. Chris further emphasizes that although logic problems are not specifically given to his gifted students, he finds real value in logic problems for his gifted students. Chris' comments

demonstrated that he is looking for creativity in problem solving as his gifted students solve the logic problems. Chris continued explaining, "A lot of times it's your gifted kids that are finished with the test early. You have other students in the same class with an IEP that says they have extended time. You try to set up your tests for the 42-minute period. Some of the gifted kids are done in twenty-minutes. Well, this gives the gifted students something else they can work on that challenges them while the other students are still working on the test. It seems to be something that has worked well. It is something that has been supplemented into the curriculum that seems to kind of keep them." Since not all students were expected to complete the logic problems, Chris viewed the problems as extra work. Chris went on to further define altered expectations for his gifted students, "If you're truly gifted you're going to try to be the top kid in the class or one of the top kids in the class, and that's every year - the students that have the 100%'s or 99%'s." Research does not fully support this perception of gifted students expressed by Chris.For example, as noted by Tannenbaum (1983), gifted students may prefer to underachieve and be popular instead of reaching honor-level status and be ostracized.

Chris walked to one of the walls in his class. The wall contained assignments and drawings. There were many identical problems solved by students in vastly different ways. This indicated that Chris was providing his students with opportunities for creative problem solving. Separate from the problems, but displayed on the same wall, was a list of students' names. Chris called the list his Geometry Hall of Fame. Chris illustrated, "Each year I keep adding to the Geometry Hall of Fame. Aside from what's in the curriculum, there are opportunities for gifted students to strive for their own excellence."

Still, in a basic sense, Chris' method for enrichment was simply giving his gifted math students additional problems. Chris summed up, "I supplement with the problem-solving

questions. That is mainly my way of trying to reach the gifted kids." As noted, Chris perceives problem-solving or logic questions to be an opportunity for his gifted students to creatively solve problems.

Lenny directly related enrichment activities to creativity. However, the activities Lenny incorporated were for the whole class, not just gifted students. Referring to enriching his secondary mathematics curriculum Lenny said, "The best way I found is through projects, real-life application things. In my Calc. II class, for instance, we learn concepts and then we try to make a real-life example of it and then try to model it with a project. We do container projects in class. We try to figure out the amount of work involved in removing liquid from a container. We do the algebra with different shape containers and things like that. I actually do a milkshake lab. We come in and we make milkshakes in Calc. We figure out the size of the cup. We do other projects as well that take several weeks where students have to do several tasks and then present a final project." Lenny also mentioned the use of a computer program. He stated, "In Calc. II we use a program which regenerates revolving shapes and things like that." It should be stressed that all Lenny's students, not just his gifted students, do enrichment activities.

Referring to gifted students, he considered creative problem solvers. Lenny said, "There are so many different stories. You have the kids who will add in their own expertise to projects. For example, we do a *Build a Park* lab. All the students make a blueprint and develop an entire bid. The bid is worth a couple hundred thousand dollars. You take this area and make it into a park. One of the bonuses is that the students do a schemata of their park. I have one student that is a gifted student. He did his completely on the computer and he presented his schemata as a walk-through. So, you went on the computer and you could physically walk through his park. Just to see how he took it to a whole other level because that is something that he was interested

in, I thought that was pretty special. I think that is one of the biggest things, just seeing the kids going above and beyond. We have rotation labs. I tell the students to make equations, and then make the equations into a three-dimensional shape, and I have students who do Christmas trees, which is probably the easiest thing you could do, but then I had a gifted student that actually did the Stanley Cup to scale where it was an exact replica of the Stanley Cup to equations, and he rotated it." Evidence of the milkshake labs were on tables throughout Lenny's classroom, which is where the interview took place. The technology Lenny mentioned was present on computers in Lenny's classroomas well.

Contrasting Lenny, who provided enrichment activities for his gifted students through projects emphasizing creative problem solving, Victoria felt she provided her gifted students with enrichment through additional tasks and personal goal setting. Victoria explained, "I provide extended topics, beyond what an average student would do, something that may involve extra reading or a different way to organize things. The gifted students have goals that they work on." For example, Victoria mentioned helping a student meet her goal of becoming a better leader, and helping a second student avoid perfectionism by improving her ability to focus on one assignment at a time. These personal goals were gifted-student-specific. Victoria was a very goal oriented teacher. Victoria also provided her gifted students with additional worksheets. Samples can be seen in Appendix D. Victoria was the only participant, in the study's sample, that differentiated specifically for her gifted students and provided work in addition to regular class work. All other participants provided artifacts that were for any student who showed the potential for advancement. A gifted label was not a consideration. Victoria's supplemental material took the form of worksheets and handouts she considered advancement opportunities. In addition, Victoria worked with gifted students on personal goals.

Like Lenny, Clinton noted technology as a vehicle for providing enrichment opportunities for his gifted secondary mathematics students. However, the technology mentioned by Clinton was in the form of an online curriculum. Clinton said, "Actually, new technology makes it easier. In our online textbooks now, for the teachers, we can go in, and the enrichment activities are already there. The big thing, more or less, is just your higher questioning and activities, definitely a lot higher level work - where the gifted students have to show their work." Also, like Lenny, Clinton chose to only provide an in-class example rather than artifacts the researcher could take with him and analyze. Clinton presented an online textbook. However, this text book was considered the class textbook and was used for all students, not just the gifted.Clinton recommends that teachers strive to consistently challenge their gifted students. Clinton advises, "Continue to push them. Challenge them. Get the most out because by targeting gifted students with challenges, you'll notice that the rest of your class will step-up and want to be challenged also. Everyone's benefitting from you pushing those students. That's what I've learned over the years, definitely."

While Clinton had found that enrichment activities could be supplied to his gifted students with little effort through an online curriculum, Laurel had found that he could provide enrichment activities through a curriculum that naturally progressed into what he considered "already enriched problems." Referring to an advanced curriculum he incorporates for his gifted students, Laurel explained, "We just do the extra because really the University of Chicago Math curriculum honestly is up there compared to the regular curriculum. So, they're almost getting an automatic enrichment already," Laurel perceived the University of Chicago Math curriculum to be a more advanced curriculum and thus adequate enrichment for his gifted students. Laurel continued, noting further supplementary materials he incorporates, "but then I throw those little

enrichment activities in there, throw a SAT question at the gifted students once in a while." Laurelprovided one SAT prep book he used when pulling questions. The cover can be seen in Appendix E.

When asked about the materials he used when working with his gifted students, David seemed to need a moment to explain his years of experience and the different things he had found that worked throughout those years. David recalled, "With the gifted, over the years, I've taught Algebra II every year I've been here, so, 16 years altogether, and with the honors, eight years. Probably the big difference between the two is in Algebra II sometimes you get caught on trying to accomplish the specific skills. With the honors kids, sometimes you get to do a little bit more enrichment." David then followed up quickly by adding, "The big thing right now has been a lot of coding. For lack of a better word, we're just doing the law of signs. I've had a handful of kids go and then program either their computers, or their cell phones, or their calculators to go ahead and apply the law of signs. Some avenues like that, or extra side projects, or I like giving puzzle-type of problems, or even proofs. That way I gear it towards the upper level kids sometimes. They are possibly looking for a little bit more of a challenge." It should be noted that David gives adaptations to students based on class and subject area. Since David had most of his gifted students in his honors classes, he felt that what he did for the honors class qualified as a method for his gifted students. David provided artifacts in the form of tests he gave to all students, not just the gifted. These tests can be seen in Appendix F.

David believed that throughout his teaching career he gained a greater understanding of how to apply enrichment activities to class content. He commented, "Just, I guess throughout the years, as far as techniques, enrichment techniques, find out what the gifted students are driven in and how you can relate the content that you are doing to hit on those topics they like. One of the

overarching themes for me is the gifted students' ability to read math, speaking the math language instead of using numbers all the time." David also stated, "One thing that I think I've learned over the years, math comes very naturally to gifted students sometimes, and I challenge that with stepping out of the realm of purely going over just computation skills. I get into more theoretical based questions and try to go into almost a proving stage instead of a computational stage."

Two of the seven teachers interviewed emphasized the importance of knowing your students' interests when enriching curriculum. Hal focused on incorporating his gifted students' interests into lessons. He recommends other teachers do the same saying, "Look at the gifted students and incorporate their interests in with any kind of additional work or additional things. Otherwise, it's a tough sell. With Statistics it's easy because if gifted students like a certain topic, you can assign a project on it, and it's real motivational. Calculus is a little different. But, if they're interested in astronomy, you can find some formulas and things. With the stuff that they're interested in, they'll put the effort out in accordance as opposed to not."David also recommends knowing your students and their interests. "Get to know your students, and learn how to move each one forward in a realm that they are naturally interested. Try to stay away from throwing global randomness out there."

One **Focus Group 2** participant stated, "I would try to challenge by extending lessons with what a gifted child is interested in."A **Focus Group 3**, participant mentioned enrichment in the form of questioning techniques explaining, "Enrichment comes in questioning techniques and asking gifted students more difficult questions, activities that require more from them or different activities. I have enriched the curriculum, but not with math. Our math program is very paper/pencil oriented. So, I haven't found any great enrichment." It was mentioned during

**Focus Group 3** that the school once had a gifted education teacher that would suggest different strategies to use with their gifted students. This gifted education teacher's position had since been eliminated. **Focus Group 3** also considered technology to be a form of enrichment, supporting the comments of both Lenny and Clinton. Technology as a form of enrichment was also mentioned during **Focus Group 4**. Examples of technology as forms of enrichment mentioned during focus groups were iMovies, coding, and online programs.

During discussions, **Focus Group 4** members concluded that enrichment activities should be connected to the real-world. Speaking for the group, onemember explained that he assigned logic problems with real-word connections potentially similar of those assigned by participants Chris and Victoria. "I usually give the gifted students two or three enrichment activities that will connect the lesson that they just did with some sort of real-world thing." The same member proceeded to explain her examples, "In one lesson, the gifted students could take any day of the year, any date in the year, and figure out what day of the week it was. So, they did that on their own. Another one was that they had to crack a code using some kind of decoder, and using some of the material they learned in class. So, stuff like that, where gifted students are able to apply to the real-world." Another**Focus Group 4** member emphasized creative problem solving stating, "Some of the gifted students get creative with the problem solving. I do a couple enrichment problems after each section. There are a couple enrichment activities with each section. My classes are already accelerated courses. So, the classes in and of themselves are enrichment." **Focus Group 4** members alsoperceived AP-style questioning to be enrichment.

**Advanced Placement Courses**

**All participants indicated that their school offered Advanced Placement (AP) courses, and that gifted secondary mathematics student had access to these courses.**

While all participants acknowledged that their schools offered AP courses and that gifted students were routinely attending these courses, there was general uncertainty as to how AP courses potentially benefitted the participants' secondary mathematics students. Neither Chris nor David was certain how their school's offerings of AP courses catered to their gifted math population. Chris said, "We have an AP Calculus and an AP Statistics." David also knew his school offered AP courses. He mentioned, "I know we have AP courses in every discipline."

In addition to AP courses, Lenny noted that his school offered AP tracks. AP tracks were sequences of classes students must take before entering an AP course. Lenny further noted that it was rare not to have gifted students in AP tracks. Lenny explained, "We have an honors track as well as an AP track which leads into the AP courses. It's very rare that you don't have a gifted student in an AP class." Victoria commented that the only qualifications for entrance into an AP course were general prerequisites. A student could progress into an AP course as long as they had the math courses required for entrance. Victoria said, "AP courses are pretty much open to whoever meets the prerequisites." It should be noted that prerequisites were mathematics courses open to all students, once passed, any student could choose to take an AP course. Clinton mentioned that permission to be included in AP courses, at his school, was grade-based, and that students simply chose the courses if they wanted them, "Our kids are allowed to choose to take the AP courses, and they'll even let kids who aren't gifted but have A's in these classes. If you have A's they'll let you in. Math-wise there's AP Calc. and AP Stats. We have a high number of kids in AP. There are over one-hundred students taking AP

exams." The "one-hundred students taking AP exams" Clinton is referring to is inclusive of all subject areas, not just math.

Due to AP courses being open to any student at his school, Laurel explained that he felt it was in the best interests of certain students to be persuaded away from taking AP courses, Laurel stated, "Any student can really take an AP course. In the math department, we only have the two. We have AP Calc., and we have AP Statistics. You pretty much have to go through the honors track. That's why we say it's not for everybody because, well, it's not for everybody. If a student is in a lower level math, I try to shy them away from taking AP courses because, you know yourself, an AP math is a lot different from taking an AP History or an AP English where, if you kind of know it, you could probably do it. If you don't know everything you need to know for AP Calculus, you're really going to struggle. So, we have a regular calculus and students usually go into there, but that's how we do it. Our honors kids and our gifted kids will go into AP." While Laurel mentioned that some regular students should be discouraged from taking AP courses, Hal briefly mentioned encouraging gifted students to take AP courses, "AP courses are for everybody." Hal said. "They're not necessarily for gifted kids, but the gifted students are encouraged to take the APs as enhanced classes."Only one focus group included high school teachers. This group was comprised of three middle school teachers and two high school teachers. These two high school teachers were only aware that their school did offer AP courses. The other three focus groups were comprised entirely of elementary school teachers, and, therefore, could not comment on AP courses since AP courses are only offered at the high school level.

## Compacting

### One participant compacted topics specifically for gifted students.

Chris did not believe he was compacting. Chris stated, "No. The students all stay on the same topic." However, as noted earlier, though Chris kept all his students on the same mathematics topic, he did have higher expectations for his gifted students. Referring to his gifted students, Chris continued, "But the expectation is for further depth of knowledge. So, it's not that they're learning anything different from the regular education students. It is a matter of the expectations for further understanding of those topics." Though Chris was not aware of it, his approach was a form compacting.

Laurel believed he was compacting specifically for his gifted students. But his comments did not reveal that this was the case. Laurel commented, "I do combine if it really does make a lesson. I do the SAT prep at night, and I try to throw in the SAT questions. I try to throw them in because obviously it is something gifted students are going to take. I just did one yesterday with my gifted Geometry students. It dealt with the equation of a circle. I told them, 'I know it's two years away, but try it out.' Some of them had the work done right away, and then some of them looked at me and were a little bit off, and I knew we had better look it over." Laurel went on to explain an additional text he uses to combine multiple lesson topics. Laurel explained, "Most of my gifted students are in Honors Geometry. We started using the University of Chicago Math Series. What I do a lot of the time with my gifted students is I'll throw in some enrichment pages that they can work on." Laurel's comments indicated a misunderstanding of the method of compacting. Recall compacting is "elimination of content that the student has already mastered allowing a faster paced learning progression based on the student's rate of acquisition/retention of new materials and skills" (PDE, 2014, p. 41).

Hal emphasized that he compacted for his higher-level classes. Hal used compacting to review before moving ahead. Hal's method is not in-line with what the literature says concerning compacting. Literature reports that after academic material is mastered and the required skills are identified, a student is permitted to skip content (Manyowa&Ncube, 2013). Hal remarked, "Yes, I combine multiple lesson topics, especially with the Calc. and Statistics. A lot of it goes back to earlier chapters or topics that we have to tie things in with, then do the full evaluations, and things like that."

David purposefully avoided compacting. David said, "Rarely would I say that actually happens. I like to introduce a chapter or a unit with a question that shows capabilities that students are going to be learning by the end of the chapter." David continued, "I try to stay fairly focused on a specific learning target or two for a given class period and then draw relationships." Concerning compacting, Lenny said, "Very rarely, a lot of the math lessons overlap as it is. I usually teach one concept at a time." Clinton and Victoria both revealed that they never compact for gifted students. All focus group members indicated that they did not compact for gifted students.

**Answer to Research Question 2**: How prepared do secondary mathematics teachers feel they are to teach gifted students? Secondary mathematics teachers indicated that they did not receive training to teach gifted students, yet still felt prepared to teach gifted students.

Chris could not recall any teacher-training preparation. Chris felt that the only training he received to work with gifted students occurred first-hand in the classroom. Chris said, "On-the-job experience. That is probably the best way to explain it." Victoria expressed an experience like Chris.' She noted, "On gifted, really no training. It's really been all hands-on and sharing." When Victoria mentioned sharing, she was referring to good relations within her

math department at her district. Clinton felt his preparedness to work with gifted students was a result of on-the-job experience rather than teacher training program preparation. As he explained it, "I would say through college, I don't think I was prepared at all, more or less learning and tweaking through my years on-the-fly."

Lenny directly indicated that during his teacher training program he received no preparation. Lenny stated, "In college, I would say nothing." Laurel could not recall anything he felt was worth mentioning regarding teacher training preparation to work with the gifted. David felt the question of receiving training to work with the gifted as part of a teacher training program was laughable, and indicated that he had received none. The only participant that could recall training during college to work with the gifted was Hal who briefly stated, "I think we covered a little bit during my master's program in our special ed. curriculum." However, training at the master's level is not training during a teacher training program.

All participants' comments were supported by focus group data. Overall, like individual teacher interviews, focus group responses revealed that very little teacher training for working with gifted students occurred.When asked if they received training for working with gifted students as part of a teacher training program, one **Focus Group 1** member simply stated, "I did not." Another indicated that she received very little stating, "I recently got my masters in reading and even in that there is just so much focus on struggling readers, and not what I should do for any advanced reader." The same member later added, "You get more training online." A third member offered further support stating, "I don't remember anything, maybe one chapter. It wasn't a full class or anything. I don't recall anything."

A **Focus Group 3** member mentioned a single course during her training in special education, "With my special education degree and course work, I think there was one course that

taught gifted education." Another **Focus Group 3** member offered support adding, "There was an actual class about extensions and the types of things you would do in a classroom for a student who would need that differentiation. I remember actually having a class on that, specifically." A third member remarked, "I had, as a facet of a special education course, there was, a portion on gifted education."**Focus Group 4** had little to say regarding training to work with gifted students. The group came to a consensus that all members only received training for lower-level special education students, not the gifted.

None of the teacher interviewees indicated that their school district provided training for working with gifted students. All participants indicated that they participated in activities for educating gifted students that they considered professional developments outside of what their school districts provide. However, these activities were usually informal collaborationstalking to other teachers concerning gifted students.

David mentioned a single incident he thought may be considered training provided by his district. The district had provided a single training led by a member of the STEM consortium. The STEM training does not coincide with what this study is looking for in terms of training teachers to work with the gifted. It did not offer training specifically for working with gifted students. Therefore, David's recollection of the training cannot be counted as a district providing training specifically for educating gifted students.Chris reemphasized that the only training he received was the opportunity to work with gifted students in his secondary mathematics classes. In other words, Chris' district provided no training to work with gifted students.

Lenny indicated his district did not provide training. Referring to his district, Lenny said simply, "None from here." However, Lenny informed the researcher that when he lived in another state, he was required to go to trainings. Lenny continued, "When I lived in another

stateyou were required to go to two conferences a year. You had to take the time and go do that, and I learned different things like teaching advanced placement." The trainings Lenny was referring to were not specifically for gifted education. However, Lenny noted that theirpurpose was for the betterment of all students including the gifted.

Laurel struggled to recall an instance of training to teach gifted students provided by his district, then commented, "Really, nothing specific. Every year when we have our Act 80 days, they keep us up with current trends." Laurel could not recall a single instance of district-provided training specific to gifted education. Laurel emphasized talking to peers and that he proactively sought opportunities to educate himself concerning gifted students. Laurel said, "I am the math competition sponsor. I see teachers from other districts and constantly we're talking to each other." Referring to seeking out information to improve his teaching methods, Laurel continued, "I always want to be above status quo. So, if other teachers are telling me they do *this* I want to go one step above it. I always like to stay above. I will do things for the Intermediate Unit. Any time I can get my hands on something to make my subject better, I am always there."

Hal could not recall a single time his district provided training for working with gifted students. However, Hal did mention that his school allows him time to attend several trainings that he believes helps him better educate his gifted students. Hal said, "I go to the US Statistics Teaching Conference every other year when they have it locally. I've attended the PCTM and NCTM which are the math conferences they have - state and nationally. I'm an AP reader. So, I go out every year to Kansas City to read AP Statistics tests."

Due to the lack of training, peer collaboration was emphasized by participants as a replacement. Victoria mentioned peer collaboration earlier in the interview and again in reference to district provided training. She considered peer collaboration on-the-job training.

Victoria said, “Same thing, we use a lot of collaboration. We’re tight-knit. We’re fortunate that we share well.” Victoria recommends teams of teachers “…meet and talk about the students’ goals, and brainstorm ways, at the beginning of the semester, on how to help individual gifted students.” Victoria also recommends discussing “…what is coming up in a math class that maybe the student could bring into another course - to come up with a good strong game plan.” Chris stated, “If someone found something that worked it’s nice to know about it. If it’s something that didn’t work, be open and have some collaboration.” Chris went on to note a need for training in addition to peer collaboration, “I’d be completely open for training, and not just so much training, just sitting around and saying, ‘What do you do?’ Like this interview, but have this with six other teachers from other schools that are going through the same thing.My recommendations for other teachers would be to share successes or frustrations and try to take what you can.” Simply put, Chris feels teachers should be given time to get together and talk about their gifted students’ needs.

Five out of seven participantsconsidered talking with other teachers, concerning their gifted students, to be their only professional development. David stated, “Talking with other teachers and seeing what they thought has been successful and the avenues they’ve tried.” David continued, “The communication with other teachers, whether it is a gifted teacher or not, people who I have interacted with, the same personnel, and then finding out the nuances that make them click and how to maximize the learning potential, I think that’s what makes teaching interesting, whether it is gifted kids or not. Then you have to try to find the way to push the gifted students forward.” Lenny felt similarly, expressing his views by mentioning the following, “A lot of it is communicating with other AP teachers, and that kind of thing, but we don’t really have opportunities to do things out side of the building.”

Focus group responses supported individual interview responses. During **Focus Group 1**, one member sternly commented, "I've never received any training, criteria, checklists, nothing. We have no criteria on gifted, we have no training. There are no criteria. We're guessing here. There are not district criteria. We have to go online to find checklists and research." **Focus Group 2** offered contradictory statements. One member stated, "Classroom teachers aren't sent to any type of gifted training. I don't think the school is ready to pay for anything." Another member countered, "The gifted education teacher that was here last year did do a training. It was a three-day training for gifted." A third member noted, "We had some sort of training when we started, but the way that they said we should differentiate was that gifted kids should be reading more." The **Focus Group 2** consensus was that most teachers had no district provided training.In addition, **Focus Groups 1 and 2** indicated that they had attended no trainings outside of what their districts provided.

**Focus Groups 3** and **4** comments included, "There are no trainings. There is more of a need at the lower end, as in more students are being serviced at that end. There are more students in the district that need that help on the lower end versus students on the enrichment end." And "We haven't really had a whole lot of training. We don't really have a gifted education teacher in our building this year, like we did last year." In addition, **Focus Groups 3 and 4**indicated that they did not attend trainings outside of what their district provides.

**Answer to Research Question 3:**What are the advantages and challenges mathematics teachers perceive when working with gifted students? Findings indicate that both advantages and challenges are evident.

**Advantages**

All participants expressed success when working with gifted students in the secondary mathematics environment.All of the teachers who were interviewed noted that their gifted students responded well to what the teachers perceived as appropriately challenging material. Chris felt one advantage his gifted students enabled was allowing him to take on a facilitator role. Chris expressed his perceptions in the following manner, "With the gifted kids, it is easier to be the guide on the side. With the regular ed. students, you find yourself more of the sage on stage vs. the guide on the side. You find yourself more or less leading them through the problem, where with the gifted, you pretty much pose the question and then you wait until they get stuck and then help, and you let them kind of guide themselves through, but there has to be that desire to learn."Chris continued, emphasizing that the advantage of being a facilitator was not as common when teaching regular education students, "Sometimes, in the regular classes, regular education students shut down. As soon as they encounter anything difficult they shut down, so, you kind of model your way through something. With the gifted, they have that desire to learn and work. A lot of it is applying."

Though not true of all gifted students, David noted the advantages of being able to move gifted students into higher level classes due to their capabilities, work ethic, and high motivational levels. David also noted the advantage of capitalizing on natural abilities when a gifted student has fallen behind.David said, "I've had decent amounts of success." Noting an instance of acceleration or planned compacting and illustrating two success stories, David said,

"One young lady, she was very motivationally driven. She was always a chapter or two ahead. We got to the point where she would stay after school, and we would attack the next curriculum. In Algebra II, she came in and we were able to cover the Pre-Calc. the same year. So, she went from Algebra II into Calculus the following year which was a pretty big accomplishment. I like capabilities, and I like work ethic, and it's great to have the naturally gifted. I've been blessed to have those, but there was a set of twins that I always tell a lot of people about. I usually get students their freshmen year, and they were both in my class. They started off the first year, and they were in the high seventies low eighties grade realm and wanted to drop my class, but we came up with a plan where they would come in during homerooms and work on previewing sections, and they ended up, at the end of the fourth nine-weeks, being in the top five percent of the class which was a great accomplishment on their part. It shows the effects of hard work. It doesn't come naturally to everyone." Referring to the three gifted students he had just finished describing, David added, "They were success stories, I guess, one of hard work and one where she just needed someone to supply information." To reiterate, the specific advantage David was illustrating was being able to move gifted students into higher level classes due to their capabilities, work ethic, and high motivational levels.

Lenny mentioned the gratification he receives from his gifted students' successesand being able to allow for autonomy as advantages to working with gifted students, "Your AP exam is a great end-product. I work with the gifted students in tenth grade Honors Pre-Calc., and then again in Calc. II. It's pretty much bringing these kids through their entire high school career, and then when I see them knock out a Calc. test; it's kind of rewarding, also seeing them go to these incredible colleges that I didn't go to." Lenny felt that autonomy allowed his gifted students to creatively flourish, "Just, in general, you have to let them breathe a little bit. You have to

provide them with stuff, but also allow them to go on. You have to allow them to do problems different ways. I think, as a teacher, when you first start out you want to have it like, 'Okay, you do it my way, and that's the way you do it,' but there are so many different creative ways the kids can do problems. Allow them that freedom." Lenny added a note referring to autonomy and engagement, "I think that when they really perk-up the most is when they get to not just sit there and be talked at. I think that's the biggest thing."

While Lenny saw advantages in end-products, Victoria mentioned advantages while working with her gifted students. Victoria felt that just talking with her gifted students was advantageous to their success. She explained, "I think talking through things helped my gifted students realize where they could improve and how the strategy worked." Victoria was the only participant that mentioned Gifted Individual Education Programs (GIEPs). Victoria felt having GIEPs was an advantage since the GIEPs provided information that she could work with to meet the gifted students' needs. Victoria continued, "Again, just things from other people, and really trial-and-error, and looking over GIEPs, and kind of reading through my gifted students' needs and their strengths and their areas where they need to work to develop things. Every year it is different because it depends on what their goals are – what their strengths are." Victoria, who, as previously noted, was very goal oriented, stated her students responded, "very well because they were part of setting their own goals."

Clinton noted the advantage of being able to challenge his gifted students with the end result of increased task commitment. In other words, Clinton felt he was successful at increasing task commitment through motivation. He said of his efforts, "It definitely got them more motivated. I challenge them all the time. It's just my thing. I like to see just where I can get them to, especially if they're willing." Laurel mentioned the advantage of fun – fun in watching

his gifted students learn. Laurel said, “Not to sound cliché, but it is fun to watch the gifted students learn. Not everyone can appreciate that, which is why not everyone is a teacher.”Hal noted the advantages of peaking his gifted students’ interests or as Hal put it, “when you get the gifted students to see an interest in the subject more.” Hal mentioned the advantages of, “when you get them to push themselves.” Hal also stated that one of the advantages to working with his gifted students was seeing them, “go to college, or do something, or when they go to college more prepared.” To summarize, Clinton, Laurel, and Hal felt advantages came in the forms of being able to challenge gifted students, having fun watching gifted students learn, being able to peak gifted students’ interests, taking advantage of the self-motivational tendencies of gifted students, and the sense of personal accomplishment that accompanies witnessingthe future successes of their gifted students.

Laurel further mentioned the advantage of being able to count on gifted students for correct answers. Laurel expressed this advantage while recounting that he perceives girls to comprise most mathematically gifted students in his classes. Describing two female students, Laurel said, “There are two gifted students that come to mind. They’re both girls, and it always makes me laugh because they say math is a guy’s thing. There are two girls one’s in my seventh period and one’s in my eighth. They’re just phenomenal – just phenomenal. Anything we do in class, I can look over, and especially the one girl, she sits right in front in the third row, and she’s just phenomenal. Anytime you look at her she has the right answer, and if she does miss one, which doesn’t happen often, but when she does, she gets real flustered and says, ‘How do you do that again?’ It’s just a wonderful thing. I love it. The other girl is the same way except she doesn’t get flustered. She kind of takes it in strides. It’s funny to have two different views of the same kind of thing. It’s just amazing. I love to watch it. It’s like you know if worse comes to

worse, and you go around, and you've asked the question a couple of times, and no one seems to get it, you can always go to those two and say, 'What's the answer.' and they respond, 'Oh, it's twenty.' It's a great thing. I love to watch it. Every year there is always those couple." Referring to how his gifted students' respond to his methods, Laurel said, "I'll tell you the truth, very positively. In fact, when I give those little extra things the gifted students want to know, if there's something they don't understand, they'll come to me, not so much in class because they don't want to take away class time, but usually in the morning, or if they know I have a period off. They love to come. They're very inquisitive. They'll ask, 'Why does this happen?' And, I've told them from time-to-time, 'Please don't lose that, especially when it comes to college. You don't want to lose that, especially in math.'" To reemphasize, simply stated, as a result of his gifted students' inquisitiveness, Laurel feels one advantage to working with gifted students is relying on them to provide correct answers when called upon.

Like Hal, one focus group participant expressed advantages in terms of gifted students' future successes stating, "I have had many children that I have placed in gifted early in my career. I have followed them, and every one has been extremely successful. They got into very good schools and went into very good professions." Another focus group member noted the advantage of heightened self-esteem, "I think that they're excited when they see that they are doing something that others aren't. Being in the higher groups boosts their self-esteem, kind of."

**Challenges**

The majority of participants expressed difficulties working with gifted students in the secondary mathematics environment. Motivation, which as Renzulli points out, is a term interchangeable with task commitment, was a common theme when discussing difficulties working with gifted students. Task commitment was lacking when gifted students did not

perceive value in the work they were doing. Task commitment was also lacking when gifted students did not feel appropriately challenged.

Though Chris felt the majority of his gifted students were highly motivated and generally worked autonomously, he expressed frustration when mentioning that some gifted students did not apply themselves in his mathematics classes, "I think the biggest difficulty is when a kid has a gift and is not applying themselves. My expectation is that if you are a gifted kid in a regular education class, you should be an A student. If you're a gifted kid in an honors class you should be an A student." However, Chris' perception contradicts literature on gifted student motivation. "Gifted motivation proved to be distinct from gifted intelligence," (Gottfried, Gottfried, Cool &Morris, 2005, p. 172), and "Predictors of learning motivation were variables related to personal identity-style, rather than general intelligence, supporting the hypothesis that learning motivation is a moderator variable of intellectual achievement for students with intellectual giftedness, rather than an inherent component of giftedness" (Schick & Phillipson, 2009, p. 15). Chris continued, "I think the biggest challenge is when they're not, when they're the ones copying the answers instead of being the one who is leading the group. That's the biggest difficulty. For every kid you try to get the best out of them, but when somebody is classified as gifted, and you see their grade doesn't match their gift, that's the frustrating thing." Chris further stated, "It's all still trial and error. The gifted student constantly wants to know why, why, why. So, I approach one student completely different than another. There should be more of a success rate."

Lack of motivation was expressed as a challenge. In terms of task commitment, the gifted students described by interview participants seemed to be at extremes. Participants portrayed their gifted students as either unmotivated or extremely motivated. There were no in-betweens mentioned. To this point, Chris contrasted two gifted students he had taught. Chris

explained, “I’m going to use one gifted student from the past. He would be going into his senior year right now, truly gifted, math came very easy. He was able to pick up things at a much faster pace than anybody else – all the problem-solving questions. And, I thought it was interesting, he was like a human computer. As you were reading through the question he would blink and then he would say, ‘Fifty-seven centimeters squared,’ and you would think, ‘Wow this kid is pretty bright and doesn’t miss too much.’ On the other side of it, my one student who is gifted this year won’t turn in any of his assignments. So, he has a gift, but doesn’t choose to open the package, not applying to the level you would like. Most questions go blank. If they don’t count for points, to him, it’s not worth doing. So, you have people at different ends of the extreme.”

Another challenge expressed by participants was the gifted students’ demand for feedback or knowledge on the part of the teacher. David illustrated two scenarios working with gifted students. He explained, “In the first scenario, oddly finding ways to challenge her, and, honestly, responding to some of the questions she asked because there comes a time when gifted students pose those questions and you’re going to be like, ‘Time-out. I need 24 hours,’ which, I think I learned, is a good thing to show students. You don’t want to do that every day because all of the sudden you’d become, ‘He doesn’t know anything,’ but I think it’s good for them to see how you respond to adversity. I don’t think our generation of high school students responds well to adversity, and that’s where I see a lot of students that want to leave the honors curriculum.”

Similar to David, the "why" questions of his gifted students are what most resonated with Laurel. “Having to know ‘why’ something happens. That was the biggest difficulty I had. With the regular education students, telling them why wasn’t an issue. The gifted students would ask, ‘Why?’ or, in Geometry, you do proofs, and they would ask, ‘Why can’t you do this?’ They

would want to argue, and they would get mad. I would say, 'Guys, I'm not mad at you. I'm actually happy that you want to banter back and forth about this. It's showing me that you care enough that you want to know what this means?'" Laurel recommends being alert and on top of what you need to know. Laurel also emphasizes the importance of honesty. "You have to be on your toes. The more you teach it, the more you are going to be in tune. If you don't know the answer, be truthful. Tell them, 'I'll look it up, and let you know.' I feel this way. The gifted students know that I care enough about them to look it up. It's almost a two-way street. Be honest with them. Just tell them, 'I'll get it, and you'll know.' Of course, in this day and age, it's easy enough for them to look too, with you. Don't panic. Relax. You don't really have to worry about behavior issues as you would in maybe another class, but you're going to have to worry about the educational side of it."

A third challenge was that some gifted students do not like to show work. They quickly provide answers that may or may not be correct. Lenny was displeased that many of his gifted students felt that they did not have to show the steps involved in arriving at their answers. Lenny explained, "My biggest complaint about a lot of the advanced kids is they don't like to show a lot of work. There're two different kinds of gifted students. There's those that like to show every step and are meticulous, but then there's the other ones that are just throwing numbers out there, and they think that they just know what they're doing, and they just throw it out there and want to keep going. That's usually my biggest gripe."

Hal's main difficulty was motivation. Hal said, "It's the motivation part of it, especially with students who are gifted. I think a lot of the time students who are gifted, I don't want to say they have motivational problems, but, the things they like, they are very focused on. The things they don't like, they're kind of, 'Ehh. It's just there.' They think it's unfair that they're gifted

and they really like History and English, but, 'I don't really like Math. I don't want to do math that much.'" Hal also felt extra work should be assigned with caution. Hal explained, "Gifted doesn't always mean that gifted students are more motivated. You almost feel like they're being punished when you say to do extra work or to do extra problems. So, when you can give them an opportunity to go further in something they're interested in they're more apt to do it than if you just say, 'Hey, you're a gifted student, you've got to do these four extra problems.'" This notion was touched upon by a **Focus Group 4** member who stated, "Some of my gifted kids have complained, they've told me, 'We just get packets.'" Hal continued stressing the importance of relating course work to his gifted students' interests. "If there were activities the gifted students were interested in, they were excited, a little bit, to work on them. But, if it's a matter of additional work that they're not interested in, they give half-effort on it."

Clinton provided contradictory responses. Clinton was the only participant who believed he had no challenges when working with his gifted students. Referring to challenges, Clinton stated, "I don't have any. I'll be honest. I like challenge myself. I'm not one of those people to get in a rut. If something doesn't work third period, I'm finding something new to do seventh and eighth period." However, contradicting this statement, Clintonadded, "Just, over the years, I've noticed that gifted students are a challenge to me because they want to be more challenged. It's not the norm when you have a student that wants self-challenge nowadays. Students just want to get through and go, but definitely the gifted students want more, and I've noticed a lot of our gifted students now are doubling-up on their math classes so they can get in the AP classes."

In addition to participants noting that gifted students tend to either be extremely motivated or not motivated at all, it should be reemphasized that two teachers made it a point to mention that female students tend to comprise most of the students they feel are mathematically

gifted. This was brought up when Clinton contrasted two experiences to illustrate a lack of gifted student motivation. Clinton said, "One gifted girl, I have her for Algebra II. She does everything on her own. I would just have to give her directions, and she did everything. She would ask for more challenge. She was real great as a group leader last year. I have another gifted student now that is kind of getting lazy on me because he over did it taking Geometry and Algebra II together. I have him the last period of the day, and he comes from Geometry straight to Algebra II. It seems like he's burned out. It's weird because they're at different ends of the spectrum, and it does seem like most of the female gifted students do better in mathematics, which is shocking because it used to be more male dominated, but it's flip flopped from what I see." Clinton then focused on the importance of challenging his gifted students. Clinton stated, "Gifted students respond well, all the time. They very seldom give me any issues. Now, if it's a review of something previously learned, sometimes some gifted students just won't do it, but anything that's a challenge they accept. I noticed that with the gifted students. They will accept any challenge you give them."

A member of **Focus Group 3** summed up much of the conversations concerning difficulties working with gifted students when she said, "It's just very frustrating that if you're gifted students are functioning at or above grade-level they don't get the attention that I think they need or deserve." Like sample participants, many focus group participants expressed difficulties working with gifted students. For example, during **Focus Group 1**, referring to her gifted students, one member recalled, "For me. It's all about the child, if the gifted student is quieter, if they're more of a within themselves sort of child, if they like to work alone. A gifted child I have this year, he's so special because he was tough at the beginning of the year. So, you have some emotional things going on, but I found, with him, sometimes he just needed to be

regarded as an adult, as he is. He has that little adult personality, and he needed to be respected, and I got more out of him. So, it was 50% emotional, 50% finding the things that appeal to him. Otherwise, if I didn't appeal to him that way, I found that he feels that he's beyond it, and all he did was cause issues. When I was able to redirect some of his activities, it was better. So, it does depend on the child. Unfortunately, that's what I've found this year anyway."

Differentiating instruction for gifted students was noted as a challenge during focus group discussions. A **Focus Group 1** member stated, "Differentiating – to be honest it's difficult when you are teaching a whole group lesson to try to have a totally different lesson for one kid. I haven't mastered that." A **Focus Group 3** member said, "Well, I think you have 25 other students in your class, and finding ways to differentiate and extend can be challenging.You really have to figure out how you're going to map that out depending on the kids you have, and the time factor. You have to be ready ahead of time, and finding certain resources can be challenging."

Focus group sessions indicated that gifted students have the potential to become behavior problems if not properly accommodated and challenged. As one group member stated, "Gifted students think they're different, and while everybody else views giftedness as if it's wonderful, to the gifted student, sometimes, they don't want to be different." Another member supported this comment stating, "If they're singled out, I find that they don't like it."

Parents and programs were criticized during focus groups. Speaking about entrance into her school's gifted program, one member of **Focus Group 1** stated, "Last year our gifted program became, 'If you wanted your child in the gifted program they were in.' That's not a gifted program." A **Focus Group 2** member mentioned a difficulty she experienced related to a gifted student's parents stating, "I had a student last year. I offered things to bring home, but the

gifted student's parents didn't want that. The mother was like, 'Don't send anything to the house.' You have to get a feel for the family. The family wanted gifted accommodations here at the school." Another **Focus Group 2** member noted a lack of school district support, "We are just pulled in too many different directions, and you have to prioritize, unfortunately." This member was speaking of prioritizing one student over another. She continued, "Years ago we had an academic support teacher, and she would come in and work with the gifted kids."

Gifted students being bullied and labeled were also mentioned as challenges during focus groups. A member of **Focus Group 4**, mentioned the bullying a gifted student endured, "One girl had gotten out of the gifted program last year. She was being bullied for being gifted." The same group member mentioned teacher-labeling of gifted students. Referring to gifted students speaking about teachers, she said, "The gifted students feel they're labeled by teachers as having no common sense. They'll say, 'Well, I'm gifted. So, I have no common sense.'" A **Focus Group 3** member offered the following advice, "I think you have to make it very much a team concept, keeping positive peer interaction within the classroom. All the students know who is being called back and who gets to do certain things – the gifted students."

One teacher, in **Focus Group 3**,felt maintaining a balance between fairness and the inevitable boredom of gifted students was a challenge, "We have to teach to all students and not just the gifted students. So, I think there's a little bit of boredom there, unfortunately. There are times when we have to do whole group lessons, and we do have to teach a specific skill that is going to be assessed to the whole class. So, we have to make sure we've covered everyone. That's a difficulty. I think that we can't tailor the gifted students' instruction for all eight hours of the day. So, sometimes the gifted students do have to sit there and be bored, and sometimes that leads to disruptive behavior depending on the child and their behavior. That's definitely a

struggle for me, maintaining that interest and trying to find ways to keep things open that even in whole group instruction can allow the gifted students to feel like they're still being challenged, and sometimes it's really tough to do."

The following difficulties, challenges, and perceptions were expressed during **Focus Group 4.** Concerning administration one member stated, "The higher, and the more upper level, the more creative the gifted students are. They don't need encouraged. They're already on that level where, when you present something, they're going through their rolodex of possible solutions. Administration is always telling us to make content relevant, but sometimes content doesn't have to be relevant. Sometimes there's just things that you do." "Things that you do" was a reference to daily course work. The group member, who made this statement, felt that course work could not always be connected to the real world at the time it was being taught, and, therefore, could not always be relevant.Another member noted a focus on competition as being counterproductive, "I think overall, our gifted program here is focused on gifted students doing competitions. The gifted program is not in class. I don't think the gifted program is that effective. Gifted students are getting pulled out of classes to go to some competition where they're working in groups, whereas my understanding of gifted was that students are learning something in addition to what the regular class is doing." Expressing their belief that gifted education should be about enriching curriculum and advancing students, a third member interjected, "I think that gifted students don't understand what gifted is supposed to be. They think that gifted is just projects. They don't understand what it truly should be."

## Summary

This chapter presented a discussion of findings, data analysis methods, and results. Data were presented in the form of a narrative as participants explored their self-perceptions of

theprograms and strategies they offered to their gifted secondary students in mathematics classes. Participants expressed views concerning enrichment, compacting, AP courses, teacher trainings to work with the gifted, advantages to working with the gifted, and challenges when working with the gifted.In the next chapter implications of findings will be presented and discussed.

# CHAPTER V

# CONCLUSIONS

Manuel and Freiman (2017) inform, "The difficulty of meeting the needs of mathematically gifted and talented students in regular classrooms is not new to researchers and teachers" (p. 79).The purpose of this qualitative phenomenological study was to explore and examine the self-perceptions of a sample group of secondary mathematics teachers as they incorporated methods and programs offered to gifted secondary students in mathematics classes. It was anticipated that participant responses would provide insights into the reasons why literature suggests programs and methods are not routinely and adequately offered to the gifted students who would benefit from such programs and methods. Throughout this chapter's exploration and analysis of data, confirmations of similar research were sought as well as possible contradictions with previous studies. This chapter will attempt to explain the study's differences and similarities with like and prior research.

The Renzulli Model of Giftedness was used as an analytic roadmap for defining choices while attempting to match findings and research questions. Supportive data were collected using phenomenological qualitative inquiry. Using this study's conceptual framework, the Renzulli model, as a guide, the researcher attempted to identify information relevant to the study. While seeking answers to research questions, the researcher considered how these answers related to creativity and commitment to task, two aspects of giftedness represented by the Renzulli framework. Research methods included the conducting of seven in-depth interviews and four focus groups. In addition, many interview participants provided artifacts (items used when educating gifted students in the secondary mathematics environment).Interviewees included seven secondary mathematics teachers who both currently work with gifted students and have

worked with gifted students in the past.Four focus groups of five teachers each provided further insights. All focus group participants teach or have taught gifted students in various grade-levels and subject areas.Grade levels taught by focus group participants ranged from kindergarten to grade 12. Data were examined, explored, coded, analyzed, and organized. Research questions and the Renzulli framework, guided the data analysis process and yielded categories and subcategories for the organization and reporting of data. This study sought answers to the following research questions:

1. What specialized methods do mathematics teachers report using when working with students who are gifted, and how do they feel about these methods?
2. How prepared do secondary mathematics teachers feel they are to teach gifted students?
3. What are the advantages and challenges mathematics teachers perceive when working with gifted students?

The Renzulli Model of Giftedness framed the problem and purpose of this study. It also provided a scaffolding to support the research problem, literature review, and research methodology, which yielded the study's findings. Thesefindings were expressed in answers to the study's research questions. Answers arose as data were analyzed. During data analysis, patterns, themes, and connections were sought. After data analysis, relevant theories and research were connected and contrasted with the study's findings.All aspects of this study such as research methods, data analysis, data collection, and research design were tied to and guided by the Renzulliframework. This chapter aims to provide interpretive insights into the study's findings in an integrated and synthesized form.

## Main Research Findings

### Summary Answer to Research Question 1

Concerning research question 1, "What specialized methods do mathematics teachers report using when working with students who are gifted, and how do they feel about these methods?" The Renzulli framework was open enough not to force data into predetermined categories. This openness was necessary when answering Research Question 1 since the degree to which participants utilized and valued the five explored programs (enrichment, cluster grouping, acceleration, compacting, and AP courses) varied greatly. It was found that participants felt they were adequately enriching curriculum. Participants also felt that they were adequately using grouping methods.Grouping was mentioned frequently amongst participants. Participants grouped all students, and routinely grouped gifted students with lower performing students. However, the literature referenced in this dissertation tells us that gifted students should be grouped with other gifted students or students of like ability. Enrichment was also mentioned often. Participants enriched their curriculum for all students. However, the literature referenced in this dissertation also reports that enrichment must extend beyond the curriculum received by the class-as-a-whole. Participants rarely mentioned acceleration or compacting during interviews, andnoted that gifted students routinely took AP courses.

### Research Question 1

"About secondary school teachers' attitudes towards basic principles of gifted education like acceleration, enrichment, and differentiation, little is known" (Endepohls-Ulpe, 2017, p. 152). The research referenced and cited in this study recommends using acceleration, compacting, enrichment, cluster grouping, and AP courses for gifted students. Each of these programs will be addressed throughout this study's findings. The first research question

was“What specialized methods do mathematics teachers report using when working with students who are gifted, and how do they feel about these methods?”When a participant indicated that they used acceleration, compacting, enrichment, cluster grouping, or AP courses to educate their secondary gifted mathematics students, this study asked how the participant’s choice enhanced their gifted students’ creativity and commit to mathematics tasks. To support their claims, some participants provided artifacts.

**Cluster Grouping**

All participants, and many focus group members, indicated that they utilized some form of grouping in their classrooms. Brulles and Winebrenner (2011) inform us that cluster groups enable instructors of gifted students in mathematics classes to understand and embrace the inherent needs of their students as well as more readily allow for compacting and content acceleration. No participants cluster grouped gifted students. In addition to academic benefits, the gifted students of participants were missing out on the social benefits of cluster grouping. Cluster groups have been found to enable gifted students to feel more accepted due to being permitted to work with students of similar ability and achievement (Delisle & Galbraith, 2002; Webb, Amend, Webb, Goerss, Beljan, &Olenchak, 2005).

Since no participants were cluster grouping, neither ring (task commitment, creativity) of the Renzulli framework was addressed through the method of cluster grouping.This lack of cluster grouping corresponds with literature. VanTassel-Baska (2017) tells us that grouping gifted students with other gifted students can be tricky, and VanTassel-Baska (2017) notes that a lack of teacher training to group is common. Referring to both issues, VanTassel-Baska (2017) states, “Making this work in reality, rather than theory, is tricky business. It means that educators must overcome their reluctance to group gifted learners together.”VanTassel-Baska,

(2017) continues, “When so many teachers are not trained in differentiation practices to the levels necessary to sustain differentiated instruction daily, the models for differentiation are compromised. Only when appropriate grouping is matched to effective differentiation practice can learning results work as planned.” Plucker (2015) reveals two prevalent phenomena. Plucker (2015, p. 5) states:

> Yet in the end, there are two major hurdles to effective differentiation. First is the aversion to ability grouping - yet without it, differentiation is more difficult because the range of ability levels in a given class increases. Second is the strong social justice mindset of many teachers, which can lead to the belief that all students should be treated similarly.We can’t have it both ways: One can believe either that students shouldn’t be grouped by ability because all children should receive the same instruction in the interest of ‘fairness,’ or that children should be grouped by ability in order to facilitate differentiation effectively. (p. 5)

In fact, “one issue that has triggered many debates all-over the world is the ability grouping classroom versus the heterogeneous classroom” (Singer, Sheffield, Freiman, &Brandl, 2016, p. 22). The participants, in this study, did not cluster group. Study participants seemed to not understand cluster grouping or its benefits. In this way, differentiation was not facilitated effectively in accordance with Plucker (2015).

**Enrichment**

The perceptions of all participants indicated that they believed they were enriching curriculum for their gifted students in the secondary mathematics environment. The Pennsylvania Department of Education (2014, p.41) defines enrichment as, “In-depth learning experiences that provide interaction with new ideas, skills, and topics that enhance the

curriculum. These experiences are based upon individual student strengths, interests, and needs." Manyowa and Ncube (2013) reports that enrichment involves presenting material with more depth, breath, complexity, and abstractness than is found in a regular education curriculum. Gagné (2011) describes enrichment as a form of differentiating instruction for talented learners that presents daily intellectual challenges.

Two participants reported that they enriched curriculum for all students, not just their gifted students. In PDE's *Gifted Education Regulations and Guidelines* it is stated that when enrichment activities are provided for gifted students, these activities "must go beyond the program that the student would receive as part of a general education" (PDE, 2014) (22 Pa. Code §16.41) (p. 23).

Participants did use enrichment for their gifted students, but it should be noted that the method of enrichment is not exclusively reserved for the gifted. Some participants enriched equally for all students by providing all students with the same enrichment activities. Other participants provided their gifted students with enrichment activities that went beyond those received by general education students. Certainly, enriched curriculum can be provided to the class as-a-whole and still be beneficial to gifted students. However, literature referring to gifted students, such as PDE (2014), informs that when enrichment is provided for a gifted student it must go beyond material received by the rest of the class.Still, artifacts were provided and there was not an absence of enriched material. After analyzing artifacts provided by participants, it was determined that the enrichment activities were effective for the gifted students.

**Advanced Placement Courses**

All participants indicated that their schools provided AP courses, and that gifted secondary mathematics students were usually taking AP courses. Gifted students taking AP

courses are a potential outcome of acceleration. Therefore, school districts were using acceleration in the form of AP courses.One participant mentioned that AP courses were parts of "tracks" of courses at his school. Gifted students were usually on these "tracks." Whereas other Participants mentioned that entrance into AP courses was dependent on pre-requisites and grades, not on being identified as gifted.The uncertainty, expressed by participants, concerning the role AP courses play in the education of their gifted students, corresponds to a gap in the literature. The trend of offering AP courses to gifted students persists but tends to go unexamined.

> Given the growing number of districts that have adopted the Advanced Placement program as the sole means for serving their gifted students at the secondary level, it was surprising that no published empirical quantitative studies were located in which the effectiveness of Advanced Placement (AP) courses in meeting the learning needs of exceptional students was examined. (Clark, Moore, & Slate, 2012, p. 2)

The use of AP courses provided gifted learners with the opportunity to advance at a pace beyond that experienced in general education math classes and was effective.

**Acceleration and Compacting**

Acceleration was rarely mentioned by participants or focus groups. The lack of acceleration being mentioned can be expected since, "Acceleration is still not very popular amongst parents and teachers" (Endepohls-Ulpe, 2017, p. 150). One participant noted an instance in which he accelerated by using planned compacting of curriculum to advance a gifted secondary mathematics student. PDE (2014) reports that acceleration may include, "planned course compacting" (p. 40). PDE further defines compacting curriculum as, "Elimination of

content that the student has already mastered allowing a faster paced learning progression based on the student's rate of acquisition/retention of new materials and skills" (PDE, 2014, p. 41).

Only one participant used acceleration and compacting. The infrequent use of the acceleration method amongst participants agrees with conversations in literature. "A long history of research shows the effectiveness of most types of acceleration, the question of why it is not more universally implemented looms large for educators, parents, and policy makers" (Steenbergen, Makel, &Olszewski-Kubilius, 2016, p. 891).

A member of **Focus Group 3** mentioned acceleration stating, "Years ago, we had a math coach, and when we had that, she used to be able to come into our classrooms, and provide some acceleration for students. But, without that support, it's a little bit more difficult for that to happen." This comment may indicate a misunderstanding concerning the method of acceleration. Recall acceleration involves presenting content to match the accelerated rate at which gifted and advanced students learn (Winebrenner&Brulles, 2008). It is likely the students may have been accelerated and then provided with enrichment. The provision of a math coach is more a potential form of enrichment than a form of acceleration.

In summary, participants generally used methods and strategies to educate gifted students. An absence of methods and strategies was not an issue. However, misuse of methods and strategies was an issue, at times. Participants were enriching their curriculum. Some participants enriched for all students, and others provided additional enrichment for their gifted students. Acceleration was mentioned, in the form of planned course compacting, by only one sample participant.Acceleration was also only mentioned once during focus groups by a single participant. AP courses were offered as potential forms of acceleration. All sample participants noted that their schools provided AP courses.Within the confines of this study, it was concluded

that the method of cluster grouping for the advancement of gifted ability, in the secondary mathematics environment, was nonexistent. However, student grouping was a common method employed by participants.Gifted students were routinely grouped with struggling learners to increase the performance of the struggling learners.Participants felt this method of grouping benefitted all students.

### Summary Answer to Research Question 2

Concerning research question 2, "How prepared do secondary mathematics teachers feel they are to teach gifted students?" Participants did not feel that they had been provided the necessary training to work with gifted students. Participants noted that they were not formally trained to work with gifted students. However, the self-perceptions of participants indicated they felt prepared to work with gifted students.

### Research Question 2

A constant theme throughout this study was that teachers were largely not trained to provide appropriate services for their gifted students. This theme was evident with participants and in focus groups. There was also a consistent desire expressed by participants and focus groups for training to work with gifted students. Despite a clear lack of training, participants believed that they were providing curriculum appropriate for their gifted students.

This study revealed that participants perceived a necessity to heavily rely on each other when seeking methods to best educate their gifted students. Though it is possible that this reliance could occur for reasons undisclosed by participant comments, it is likely that this reliance occurred due to the absence of formal training to work with the gifted.Participant comments, during interviews, indicated that a lack of teacher training may lead to

communication amongst peers concerning methods and programs for reaching gifted secondary mathematics students.

In addition to communicating with other teachers concerning methods and programs for reaching their gifted secondary mathematics students, participants noted personal choices. Examples of personal choices include curricular decisions, student grouping arrangements, and goal setting. It was not surprising that study participants would refer to their personal choices and the help they received from other teachers when asked about their primary training to work with gifted students. The National Association for Gifted Children recognizes this lack of training opportunities and its consequences when they state, "A patchwork system of teacher training, availability of services, and the lack of reporting and accountability has real consequences for high-ability students who may not succeed without specialized and rigorous instruction" (NAGC, 2009, p. 2). Using the Renzulliframework as a guide, this study sought data that both confirmed secondary mathematics teachers were using methods and programs tailored to gifted students' advanced potential fortask commitment and creativity or revealed that secondary mathematics teachers were not using methods and programs inclusive of opportunities foradvanced task commitment and creativity. At times, participants were using methods and programs tailored to their gifted students' potentials.

Participants often considered talking with colleagues to be their only training to work with their gifted students. There were a few exceptions. For example, some participants noted that they received a very small amount of training while in college. Responses indicated that training opportunities, to work with gifted students, were either erratically provided or completely unavailable.

It was not surprising that study participants reported little to no training to work with gifted students since funding to provide such training and other services is inadequate. The NAGC (2015) states, "Of the 32 states with mandates related to gifted and talented education, four states fully funded the mandate at the state level, 20 partially funded the mandate, and eight did not fund the mandate. One respondent with a mandate did not provide the level of funding for at least one of the past three years" (NAGC, 2015, p. 24).

It is important for teachers who work with gifted students to attend trainings since teachers who participate in professional development activities demonstrate improved attitudes toward gifted education (Kronborg& Plunkett, 2012).Responses from both participants and focus groups indicated that teachers are not provided the opportunity to attend these trainings. Participants also noted that they did not attend conferences on gifted education. Given the importance of training teachers to work with gifted students, the lack of training opportunities both as part of teacher training programs and in the form of professional developments is unsettling. As previously mentioned, the lack of teacher training opportunities effects the implementation of beneficial methods and programs teachers can incorporate into their curriculum to reach their gifted students. For example, teachers were not provided training to adequately use grouping to reach all ability levels.This lack of training resulted in students not being permitted to work at their own pace. However, it is also possible that participants did not understand how their professional developments applied to all students and addressed the gifted.

Teachers who have gifted students in their classrooms still face the same demands and issues as all teachers. Therefore, it was not surprising that the focus of study participants may lean towards struggling learners, as is typical in today's public education culture of high stakes testing. A **Focus Group 3** member emphasized the focus on struggling learners due to high

stakes testing stating, “If the students at the low end don’t do well, our district suffers as a whole. The gifted kids get us the scores that we need.”

Within the confines of this study, it was found that training to work with gifted students was not provided in teacher education programs. Not preparing teachers to work with gifted students during teacher training programs stands in the way of progress for gifted learners. However, as is the case for all teachers, participants in this study must manage the demands of diverse classrooms, various issues, administrative dictates, and current educational mandates – all of which affect educational decisions. In all cases, the participants in this study had to make decisions to maintain their employment and satisfy administration, as well as decisions they felt were best for all students. Participants expressed a desire to attend trainings to work with the gifted and hoped that their school districts would provide these opportunities in the future. Like colleges, school districts were largely not providing trainings for working with gifted students.

Other than seeking information, concerning individual gifted students, from other colleagues who had taught the students in the past, participants were, for the most part, not seeking professional developments outside of what their districts provided. One participant commented, “(there is) nothing that I would go out and do professionally, seminars or anything like that, but it’s pretty much in-house that we collaborate.” Participants noted how collaborating with other teachers helps when transitioning gifted students from one grade level to the next.

Given the various pressures teachers may have felt when making educational decisions, incorporating programs and methods for their gifted students, who were already succeeding, may have seemed insignificant. Maintaining balance between learners who struggled and learners who were succeeding was a likely factor in potentially diminishing the perceived necessity to

accommodate individual gifted students. When the demands of the struggling learners increased, the time and energy necessary to provided curriculum appropriately paced for gifted learners may have been affected. Maintaining balance can be difficult and stressful, and when there is little to no training for working with gifted students, the perceived necessity for this balance is likely to result in compensating for struggling learners and undercompensating for gifted learners. Teachers are left self-reliant when making decisions to educate their gifted students. Summarizing the perceptions of participants are two comments; Chris stated, the only training he received to educate gifted students was, "on-the-job experience," or as Victoria puts it, "all hands-on and sharing."

The lack of training to work with gifted students, expressed in this study, is not uncommon. As literature cited throughout this study noted, there exists a lack of preparedness to work with the gifted. Participants found themselves amongst the many teachers who are denied the training opportunities necessary to adequately educate gifted mathematicians at the secondary level. Unfortunately, the methods and programs chosen by participants were impacted by a lack of training and the perceived necessity of focusing on lower performers.

In summary, this study revealed an overwhelming lack of training at the collegiate level to work with gifted students. This phenomenon was expressed by participants and supported by focus groups. Adding to the lack of training at the collegiate level and expressed by participants and supported by focus groups, this study revealed an overwhelming lack of professional development training to work with gifted students.The lack of professional development training to work with the gifted, revealed by this study, supports the work of Fraser-Seeto, Howard, and Woodcock (2015) who found that a lack of preparation to work with the gifted may be related to teachers' professional developments. When considering the aspects of giftedness expressed by

the Renzulli framework, this study found that trainings on providing curriculum that correspondsto gifted students' high levels of task commitment and creativity were not being provided.

## Summary Answer to Research Question 3

Concerning research question 3, "What are the advantages and challenges mathematics teachers perceive when working with gifted students?" Advantages included the opportunity to utilize the abilities of gifted secondary mathematics students to aid struggling learners, allowing for autonomy, and expecting correct answers. Challenges included lack of motivation, lack of time to meet the needs of gifted students, and behaviors.

## Research Question3

Sample participants and focus group members expressed the following advantages and challenges.When possible, these advantages and challenges will be discussed in terms of what the literature reports on the phenomenon. The advantages and challenges discussed are personal advantages and challenges experienced by the teacher, not advantages and challenges experienced by students.

### Advantages

**Advantage 1 – aiding fellow students.** The most frequently mentioned advantage, noted by participants, was the opportunity to utilize gifted students to aid fellow students. Participants grouped their gifted students with their struggling learners to raise the performance of their struggling learners. In contrast, elementary teachers in focus groups cluster grouped gifted students with other gifted students for the advancement of gifted ability.

**Advantage 2 – autonomy.** Participants felt working with gifted students allowed for more autonomy since gifted students did not need as much guidance as regular education

students. Autonomy yielded mathematics creativity in the form of moving away from modeling problems and moving towards applying concepts without teacher guidance. Autonomy is noted in the literature as a need for gifted and talented students. "Inquiry, autonomy, innovation, and creativity all of these are needs of gifted and talented students" (Moore, 2017, p. 7).

**Advantage 3 – correct answers.** Participants felt that gifted students were reliable. One participant mentioned that being able to expect correct answers from his gifted students was a teacher advantage. The participant said that he always has a couple gifted students every year that he can count on for correct answers.

Focus group responses, concerning advantages, varied greatly. There did not seem to be any discernable patterns, nor did responses correspond to the advantages noted by participants. No focus group members mentioned using gifted students to raise the performance of struggling learners, autonomy, or expecting correct answers as advantages.

**Challenges**

**Challenge 1 – lack of motivation.**Participants expressed the motivation or task commitment of their gifted students in terms of opposite extremes and noted that when a gifted student did not see inherent value in a task their motivation waned. Participants felt their gifted students were either unmotivated or very motivated. In other words, participants, who felt motivation was a challenge, did not perceive any middle ground. As one participant put it, his gifted students fell, "at different ends of the extreme."

Renzulli (1998) tells us motivation is inclusive of perseverance, determination, dedication, high levels of interest, enthusiasm, and fascination. Ritchotte, Suhr, Alfurayh, and Graefe, (2016) report, "Motivation is a multi-dimensional construct that consists of varying components such as interest, value, or autonomy, depending on whose model/theory one chooses

to reference" (p. 26). The lack of motivation was the most frequently mentioned challenge expressed by the secondary mathematics teachers that comprised this study's sample. This challenge was directly related to the Renzulli framework which considers motivation/task commitment an attribute of giftedness. According to Renzulli, the terms task commitment and motivation are essentially the same term. Other participants mentioned lack of motivation in terms of showing work. It was noted that gifted students considered themselves too advanced for the work they received. As a result, these students would just give answers. These answers were not always correct.

**Challenge 2 – lack of time.** Lack of time to adequately educate gifted students was noted as a challenge. VanTassel-Baska and Stambaugh (2005) report, "In differentiating instruction, educators need time to adjust the curriculum, find the needed resources, and cooperatively work with vertical and horizontal teams of educators" (p. 214). Due to a lack of time, participants expressed regret that they cannot continue doing creative projects with gifted students, and noted that they now generally gives gifted students, who would have benefitted from creative projects, worksheets. It takes time to effectively differentiate instruction and incorporate projects for gifted students. Both participants and focus group members expressed frustration concerning the lack of time to address their gifted students' needs. VanTassel-Baska and Stambaugh (2005) continue, "Without sufficient planning time, educators may feel frustrated and overwhelmed by the idea of meeting the needs of gifted learners. To differentiate effectively, daily and weekly planning segments are necessary" (p. 214).

**Challenge 3 – behavior.**Gifted student behaviors were expressed as a challenge. **Focus Group 4** members adamantly emphasized the challenge of dealing with gifted student behaviors. These challenges included students not wanting to be considered different, bullying, and being

labeled as not having common sense. It was surprising that gifted student behaviors were not mentioned as a challenge during sample participant interviews.This phenomenon may have been the result of participants teaching more mature students. Participants only taught secondary students. Focus groups were inclusive of all grade levels, but were dominated by elementary school teachers. It is also possible that the absence of behavioral challenges being mentioned by participants was due to the small sample size. Behavioral issues amongst gifted students are not uncommon, and occur with such frequency that, "Many gifted children are "double labeled," namely in addition of being gifted they are also learning disabled and/or suffer from emotional, social or behavioral problems" (Hanna, 2017, p. 22).Vialle, Heaven and Ciarrochi (2007) report that, "gifted students reported feeling more sad and less satisfied with their social support than their non-gifted counterparts" (p. 2). According to Hanna (2017) gifted students can be considered, "hard-to-manage, badly behaved, or just plain odd – despite, or perhaps because of, their high intelligence" (p. 22). This situation may be indicative of a finding explained by Hanna (2017),

> A gifted girl or boy might feel difficulties when having to participate in activities they are not interested in, holding back rather than expressing their feelings or thoughts because of knowing they 'do not fit' – either linguistically and/or substantially. A gifted child who needs to hold back most of the time might develop behaviors such as day dreaming or abstention. He or she might become 'the clown' and disturb the teachers during classes by making funny noises, joking aloud, make fun of the teacher or of other students. Such behaviors do not result from the giftedness per se, but they might define the gifted child who adopts them as "socially unfit," just "unfit" and the like. (p. 24)

Another **Focus Group 4** member summed up the group's discussion stating, "I feel like people think, 'You teach the AP classes. Your kids are really good.' Not always."

## Summary

Sample participants felt they were adequately enriching curriculum for gifted students, and that they were adequately incorporating grouping methods for all students. Participants enriched curriculum for entire classes while literature referenced in this dissertation reveals that enrichment for gifted students must extend beyond that received by the rest of the class. Participants routinely grouped gifted students with lower performing students while the literature referenced in this dissertation reveals that gifted students should be grouped with students of like ability. Despite the benefits of acceleration and compacting, participants rarely incorporated either program. However, participants noted that gifted secondary mathematics students routinely take AP courses which may be considered potential forms of acceleration. Participants indicated that they had not been trained to work with gifted students, and most participants did not seek out opportunities to educate themselves concerning how best to educate their gifted students. Advantages perceived by participants, when working with gifted students, included the opportunity to utilize the abilities of gifted secondary mathematics students to aid struggling learners, allowing for autonomy, and expecting correct answers, while challenges included lack of gifted student motivation, lack of time to meet the needs of gifted students, and behavioral issues.

## Recommendations

The following recommendations are suggested for teachers, policy makers, administrators, and teacher training programs.

### Recommendations for Teachers

1. Teachers can educate themselves and seek out training opportunities for reaching their gifted students. It is recommended that teachers seek out trainings on the programs explored in this study (acceleration, enrichment, compacting and cluster grouping). This study's literature review has demonstrated each program to be beneficial. However, this study's data demonstrated that these program options, in many instances, were under-utilized or not utilized at all. Data revealed that participants did not accelerate their gifted students, compact their gifted students' curriculum, enrich specifically for gifted ability and advancement, or cluster group by ability level. This study shed light on the contrast between literature supported programs for gifted students and those programs that find their way into classrooms. In doing so, this study made contributions to the disciplines of mathematics and gifted education extending upon literature that has demonstrated the necessity of incorporating proper programs and methods to allow gifted secondary mathematicians to flourish and reach their personal potentials, which is the right of all students. In short, participants felt that they were meeting the needs of their gifted students in the absence of acceleration, compacting, enriching specifically for gifted ability, and cluster or ability grouping. Though participants did rely on each other for support and held discussions concerning their gifted students, participants did not receive proper gifted education training, thus, their discussions, concerning their gifted students, may be considered instances of the blind leading the blind.

2. Teachers can petition their administrators to provide trainings for working with gifted students. The data presented in this study extends upon literature that supports the necessity to train teachers to work with gifted students. Consider that Lichtenwalter, 2011, p. 92) states, "Research yields an overwhelming amount of positive effects that come out of training teachers in gifted education." This study is also an extension of literature supporting the necessity of training teachers to work with the gifted. In doing so, this study has found its place in history.
3. Teachers can educate themselves through conferences and professional organizations. Hoagies' (http://www.hoagiesgifted.org/) is a good place to start.
4. Teachers can make themselves aware of state mandates relevant to gifted education. In Pennsylvania, PDE (2014) requires school districts to, "Provide opportunities to participate in acceleration or enrichment, or both, as appropriate for the student's needs. These opportunities must go beyond the program that the student would receive as part of a general education (22 Pa. Code §16.41) (p. 23)." Other states may have similar mandates.
5. Specifically concerning the program option of cluster grouping, participants felt that their grouping programs were effective, but did not consider or were not aware of the benefits of cluster grouping by ability level. Teachers can make themselves aware of the difference between cluster grouping by ability level and other types of grouping. Teachers can seek out trainings opportunities for the effective grouping of all students. This study's data revealed that participants predominantly grouped gifted students with struggling learners to raise the performance of struggling learners. This method of grouping contradicts literature that reports on the effectiveness of cluster grouping by

ability level. It was recently reported that "The key trend was that cluster grouping had a positive effect on the academic and social achievements of all students" (Ibdah, 2017, p. 117). It should be emphasized that when a teacher has not been properly trained in gifted education, it is understandable that the teacher may not realize that there exists a difference between grouping and cluster grouping. Since participants generally did not have the training necessary to properly reach their gifted students in any capacity, participants may not have recognized that all grouping is not the same.

**Recommendations for Policy Makers and Administrators**

6. Policy makers and administrators can use the information in this study to help make more informed decisions concerning the implementation of gifted programs.
7. Policy makers and administrators can provide trainings and support for teachers who are working with gifted students. These trainings can be inclusive of acceleration, enrichment, cluster grouping, and compacting. Training in cluster grouping is of importance as this study found that generally participants did not group by ability level for gifted advancement, and were using gifted students to raise the performance of struggling learners. Trainings on enrichment, specifically for gifted students, would also be particularly beneficial as this study revealed that participants commonly enriched curriculum for classes as wholes. Enriching curriculum in this manner limits gifted students to the same achievement levels of all students. Finally, trainings on acceleration and compacting would be beneficial since data demonstrated that most participants were not doing either.

**Recommendations for Teacher Education Programs**

8. Teacher education programs can offer courses specifically for educating gifted students. The curriculum can include the programs explored in this study (acceleration, enrichment, compacting, and cluster grouping).
9. Teacher education programs can expand the curriculum of special education courses to include more curriculum devoted to gifted education, or, if these courses do not contain any material related to gifted education, this material could be added.

**Recommendations for Related Research**

10. This study's data revealed that secondary mathematics teachers were not cluster grouping by ability level. In contrast, elementary teacher focus group participants were cluster grouping by ability level. A study contrasting the grouping practices employed by elementary schools and secondary schools is recommended.
11. The current conditions for training teachers to work with gifted students are lacking. An absence of training occurs during teacher training programs and continues in the form of an absence of school district provided trainings. Research exploring this phenomenon may be advantageous and is recommended.
12. This study found that gifted students are routinely being used to help raise the performance of struggling learners. This study revealed that gifted students often found themselves grouped with lower performing students. Given that the research referenced in this study supports the method of cluster grouping by ability for the advancement of gifted potential, future qualitative phenomenological studies exploring the issue of grouping practices concerning gifted students would be of value.

## Final Reflection

This study illustrated the experiences of seven secondary mathematics teachers.Participants received little to no training in gifted education.When programs or methods were incorporated to reach gifted students, these programs or methods were not incorporated in accordance with literature. For example, in many instances, enrichment for gifted students did not extend beyond the enrichment which was offered to all students. Participants often expressed little to no knowledge base concerning the current methods, expressed in literature, to best educate their gifted students. Though PDE (2014) requires school districts to, "Provide opportunities to participate in acceleration or enrichment, or both, as appropriate for the student's needs" (p. 23), and, despite PDE (2014) also stating, "These opportunities must go beyond the program that the student would receive as part of a general education (22 Pa. Code §16.41)" (p. 23), many study participants simply did not provide curriculum to their gifted students that went beyond that provided to all students.However, participants routinely discussed their gifted secondary mathematics students with other educators seeking best practice, andmade efforts to reach their gifted students. Participants presented artifacts in support of their efforts. In closing, this this study revealed evidence in support of NAGC (2009) who inform us, "The U.S. is largely neglecting the estimated 3 million academically gifted and talented students who represent diverse experiences, skills, ethnicity, and cultural and economic backgrounds. All of them require a responsive and challenging educational system if they are to achieve to their highest potential" (p. 2).

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Appendix A

Interview Questions

**Demographic Questions**

1. How many years have you been teaching?
2. What mathematics subject areas have you taught?

**Interview Questions based on Research Question #1**

1. Do you use grouping in your classroom?
2. Do you ever combine multiple lesson topics for gifted students?
3. How do you enrich your curriculum for students who are gifted?
4. How does your school use AP courses?
5. What kind of materials do you use with gifted students?

**Interview Questions based on Research Question #2**

6. What preparation did you receive in your teacher-training program?
7. What training did you get from the school district?
8. What techniques did you learn about for working with gifted students?
9. Is there any additional professional development you participate in outside of what is provided by the school, such as attending conferences, webinars, reading books and articles related to the topic, talking to other teachers?
10. Discuss how effective these different trainings have been to prepare you to work with gifted students?

**Interview Questions based on Research Question #3**

11. Tell me about two students you worked with who were gifted.
12. How did these students respond to the activities you used?

13. What difficulties did you have when working with them?

14. What successes did you have when working with them?

15. What recommendations would you have for other teachers?

Appendix B

Focus Group Questions

**INTRODUCTORY QUESTION (to connect participants to topic)**

1. Tell me about the gifted students at your school.

**TEACHER PREPARATION QUESTIONS**

2. Explain professional developments or trainings (if any), concerning gifted education, you have participated in, and that your school has provided.
3. Explain professional developments or trainings (if any), concerning gifted education, you have participated in outside of your school.
4. Describe the training (if any) you received, concerning gifted education, during your teacher training program.

**TRANSFER QUESTIONS (to bridge introductory question and preparation questions to key questions)**

5. Describe the effectiveness of your professional developments or training.
6. Please describe any specific techniques you have learned for working with gifted students.

**KEY QUESTIONS (core of the focus group)**

7. Describe programs or strategies you have used in your classroom for gifted students. These programs or strategies can include grouping, combining multiple lessons, enriching the curriculum, or any materials, strategies, or programs you may personally incorporate.
8. Describe the effectiveness of these programs.
9. How do you feel the students respond attitudinally to the programs and strategies?
10. Describe some successes and difficulties you have experienced teaching gifted students.

**SPECIFIC QUESTIONS (dependent upon key question responses)**

Dependent upon responses, the researcher will present teacher participants with specific questions enabling further discussion and deeper exploration.

Appendix C

Chris' Logic Problems

Problem Solving Question Name_____

3 Brothers on a Farm

Three Brothers live on a farm. They agreed to buy new seeds: Adam and Ben would go and Charlie stayed to protect the fields. Ben bought 75 sacks of wheat in the market whereas Adam bought 45 sacks of wheat. At home the 3 brothers split the sacks of wheat equally. Charlie paid $1,400 for the wheat. How much of that $1,400 should go to Adam and how much should go to Ben? They all pay the same amount and have the same amount of wheat.

Show all your work and explain how you got your answer.

Barber Shop Name _____
Problem Solving Pd. _____

You are on a small island and need a haircut. There are only two barbers, to select from. The barber from Shop #1 has a real bad haircut. His shop is not very clean and there is a lot of hair covering the floor. The Barber from Shop #2 has a great haircut, clean shave, and his shop is very clean and well kept. Which barbershop would you choose to go to, and why?

Problem solving Name _____

Pd. _____

The craziest thing happened the other day. I was in situation where there was a bomb about to go off. The only way to stop the bomb from going off was to put exactly 4 gallons of water on the bomb. I had a water fountain with unlimited water, but only had two containers. One container, when full, was exactly 5 gallons. The other container, when full, was exactly 3 gallons. Neither container had any other markings on them. How could I stop the bomb from going off?

Show your work and explain your solution.

Problem Solving Name _____

Paint Ball Pd. _____

Four friends were going to have a fun weekend of playing paintball. The paint came in blue, green, yellow, and red. Coincidentally, the four friends had T-shirts the same colors (blue, green, yellow, and red). Brenda used blue paint balls. The person wearing the green shirt used yellow paint balls. James was not wearing a red T-shirt. Diane used green paint balls and wore a blue T-shirt. Simon was the only person using the same color paint and wearing the same color T-shirt. Can you tell which color paint each person used and what color shirt they had on? Show your work and explain how you figured it out.

| Name | T-shirt | Paint balls |
|---|---|---|

I came across this logic problem and found something logically wrong with the problem itself. Do you notice anything wrong about how they are going to play the game?

# Appendix D

## Victoria's Worksheets

The scale used to measure the intensity of an earthquake is a logarithmic function. This scale is called the _____ Scale. The reason that the scale is logarithmic is because for each one unit increase on the scale the intensity is 10 times greater.

$$\text{The equation used is: } R = \log \frac{A}{P}$$

where R is the intensity, A is amplitude (measured in micrometers), and P is period (the time of one oscillation of the earth's surface, measured in seconds).

Notice that this equation has the common base 10. Again, that's because each unit indicates an intensity that is 10 times greater.

In 1989, and earthquake occurred in Northern California that killed 70 people and injured 2400. It measured 7.1 on the Richter Scale. Scientists were able to measure its aftershock. They recorded the amplitude at 2500 micrometers over a period of 0.07 seconds. Find the intensity of the aftershock. Show your work below.

In June of 1997 an Indonesian earthquake registered 6.5 on the Richter scale. A month earlier, May 1997, a Japanese earthquake registered a 7 on the Richter scale. How many times more intense was the Japanese earthquake?

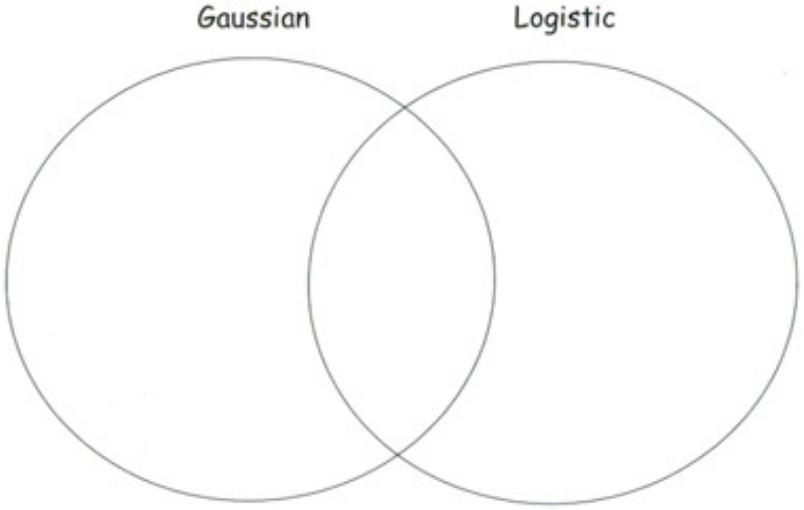
On August 23, 2011, an earthquake was felt here in North Huntingdon. Where was the epicenter? What was the measure on the Richter scale?

Name _____ Section 3.5

Objective:

- Compare and contrast Gaussian and Logistic models.
- Solve real-life problems using these two models.

1) Using the Venn diagram below, compare and contrast the Gaussian model with the Logistic model. You can read about these models in your book starting on page 261.




2) Check out (READ) Examples 4 and 5 in this section. Use these examples to help you complete page 266-267 # 47 - 49 on the back side of this sheet.

# Forensics – Crime Scene Investigation

**Objective – Solve the mystery of the dead mathematician with the broken watch.**

The equation below is used to determine the time elapsed since death. $T_R$ is the room temperature, $T_B$ is the body temperature at death, and T is the temperature of the person's body at the present time.

$$t = k \ln\left(\frac{T - T_R}{T_B - T_R}\right)$$

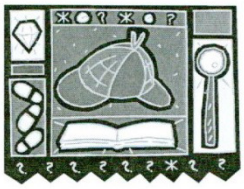
Dr. Newton was discovered dead on the morning of October 24th in his mansion. Reports say they believe he died of blunt force trauma and indications are that he died at 3:00. The reason for this theory is that they discovered a pocket watch on the body that had been crushed by a heavy blow and the hands of the watch had stopped precisely at 3:00. Since the place had been meticulously cleaned of prints, indications are that the murderer must have overlooked the watch, or maybe, didn't know that it had been broken. The coroner's report says that the body temperature at the time of discovery was 85.696 degrees Fahrenheit and the time was precisely 9:00 am when they examined poor Dr. Newton.

Detective Columbo of the Pythagorean Police Department has been assigned to the case and has been investigating all possibilities. He has many facts in the case and has meticulously examined the evidence and has interviewed many possible suspects. He has narrowed his suspect list down to one person, the scrupulous cousin of Dr. Newton, Gottfried Leibniz. Gottfried is the sole beneficiary of Dr. Newton's estate, a huge fortune amassed by exponentially growing his bank account using very complicated exponential growth models. Leibniz also a mathematician believed his cousin stole his theories and therefore always resented the fact that Dr. Newton was wealthy and had obtained a huge fortune.

Facts of the case discovered by Detective Columbo:

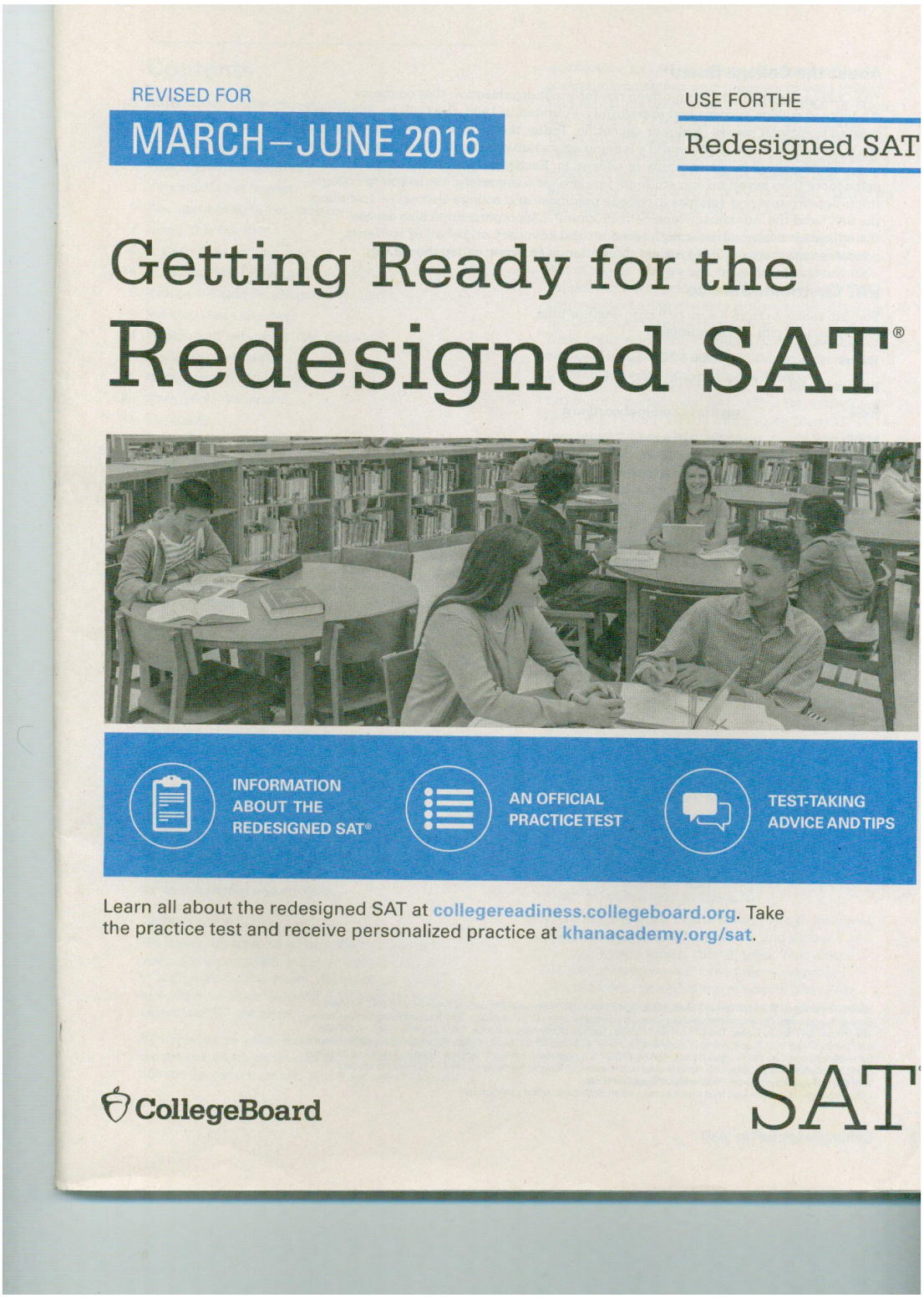
1. The pocket watch was crushed and stopped working at 3:00.
2. All suspects have an alibi. But Columbo believes the killer is Gottfried Leibniz, as he has motive and the strength to kill Dr. Newton.
3. The Newton mansion had an extravagant alarm system that armed itself each night at 9:00 pm. and turned itself back off again at 7:30 am. The alarm was still set in automatic mode and showed no breach of security on the night in question. Only family members and the nurse know the code to the alarm system.
4. The Newton mansion is quite impressive and modern. Most interestingly it operates on a special HVAC system, an air conditioning system that can be remotely set to different temperatures which immediately change the temperature of the surrounding environment. Temperature ranges in the mansion can be adjusted between 60 and 85 degrees, but are normally set at 70 degrees. The temperature of the house when they discovered the body.
5. The main suspect has a really good alibi; Gottfried was at an awards dinner honoring him as the "Mathematician of the Year" from 8 pm. – 12 am, on the night of October 23rd. This alibi is rock solid because it takes a minimum of 4 hours to drive from Eulersville the site of the banquet to Pythagorus the home of the now deceased Dr. Newton.
6. Dr. Newton was last seen alive on October 23rd, his nurse stopped by around lunch time and checked his vital signs. The nurse's log says that he had a normal temperature of 98.6 degrees Fahrenheit. He was in good spirits and was looking forward to watching the Penguins game on TV.
7. From past experience the temperature of a body the same size and age as Dr. Newton will cool to a temperature of 98.12728 degrees in 10 minutes.

The problem: Detective Columbo is almost certain that Gottfried committed this crime. He just can't figure out how he did it, nothing seems to make sense. His alibi for the times mentioned is very solid evidence. Columbo would like you to check the time of death at 3 am to determine if the body temperature was accurate (could 3:00 be the time of death?) He would also like you to mathematically explore the possibility of another scenario, and back it up with mathematical proof. Perhaps you can be the one that breaks the case with your mathematical skill. Can you prove that Gottfried could have done it? At this point it appears that Gottfried Leibniz has committed the perfect crime.



Appendix E

Laurel's Artifact



# Appendix F

## David's Tests

**Algebra II Chapter 4 Test**

Name _____ Date _____ Period _____

**All work must be shown for each question.**
**When applicable, please write your final answer on the space provided.**

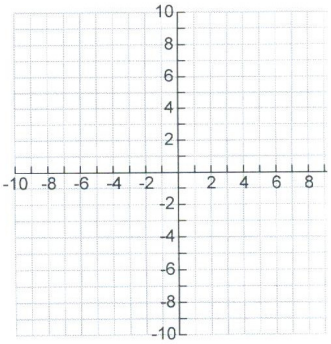
1. For the equation $y = -3x^2 + 18x - 20$ find the following information.
   A. Does the parabola open upward or downward? (Justify your answer in a sentence.)

   B. State the vertex _____

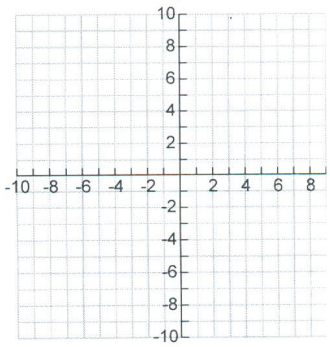
   C. Is the vertex a maximum or minimum point? _____

   D. List the axis of symmetry. _____

2. Graph the quadratic equation $y = x^2 - 4x - 5$. You must include a table of values with 5 points which includes the vertex.




3. Graph the equation quadratic equation $y = \frac{1}{2}(x-3)^2 - 5$.



Solve. All radical answers must be completely simplified. Circle your final answers.

4. $x^2+14x+48=0$

5. $x^2-36=0$

6. $4x^2-49=0$

7. $x^2+14x+49=0$

8. $3x^2-10x+8=0$

9. $4x^2-17x-15=0$

10. $x^2=144$

11. $3x^2=75$

12. $x^2-8=0$

13. $\frac{x^2}{8}=10$

# Chapter 4 Exam

Name_____

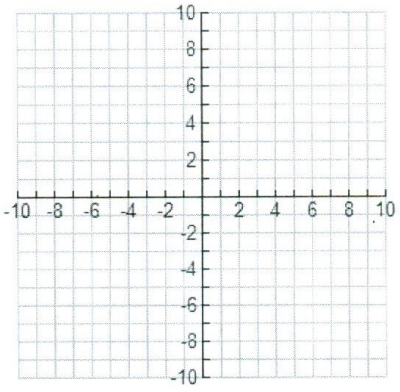
Pd_____

1. The graph of the equation $y = ax^2 - 4x + c$ has a vertex of (2,5).

   a. Explain and show how to use the formula for the x-coordinate of the vertex to find the value of a.

   b. Determine the values for a and c, then write the equation in standard form.

2. Graph the parabola $y = (x + 3)^2 + 2$ and label the vertex and axis of symmetry.



3. A farmer wants to fence off a portion of a square field for a vegetable garden. The length of the garden will be 4 feet less than the length of the square field. The width of the garden will be 8 feet less than the length of the square field.

   a. Using x as the length of the square field, write an expression for the area of the garden.

   b. If the area of the garden will be 192 $ft^2$, calculate the dimensions of the vegetable garden?

   c. Explain how you could use the graph to check your answer in part (b).

4. Solve the following using factoring: $3x^2 + 5x - 12 = 0$

5. Solve the following using completing the square: $-x^2 + 4x = 2x^2 - 5$

6. Write the expression as a complex number in standard form. $\frac{2+2i}{8+5i}$

7. The height h (in meters) of a falling object is given by $h = -1/2gt^2 + h_o$ where $h_o$ is the object's initial height, g is the acceleration due to gravity, and t is the time in seconds. Suppose an object is dropped from a height of 1960 meters:

   a. How long will it take the object to reach the ground (use $g = 9.8\ m/s^2$)?

   b. How long will it take the object to fall half the distance to the ground, Explain why the answer will not be half the time you found in part a.

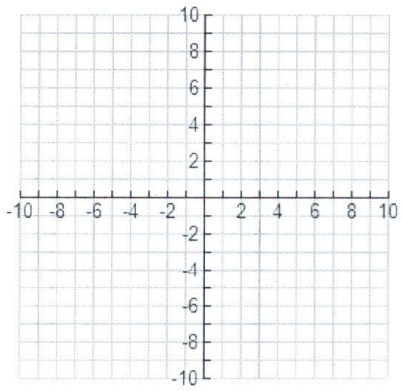
8. A rock is thrown from the top of a tall building. The distance, in feet, between the rock and the ground t seconds after it is thrown is given by the following table:

| Time (s) | 1 | 3 | 4 | 5 | 5.5 |
|---|---|---|---|---|---|
| Height (ft) | 715 | 583 | 469 | 323 | 238 |

   Derive the quadratic model for the given scenario and calculate how long after the rock is thrown is it 400 feet from the ground.

9. Graph the following system of inequalities: $y > \frac{1}{2}x^2 - 2x - 2$

   $y \leq -(x-2)^2 + 3$




10. Write a quadratic function in standard form for the parabola that passes through the points (-2,11), (0,3) and (1,2).

11. Write the following expression as a complex number in standard form where a,b,c and d are integers.

$$\frac{a+bi}{c+di}$$

**BONUS** Calculate the x-intercepts of $y = ax^2 + bx + c$, by completing the square, all work must be shown

Appendix G

Letter to Superintendents of Schools

April 17, 2017

Dear _____:

My name is Michael Poli. I am a doctoral student at Indiana University of Pennsylvania in the Department of Professional Studies in Education. I am currently conducting a research project as part of my dissertation on gifted education. This study explores and examines the effectiveness, implementation, and availability of gifted programs and strategies made available to gifted secondary students in the mathematics environment. This project has been approved by the Indiana University of Pennsylvania Institutional Review Board. I would like to request permission to invite your secondary mathematics instructors to participate in this research study. The study will take approximately 30 minutes of their time. Teachers are eligible for participation if they teach or have taught mathematics to gifted secondary students. Teachers will be briefly interviewed and asked questions concerning specialized methods, preparation, and challenges. The information gained from this will be used to develop methods of improving mathematics education for gifted and talented students.

Sincerely,
Michael Poli

Date: _____

**Primary Researcher:**
Mr. Michael Poli, Doctoral Candidate
1440 Rostraver Street
Monessen, PA 15062
zbzq@iup.edu

**Project Director:**
Dr. Edel Reilly
210 Stright Hall
Indiana, PA 15705-0001
Indiana University of Pennsylvania
ereilly@iup.edu

Appendix H

Letter to Principals of Schools

April 17, 2017

Dear _____:

My name is Michael Poli. I am a doctoral student at Indiana University of Pennsylvania in the Department of Professional Studies in Education. I am currently conducting a research project as part of my dissertation on gifted education. This study explores and examines the effectiveness, implementation, and availability of gifted programs and strategies made available to gifted secondary students in the mathematics environment. This project has been approved by the Indiana University of Pennsylvania Institutional Review Board. I would like to request permission to invite your instructors to participate in this research study by attending a small focus group of approximately five teachers. The focus group will take approximately 30 minutes of their time. Teachers are eligible to participation if they teach or have taught gifted students. Teachers will be asked to briefly discuss specialized methods, preparation, and challenges. The information gained from this will be used to develop methods of improving mathematics education for gifted and talented students.

Sincerely,
Michael Poli

Date: _____

**Primary Researcher:**
Mr. Michael Poli, Doctoral Candidate
1440 Rostraver Street
Monessen, PA 15062
zbzq@iup.edu

**Project Director:**
Dr. Edel Reilly
210 Stright Hall
Indiana University of Pennsylvania
Indiana, PA 15705-0001 ereilly@iup.edu

Appendix I

Letter to Participants

April 17, 2017

Dear _____:

My name is Michael Poli. I am a doctoral student at Indiana University of Pennsylvania in the Department of Professional Studies in Education. I am currently conducting a research project as part of my dissertation on gifted education. You are eligible for participation in this research project because you either currently teach or have taught gifted secondary students mathematics. To assist in making an informed decision about participation the following information is being provided. This project has been approved by the Indiana University of Pennsylvania Institutional Review Board. This study explores and examines the effectiveness, implementation, and availability of gifted programs and strategies made available to gifted secondary students in the mathematics environment. You will be briefly interviewed and asked questions pertaining to specialized methods, preparation, and challenges. Your responses will be anonymous. Your participation is voluntary and you are free to decide not to participate or withdraw from the study at any time. The study will take approximately 30 minutes of your time. The information gained from this study may be published in educational journals or professionally presented.

Sincerest Thanks,
Michael Poli

**Primary Researcher:**
Mr. Michael Poli, Doctoral Candidate
1440 Rostraver Street
Monessen, PA 15062
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**Project Director:**
Dr. Edel Reilly
210 Stright Hall
Indiana University of Pennsylvania
Indiana, PA 15705-0001 ereilly@iup.edu

**Informed Consent Form (continued)**

**VOLUNTARY CONSENT FORM:**

**I have read and understand the information in this letter and I consent to volunteer to be a subject in this study. I understand that my responses are completely confidential and that I have the right to withdraw at any time. I have received an unsigned copy of this informed Consent Form to keep in my possession.**

**Name (PLEASE PRINT)**

**Signature**

**Date**

**Phone number or location where you can be reached**

**Best days and times to reach you**

**[NOTE: NOT ALL STUDIES REQUIRE A SIGNATURE FOR INFORMED CONSENT. TYPICALLY IN STUDIES USING AN ANONYMOUS SURVEY WHERE THE ONLY LINK BETWEEN THE RESEARCH SUBJECT AND THE STUDY IS THE INFORMED CONSET, A SIGNATURE WOULD NOT BE REQUIRED. IN THESE CASES, SUBJECTS WOULD BE INFORMED THAT THEIR COMPLETION OF THE STUDY IMPLIES THEIR CONSENT. THEIR DATA WOULD NOT BE ABLE TO BE WITHDRAWN AFTER SUBMISSION AS THERE WOULD BE NO WAY OF KNOWING WHICH DATA BELONGED TO WHICH INDIVIDUAL.]**