Teachers’ Perspectives on Teaching Mathematics to Gifted/Talented Students

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Educational Specialties

by

Abraham Ayebo

Dr. Lynda R. Wiest/Dissertation Advisor

December, 2010
We recommend that the dissertation prepared under our supervision by

ABRAHAM AYEBO

entitled

Teachers' Perspectives on Teaching Mathematics to Gifted/Talented Students

be accepted in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Lynda R. Wiest, Ph.D., Advisor

Teruni Lamberg, Ph.D., Committee Member

Christine Cheney, Ph.D., Committee Member

Eleni Oikonomidoy, Ph.D., Committee Member

Livia D'Andrea, Ph.D., Graduate School Representative

Marsha H. Read, Ph. D., Associate Dean, Graduate School

December, 2010
Abstract

The purpose of this study was to investigate the perspectives of gifted/talented teachers on perceived characteristics of mathematical giftedness and talent, as well as what current instructional strategies are being used with mathematically gifted and talented students in the general education classroom. The following research questions were addressed: 1) What student characteristics do K-12 teachers identify as possible indicators of mathematical giftedness/talent? 2) How are K-12 students identified as being gifted/talented in mathematics? 3) What instructional approaches do K-12 teachers suggest to support the learning of mathematically gifted/talented students?

In order to answer these questions, a survey instrument was developed based on an extensive review of the professional literature. The online survey was administered to teachers of gifted/talented students across the United States. Responses from 114 teachers who participated in the survey were analyzed. The quantitative analysis consisted of descriptive and inferential statistics using Chi Square test of independence and Fisher Exact test. Participants’ written comments that accompanied the survey instruments, as well as their responses to open-ended questions, constituted the qualitative piece of the study. These qualitative data were analyzed using content analysis.

The most significant conclusion of this study is that teachers do often recognize mathematically gifted and talented students within their classrooms and know that differentiation is needed for these students. However, teachers have difficulty providing the best possible instruction for these students because they feel that they face a number
of obstacles. The obstacles include large class size, lack of training, lack of help in the classroom, and lack of time to plan. The study reveals that, in the opinion of teachers, little differentiation occurs consistently for gifted and talented students. In order to more effectively meet the needs of gifted and talented students in the general education classroom, survey participants felt that a collaborative effort will be required from administrators and teachers to provide appropriate staff development about differentiated instruction.
Dedication

I dedicate this dissertation, with love and gratitude, to my wife Salomey, and my children Oswald and Benita, whose encouragement, support, and belief in me helped see this study through.
Acknowledgements

Many people have offered help and encouragement throughout this journey.

I owe a special debt of gratitude to Dr. Lynda Wiest, my doctoral advisor and chair. A top researcher in her field, Dr. Wiest’s expertise helped lead me to my dissertation topic, and her gentle guidance, support, and friendship were evident throughout the process. Her belief in my ability to complete this degree was invaluable, and her fine editorial eye was very essential.

I would like to thank the members of my dissertation committee: Dr. Livia D’Andrea, Dr. Eleni Oikonomidoy, Dr. Christine Cheney, and Dr. Teruni Lamberg, for their guidance and constructive feedback. I especially want to thank them for being flexible with me and agreeing to my remote dissertation defense. I also thank Dr. Kozubowski and Dr. Maddux for their invaluable advice. I thank the faculty and staff of EDS for making my stay at UNR such a memorable one.

My friends and colleagues have encouraged me throughout this process and I am very grateful to them. Special thanks to Frank Amankonah for all his love and concern; Moses Anabila, Albert Adu-Acheampong, Alana Pahku, Heather Crawford, Stephanie Vega, Colin Hodgen, Hasan Aydin, Dr. Mike Dornoo, and Dr. Charles Assuah. I thank Betty Ebbs and Janet Smith for their support.

My family shares this achievement with me. Their support and prayers throughout this journey was priceless. They buoyed my spirit and made me feel invincible.
Last, but not least, I want to thank my children, Oswald and Benita, for tolerating my absorption with books, and my wife Salomey, for encouraging me and pushing me to achieve my dream.
Table of Contents

Abstract ........................................................................................................................................... i.

Dedication ....................................................................................................................................... iii

Acknowledgements .......................................................................................................................... iv

Table of Contents ............................................................................................................................ vi

List of Tables ...................................................................................................................................... xi

List of Appendices ........................................................................................................................... xii

Chapter One: Introduction ........................................................................................................... 1

  Statement of the Problem .............................................................................................................. 1

  Purpose of the Study ...................................................................................................................... 2

  Conceptual Framework for the Study ........................................................................................... 3

  Definition of Terms ...................................................................................................................... 10

  Significance of the Study ............................................................................................................ 12

  Overview of Chapters 2-5 ........................................................................................................... 12

Chapter Two: Literature Review ....................................................................................................... 13

  Organization of the Review ......................................................................................................... 13

  Search Strategies .......................................................................................................................... 14

  Definitions of Academically Gifted and Talented Students ....................................................... 15

  Definitions of Mathematically Gifted and Talented Students .................................................. 19

  Teaching the Mathematically Gifted ........................................................................................... 26

  Major themes on Instruction for the Mathematically Gifted ..................................................... 47

  Other Studies Related to This Research ...................................................................................... 50
<table>
<thead>
<tr>
<th>Summary</th>
<th>54</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chapter Three: Method</strong></td>
<td>55</td>
</tr>
<tr>
<td>Research Design</td>
<td>55</td>
</tr>
<tr>
<td>Basic Steps in Designing a Mixed-Methods Study</td>
<td>58</td>
</tr>
<tr>
<td>Research Design for this Study</td>
<td>59</td>
</tr>
<tr>
<td>Research Participants</td>
<td>61</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>63</td>
</tr>
<tr>
<td>Reliability and Validity</td>
<td>67</td>
</tr>
<tr>
<td>Ethical Considerations</td>
<td>69</td>
</tr>
<tr>
<td>Data Collection</td>
<td>69</td>
</tr>
<tr>
<td>Data Analysis</td>
<td>70</td>
</tr>
<tr>
<td><strong>Chapter Four: Results</strong></td>
<td>73</td>
</tr>
<tr>
<td>Quantitative and Qualitative Results</td>
<td>73</td>
</tr>
<tr>
<td>Research Question 1: Quantitative Results</td>
<td>73</td>
</tr>
<tr>
<td>Research Question 1 by Age</td>
<td>74</td>
</tr>
<tr>
<td>Research Question 1 by Number of Credits Earned in G/T Education</td>
<td>76</td>
</tr>
<tr>
<td>Research Question 1 by Years of Teaching G/T Students</td>
<td>78</td>
</tr>
<tr>
<td>Research Question 1 by School District Type</td>
<td>80</td>
</tr>
<tr>
<td>Mann-Whitney and Kruskal-Wallis Test on Research Question 1</td>
<td>83</td>
</tr>
<tr>
<td>Research Question 1: Qualitative Results</td>
<td>84</td>
</tr>
<tr>
<td>Participants’ Comments Explaining Ratings</td>
<td>86</td>
</tr>
<tr>
<td>Open-Ended Questions on Part 1</td>
<td>90</td>
</tr>
</tbody>
</table>
Problem Solvers................................................................................................. 90
Independent Learners......................................................................................... 91
High-level Thinkers............................................................................................. 91
Summary of Results for Research Question 1.................................................... 93
Research Question 2: Quantitative Results.......................................................... 94
Research Question 2 by Age.................................................................................. 94
Research Question 2 by Years of Teaching G/T Students................................... 96
Research Question 2 by Number of Credits Earned in G/T Education ............. 98
Research Question 2 by School District Type....................................................... 99
Mann-Whitney and Kruskal-Wallis Test on Research Question 2.................. 101
Research Question 2: Qualitative Results............................................................. 101
Participants’ Comments Explaining Ratings....................................................... 102
  Teacher Nomination............................................................................................ 102
  Parent Nomination............................................................................................ 103
  Performance on Mathematics Tests................................................................. 104
  Mathematics Course Grades.............................................................................. 105
Open-Ended Questions on Part 2......................................................................... 106
  Communication Difficulties.............................................................................. 107
  Boredom/Behavior Problems............................................................................ 108
  Student Diversity............................................................................................. 109
  Poor Test Scores.............................................................................................. 110
  Lack of Support............................................................................................... 110
Chapter Five: Discussion

Introduction: Purpose of the Study

Summary of the Research Findings

Interpretation of Findings

Implication for Social Change

Recommendations for Action

Limitations

Recommendations for Further Study
## List of Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1</td>
<td>Participant Characteristics</td>
<td>62</td>
</tr>
<tr>
<td>Table 2</td>
<td>Alignment of Research Questions and Survey Items</td>
<td>65</td>
</tr>
<tr>
<td>Table 3</td>
<td>Mean and Standard Deviation for Part 1a Survey Items: Characteristics of Mathematically Gifted/Talented Students</td>
<td>74</td>
</tr>
<tr>
<td>Table 4a</td>
<td>Descriptive Statistics for Research Question 1 by Age</td>
<td>75</td>
</tr>
<tr>
<td>Table 4b</td>
<td>Chi-Square/Fisher Exact Test for Research Question 1 by Age</td>
<td>76</td>
</tr>
<tr>
<td>Table 5a</td>
<td>Descriptive Statistics for Question 1 by Number of Credits Earned in G/T Education</td>
<td>77</td>
</tr>
<tr>
<td>Table 5b</td>
<td>Chi-Square/Fisher Exact Test for Research Question 1 by Number of Credits Earned in G/T Education</td>
<td>78</td>
</tr>
<tr>
<td>Table 6a</td>
<td>Descriptive Statistics for Research Question 1 by Years of Teaching G/T Students</td>
<td>79</td>
</tr>
<tr>
<td>Table 6b</td>
<td>Chi-Square/Fisher Exact Test for Research Question 1 by Years of Teaching G/T Students</td>
<td>80</td>
</tr>
<tr>
<td>Table 7a</td>
<td>Descriptive Statistics for Question 1 by School District</td>
<td>82</td>
</tr>
<tr>
<td>Table 7b</td>
<td>Chi-Square Test for Research Question 1 by School District Type</td>
<td>83</td>
</tr>
<tr>
<td>Table 8</td>
<td>Participant Response Numbers for Written Portions of Survey Instrument Part 1</td>
<td>85</td>
</tr>
<tr>
<td>Table 9</td>
<td>Mean and Standard Deviation for Part 2a Survey Items: Characteristics Mathematically Gifted/Talented Students</td>
<td>94</td>
</tr>
<tr>
<td>Table 10a</td>
<td>Descriptive Statistics for Research Question 2 Survey Items by Age</td>
<td>95</td>
</tr>
<tr>
<td>Table 10b</td>
<td>Chi-Square/Fisher Exact Test for Research Question 2 by Age</td>
<td>96</td>
</tr>
<tr>
<td>Table 11a</td>
<td>Descriptive Statistics for Research Question 2 Survey Items by Years of Teaching G/T students</td>
<td>97</td>
</tr>
</tbody>
</table>
Table 11b. Chi-Square /Fisher Exact Test for Research Question 2 Survey Items by Years of Teaching G/T students……………………………………….97

Table 12a. Descriptive Statistics for Research Question 2 Survey Items by Number of Credits Earned in Gifted Education ……………………………….98

Table 12b. Chi-Square /Fisher Exact Test for Research Question 2 Survey Items by Years of Teaching G/T Students………………………………………99

Table 13a. Descriptive Statistics for Research Question 2 Survey Items By School District Type……………………………………………………100

Table 13b. Chi-Square /Fisher Exact Test for Research Question 2 by School District…………………………………………………………101

Table 14. Participant Response Numbers for Written Portions of Survey Instrument Part 2…………………………………………………………102

Table 15. Descriptive Statistics for Research Question 3 Survey Items………………………………………………………………………………..117

Table 16a. Research Question 3 Survey Items by Age…………………………………………………………118

Table 16b. Chi-Square/Fisher Exact Test for Research Question 3 by Age…………………………………………………………………………119

Table 17a. Descriptive Statistics for Research Question 3 Survey Items by Years of Teaching……………………………………………………120

Table 17b. Chi-Square /Fisher Exact Test for Research Question 3 by Years of Teaching G/T students…………………………………………………121

Table 18a. Table 18a: Research Question 3 Survey Items by Gifted Credits Earned…………………………………………………………………122

Table 18b. Chi-Square /Fisher Exact Test for Research Question 3 Survey Items by Gifted Credits Earned………………………………………………123

Table 19. Participant Response numbers for Part 3 of Survey Instrument……………………………124
List of Appendices

Appendix A: Online Questionnaire..............................................................159
Appendix B: Recruitment Emails...............................................................172
Appendix C: Pilot Test Review Sheet.........................................................175
Appendix D: IRB Approval Letter...............................................................177
CHAPTER 1: INTRODUCTION

Teachers face the overwhelming challenge of providing appropriate and differentiated educational activities for all children in their classroom. Some students may qualify for special education services and have an Individualized Education Plan requiring the teacher to make modifications and conduct remediation in the classroom in order to meet the minimum education standards, whereas others may already have mastered much of the curriculum and find the content and performance standards unchallenging. Each student is an individual with unique strengths, weaknesses, and abilities and thus different instructional needs. Therefore, teachers have a difficult responsibility when trying to meet the needs of all students in their classroom, especially when students with exceptional abilities are present. These students with exceptional academic abilities are usually referred to as gifted and talented students.

Statement of the Problem

“The student most neglected, in terms of realizing their full potential, is the gifted student of mathematics. Outstanding mathematical ability is a precious societal resource, sorely needed to maintain leadership in a technological world” (NCTM Task Force on Promising Students, 2006, p.1). Mathematically gifted students learn differently from their peers. They require special attention and differentiated curriculum to meet their specific needs (Cross & Coleman, 2005). When these students do not receive the learning experiences that are appropriate for their unique abilities, they can become bored and frustrated and eventually become underachievers (Kennard, 2001). Requiring mathematically gifted students to participate while concepts are repeated for the rest of
the class is not a good approach for the gifted student. Studies have shown that curricula in general education classrooms are frequently inappropriate for gifted students. For example, a national study by Max and Xu (2004) found that an average of 35 to 50 percent of the regular curriculum at the elementary level could be eliminated for gifted students. Feldhusen (2005) also cites research showing that mathematically gifted students can complete a year of grade-level mathematics in three to six months. Mathematically gifted students are more likely to retain mathematics content accurately when taught two to three times faster than the average student (Feldhusen, 2005). Thus, schools need to make curricular changes to account for the learning needs of mathematically gifted students. This study was therefore designed to examine teachers’ perceptions of mathematically gifted students and how to meet the instructional needs of such students.

Purpose of the Study

The purpose of this study was to investigate the perspectives of K-12 teachers on perceived characteristics of mathematical giftedness and talent, as well as what current instructional strategies are being used with mathematically gifted and talented students in the general education classroom.

1. What student characteristics do K-12 teachers identify as possible indicators of mathematical giftedness/talent?

2. How are K-12 students identified as being gifted/talented in mathematics?

3. What instructional approaches do K-12 teachers suggest to support the learning of mathematically gifted/talented students?
Conceptual Framework for the Study

The conceptual framework for this survey research is grounded in the works of Piaget, Gardner, Renzulli, Tomlinson, and Winebrenner. Piaget (1972) is known for his cognitive development theory, and he developed four stages of cognitive development: sensorimotor, pre-operational, concrete operational, and formal operational. In the sensorimotor stage, intelligence is demonstrated through physical experiences, object manipulation, and some language abilities in infants. In the pre-operational stage, intelligence is demonstrated through the use of symbols, but egocentric thinking predominates in this stage. In the concrete operational stage, intelligence is demonstrated through logical and systematic manipulation of symbols related to concrete objects. During this stage, operational thinking develops and egocentric thinking diminishes. In the formal operational stage, intelligence is demonstrated through the logical use of symbols related to abstract concepts. Piaget’s ideas are also a significant part of the foundation for modern-day constructivism. Moreover, the work of Piaget is closely related to mathematical thinking. Gardner uses Piaget’s work to demonstrate the relationship between Piaget’s stages of cognitive development and logical-mathematical intelligence as children discover the world around them.

Gardner (1983) has made significant contributions to the field of gifted education with his theory of multiple intelligences. Gardner’s theory proposes that people are intelligent in different areas. Originally, Gardner identified seven multiple intelligences: linguistic, logical-mathematical, musical, bodily-kinesthetic, spatial, interpersonal, and intrapersonal. Later, he added three “new” intelligences; naturalist, spiritual, and
existential. Gardner’s theory briefly addresses gifted children. Gardner defines children with talents and gifts as those who excel in certain pursuits and stand out, typically because they perform at an adult level, while still children. Gardner feels that being a prodigy has its advantages and disadvantages, such as having an ability to relate to older people but lacking social skills to get along with peers. In addition, Gardner’s theory can be implemented in the classroom for use with all children at all levels with various intelligences. Differentiation and an “individually configured education” (Gardner, 1999, p. 151) are the keys to applying Gardner’s theory to classroom instruction. In order to effectively work with gifted children, teachers should get to know their students and then draw on this knowledge to make academic decisions. Gardner (1983) used Piaget’s theory to support his definition of logical-mathematical intelligence. More specifically, in relation to the logical- mathematical intelligence, Gardner (1983) explained that the logical-mathematical intelligence encompasses logical thinking (as might be used in chess or deductive reasoning, for example) as well as mathematical and scientific problem solving. This intelligence deals with logic, numbers, and abstractions. Gardner based his beliefs about the development of logical-mathematical intelligence on Piaget’s work, which he says revealed the origins of logical-mathematical intelligence in the child’s action upon the physical world; the crucial importance of the discovery of number; the gradual transition from the manipulation of objects to interiorized transformations of actions; the significance of relations between the actions themselves; and the special nature of higher tiers of development, where the individual begins to work with
hypothetical statements and to explore relationships and implications which obtain among these statements. (p. 58)

In addition to the ideas of Piaget, Gardner also supports his definition of logical-mathematical intelligence with ideas from various mathematicians who are leaders in the field of mathematics, such as Adler. Adler (1964) characterizes people with mathematical gifts as possessing a love for abstraction, as a maker of patterns, and as someone who can skillfully handle long chains of reasoning. Gardner (1983) further adds to these characteristics by stating that mathematical talent “requires the ability to discover a promising idea and then draw out its implications” (p.143). He also states that at the center of mathematical talent is the ability to recognize and solve significant problems.

Renzulli also provides a framework for this study. Not only does Renzulli provide a definition of giftedness, but he also provides a program that can be used with gifted and talented students to meet their needs in the general education classroom and beyond. Renzulli’s (Renzulli & Reis, 2006) definition of giftedness has three categories. The categories are: above-average ability, task commitment and creativity. Above-average ability is associated with academic success, such as test-taking and lesson-learning. Students in this category are typically identified for gifted and talented programs. Another category is creative-productive giftedness. This describes those areas where a high value is placed on the development of original material and of products designed for specific audiences. Renzulli states that both categories are important and that there is usually interaction between the two. The second category has a number of facets. One of
these facets is called task commitment, and the other is creativity. Renzulli suggests that a balance of all three areas is needed. Above-average ability with creativity is not likely to produce productivity if there is little task commitment. Likewise, above-average ability with high task commitment will not necessarily lead to new, original, or unique concepts or products. The three-ring concept has been developed from this formulation, setting the three areas in the context of specific performance areas. The general performance area covers activities such as mathematics, science, and languages arts, whereas the specific performance area covers the huge array of specific human activities from film making to fashion design.

Renzulli also provides a possible program for gifted and talented students through his enrichment triad model. The enrichment triad model promotes creativity on the part of young people by exposing them to various topics, areas of interest, and fields of study. This program also trains students to apply advanced content, process-training skills, and methodology training to self-selected areas of interest (Renzulli & Reis, 2006). This model has a three-pronged approach with three different types of enrichment activities. If the Enrichment Triad is implemented appropriately in the general education classroom, the needs of mathematically gifted and talented learners can be met effectively. Renzulli and Reis offer the following explanations of the three different types of enrichment activities. Type I activities are called general exploratory activities. Type I enrichment is designed to expose students to a wide variety of disciplines, topics, occupations, hobbies, people, places, and events that would not ordinarily be covered in the regular curriculum. A Type I enrichment specific to mathematics could include an exposure to careers and
real-life situations where mathematics is involved. Type II activities are referred to as
group training activities. Type II enrichment consists of materials and methods designed
to promote the development of thinking and feeling processes. Some Type II training is
general and is usually carried out both in classrooms and in enrichment programs. Other
Type II enrichment is specific, as it cannot be planned in advance and usually involves
advanced methodological instruction in an interest area selected by the student. For
example, students who become interested in geometry after a Type I experience might
pursue additional training in this area by doing advanced work in geometry or by doing
problem-solving activities with real-life applications in geometry. Type III enrichment is
referred to as individual and small-group investigations of real problems. Type III
enrichment involves students who become interested in pursuing a self-selected area and
are willing to commit the time necessary for advanced content acquisition and process
training in which they assume the role of a first-hand inquirer. Some examples of Type
III enrichment activities related to mathematics at the elementary level are author of math
puzzles, games, and quizzes for children’s sections of newspapers, organizer of math
tutoring services, consultant in math for a school, and programmer for computers.

Tomlinson’s (1999) work on differentiation informs this study because
differentiation is frequently recommended as a strategy to meet the needs of gifted and
talented students in the general education classroom. Modifications can be made to
differentiate instruction for the gifted learner in the general education classroom
according to the interests of the child, the pace of the curriculum, or the depth of the
curriculum. Tomlinson (1999) offered four characteristics of the effective differentiated
classroom. The first characteristic is that instruction is concept-focused and principle-driven. The next characteristic is that ongoing assessment of student readiness and growth are built into the curriculum. A third characteristic of the effective differentiated classroom is that flexible grouping is consistently used. Tomlinson (2003) defined flexible grouping as “students consistently working in a variety of groups based on readiness, interest, and learning profile, and both homogeneous and heterogeneous in regard to those three elements” (p. 84). A final characteristic of the effective differentiated classroom is that students are active explorers with teachers guiding the exploration.

Tomlinson (2003) defined differentiation as:

responsive teaching, [that] stems from a teacher’s solid (and growing) understanding of how teaching and learning occur, and responds to varied learners’ needs for more practice or greater challenge, a more active or less active approach to learning, and so on. (p.2)

Tomlinson explains differentiation of instruction as a teacher’s response to students’ needs, guided by general principles of differentiation. The principles of differentiation include the following: focusing on essentials; attending to student difference; aligning assessment and instruction; modifying content, process, and products; working and learning together; respectful tasks; flexible grouping; and ongoing assessment and adjustment. Tomlinson recommends that teachers differentiate content, process, or products based on student readiness, interests, or learning profile. Readiness refers to a student’s knowledge, understanding, and skill that designate their entry point
within a particular sequence of learning. It can be influenced by factors such as prior experience, attitudes, and habits of mind. Interest refers to topics that are of interest and are a passion for the learner. The learning profile refers to how students learn best and includes learning style, intelligence preference, culture, and even gender. Tomlinson adds that differentiation can occur through various instructional and management strategies. Some of the more critical strategies she suggests for differentiation include literature circles, tiered lessons, learning contracts, independent study, varied questioning strategies, compacting, and varied homework.

Finally, the work of Winebrenner (2001), who has several specific strategies for general education teachers on how to meet the needs of gifted and talented learners in their classroom, also informs this study. Winebrenner believes that when gifted children are not being challenged in the classroom and their learning needs are not being met, they may be perceived as children with behavior, motivation, or attitude problems. In order to help teachers better meet the needs of gifted and talented students in the general education classroom, Winebrenner suggests multiple strategies that general education teachers can use with gifted and talented students. Some examples are curriculum compacting, learning contracts, and independent projects. Winebrenner also suggests using multiple resources, various assessments, and interest centers.

Thus, the work of Piaget, Gardner, Renzulli, Tomlinson, and Winebrenner informs the conceptual framework of this study. Each of these experts in the field of gifted education defines gifted and talented and suggests characteristics of gifted and talented students. Each offers strategies for meeting the needs of gifted and talented
students. Further, each expert has unique contributions and ideas about gifted and talented students and has made an impact on the field of gifted education. The works of Piaget, Gardner, Renzulli, Tomlinson, and Winebrenner must be considered when examining the needs of mathematically gifted and talented students in the general education classroom.

Definition of Terms

The following definitions will be used for key terms that appear in this document. 

Assessment: The process of gathering and discussing information from multiple and diverse sources in order to develop a deep understanding of what students know, understand, and can do with their knowledge as a result of their educational experiences; assessment results are used to improve subsequent learning.

Differentiation: Differentiation is the practice of making lessons different in content, process, and/or product to accommodate the needs and abilities of different students in a single classroom. A classroom may have students with a wide range of abilities; therefore, a teacher may alter lessons so that all students in a classroom will benefit.

Gifted and Talented: There are currently many definitions of gifted and talented. No consensus has been reached by experts in the field of gifted and talented. The most recent United States Office of Education (USOE) (1993) definition of gifted and talented is as follows:

Children and youth with outstanding talent perform or show the potential for performing at remarkable high levels of accomplishment when compared with others of their age, experience, or environment. These children and youth exhibit
high performance capability in intellectual, creative, and/or artistic areas, possess an unusual leadership capacity, or excel in specific academic fields. They require services or activities not ordinarily provided by the schools. Outstanding talents are present in children and youth from all cultural groups, across all economic strata, and in all areas of human endeavor. (U.S.O.E. Public Law 91-230) (p. 26).

Instructional Strategies: Instructional strategies encompass a wide variety of instructional approaches used to achieve learning objectives and conduct assessments

Mathematically Giftedness Children: Children who have strong mathematical skills. These children tend to perform better on spatial, nonverbal reasoning, speed, memory, and mechanical comprehension tests than the average child.

Math Curriculum: The learning content implemented by classroom teachers, often based on the state standards for mathematics.

General education classroom: A traditional, single grade level, self-contained classroom with one teacher and 20-30 students of varying ability levels.

Significance of the Study

This study was designed to provide a deeper understanding of teacher perception of the unique needs of mathematically gifted and talented students, as well as gain insight into what teachers perceive as appropriate instructional approaches to meeting those needs. As a result of the study, schools may be able to better prepare their teachers to meet the needs of all mathematically gifted and talented children in the classroom. The researcher hopes that the needs of mathematically gifted and talented students will be recognized by all classroom teachers instead of being overlooked, as is the tendency with
these children. Moreover, the researcher hopes that the recognition of these needs will inspire teachers to use appropriate instructional methods to challenge mathematically gifted and talented students. Finally, this study highlights the needs of mathematically gifted/talented students, who need specialized instruction in school settings, and it provides a research design that allows for further research studies to be conducted.

Overview of Chapters 2-5

Chapter 2 of this study explores the current literature on gifted and talented students, including definitions, specific needs, appropriate instructional methods and teaching strategies, and ideas of key theorists in the field. Chapter 3 details the research methods, including a description of the participants, data collection, and data analysis. In Chapter 4 results of the analyzed data are summarized. Chapter 5 provides a discussion of the study results and how these results impact schools.
CHAPTER 2: LITERATURE REVIEW

The review of literature for this study relates to research on gifted and talented students, specifically to mathematically gifted and talented students. In addition, the review includes literature on differentiation, including instructional strategies recommended for mathematically gifted and talented students at the K-12 level.

The problem statement and research questions of this study are closely related to the review of literature. Current research (Mingus, 1999; Rotigel & Fello, 2004; Tomlinson, 1995; Winebrenner, 2001) indicates that the needs of mathematically gifted and talented children are consistently not met in the general education classroom, but it is not clear why. The intent of this study was to investigate the perspectives of K-12 teachers on perceived characteristics of mathematical giftedness and talent, as well as what current instructional strategies are being used with mathematically gifted and talented students in the general education classroom. The following research questions are closely tied to the problem statement.

1. What student characteristics do K-12 teachers identify as possible indicators of mathematical giftedness/talent?

2. How are K-12 students identified as being gifted/talented in mathematics?

3. What instructional approaches do K-12 teachers suggest to support the learning of mathematically gifted/talented students?

This review of the literature will focus on who gifted and talented students are and, more specifically, who mathematically gifted and talented students are. Moreover, the review of literature will describe some of the mathematical instructional strategies...
that are currently used in the general education classroom with mathematically gifted and talented students. It will also describe what instructional strategies are recommended for mathematically gifted and talented students by experts in the field of gifted education. Finally, the challenges that general education teachers face in trying to meet the needs of mathematically gifted and talented students along with instructional strategies for how these challenges can be met will be explored.

Organization of the Review

This review of literature is organized as follows: (a) definitions of academically gifted and talented students, (b) definitions of mathematically gifted and talented students, (c) literature relevant to the conceptual framework and the research questions, and (d) discussion of recurring themes from the literature.

Search Strategies

The databases used in researching this topic were: Academic Search Premier, ERIC, Google Scholar, the National Research Center (NRC) on the Gifted and Talented, and the National Council of Teachers of Mathematics (NCTM). Journals used were: Gifted Child Quarterly, Gifted Child Today, Roeper Review, Journal of Secondary Gifted Education, Teaching Exceptional Children, Theory Into Practice, High Ability Studies, Psychology in the Schools, Early Childhood Education Journal, and School Science and Mathematics. Some of the keywords used to search the databases and journals were: gifted, mathematics, instructional strategies, mathematics instruction, and talented.
Definitions of Academically Gifted and Talented Students

This study was designed to investigate the perspectives of K-12 teachers on perceived characteristics of mathematical giftedness and talent, as well as on effective mathematics instruction for gifted/talented students. There is little consensus in the field of gifted education on the definition of giftedness and talent. The United States Office of Education (USOE) developed a definition for giftedness and talent in 1972 with the Marland Report. The original definition included a high performance area of psychomotor ability that was omitted in 1978 because many schools already had a gifted program for sports. In 1993, the definition was revised to reflect the idea that gifted and talented students are at high levels of accomplishment when compared to others of their age, experience, or environment. In addition, the revision reflected the idea that gifted and talented students come from all cultural and economic backgrounds. Not all states use the current federal definition, and definitions of gifted and talented can vary widely from school district to school district (Sayler, 2002). Many definitions of giftedness and talent are offered in the field of education, and there is still controversy over how giftedness and talent should be defined (Harrison, 2004). The current definition offered by the USOE is:

Children and youth with outstanding talent perform or show the potential for performing at remarkable high levels of accomplishment when compared with others of their age, experience, or environment. These children and youth exhibit high performance capability in intellectual, creative, and/or artistic areas, possess an unusual leadership capacity, or excel in specific academic fields. They require
services or activities not ordinarily provided by the schools. Outstanding talents are present in children and youth from all cultural groups, across all economic strata, and in all areas of human endeavor. (USOE Public Law 91-230)

As with many of the existing definitions of gifted and talented, there has been some criticism that the USOE definition does not provide identification of a broad enough range of gifted and talented students (Cash, 2005.) Reis (1999) argues that many educators may use the federal definition but focus only on academic and intellectual abilities when identifying gifted and talented children, as opposed to other areas such as creativity or artistic abilities.

Howard Gardner also provides a definition of giftedness and talent. Gardner is best known for his theory of Multiple Intelligences (MI). His latest definition of intelligence is “a biopsychological potential to process information that can be activated in a cultural setting to solve problems or to create products that are of value in a culture” (1999, p. 33). His theory states that intelligence is neural potential, waiting to be activated or further developed by various factors such as the influences of culture, available opportunities, personal decisions, families, teachers, and experiences. Gardner (1983) has established eight criteria for something to qualify as a multiple intelligence: potential of isolation by brain damage; an evolutionary history and evolutionary plausibility; an identifiable core operation or set of operations; susceptibility to encoding in a symbol system; a distinct developmental history, along with a definable set of expert end-state performances; the existence of idiot savants, prodigies, and other exceptional people; support from experimental psychology tasks; and support from psychometric findings.
Originally, Gardner identified seven multiple intelligences: linguistic, logical-mathematical, musical, bodily-kinesthetic, spatial, interpersonal, intrapersonal. In 1999, he added three other intelligences: naturalist, spiritual, and existential. Gardner (1999) also addressed gifted children in his multiple intelligences theory and gives a definition of gifted children. He defines talented and gifted as children who excel in certain pursuits and stand out, typically because they perform at adult level while still children. Gardner (1983) also states that a human intelligence must enable the individual “to resolve genuine problems or difficulties and when appropriate, to create an effective product – and must also entail the potential for finding or creating problems – thereby laying the groundwork for the acquisition of new knowledge” (pp. 60-61).

Renzulli (1985) provides a definition of giftedness along with a program that can be used with gifted and talented students to meet their needs in the general education classroom and beyond. He defined giftedness as the interaction of three cluster traits: above-average ability, task commitment, and creativity. Renzulli (1998) states that:

Gifted behavior consists of behaviors that reflect an interaction among three basic clusters of human traits--these clusters being above average general and/or specific abilities, high levels of task commitment, and high levels of creativity. Gifted and talented children are those possessing or capable of developing this composite set of traits and applying them to any potentially valuable area of human performance. Children who manifest or are capable of developing an interaction among the three clusters require a wide variety of educational opportunities and services that are not ordinarily provided through regular
instructional programs. (p. 25)

Evidently, varying definitions and ideas of giftedness and talent exist within the field of gifted education. There are some differences among the definitions. The USOE definition is broad and is often criticized as being “frequently ambiguous, indefinable, or overlapping, and [as] frequently adopted without regard for the actual implications for identification or programming” (Treffinger & Renzulli, 1986 as cited in Davis & Rimm, 2005, p. 13). Scholars consider Renzulli’s definition to be more specific than the USOE definition because it addresses performance areas whereas the USOE does not. However, Renzulli’s definition of giftedness allows for a larger percentage of students to be identified as gifted and talented, because his definition suggests that gifted behaviors can be developed in a broader spectrum of the school population (up to 15 to 20 percent) than the small percentage of students who are usually identified by high scores on intelligence or achievement tests. Gardner’s definition of giftedness has received criticism as well. The fundamental criticism of Gardner’s theory of multiple intelligence is the belief that each of the multiple intelligences is, in fact, a cognitive style rather than a stand-alone construct (Morgan, 2006). Morgan (2006) refers to Gardner’s approach of describing the nature of each intelligence with terms such as abilities, sensitivities, and skills as evidence of the fact that the "theory" is really a matter of semantics rather than new thinking on multiple constructs of intelligence. Morgan also says Gardner’s theory is not empirical and cannot be measured or tested.
Definitions of Mathematically Gifted and Talented Students

This study focuses specifically on mathematically gifted and talented students. Therefore, literature related to the characteristics, needs, and abilities of mathematically gifted and talented children must also be examined. There are varying definitions for mathematically gifted and talented children found in the current literature.

Gardner (1983) offers a definition for logical-mathematical intelligence within his theory of multiple intelligences. His theory is one that defines and assesses intelligence from multiple perspectives. Specifically, Gardner’s theory explains logical-mathematical intelligence as encompassing logical thinking as well as mathematical and scientific problem-solving. Students who possess mathematical intelligence demonstrate the capacity to analyze problems logically, carry out mathematical operations, and investigate issues scientifically. They are able to detect patterns, reason deductively, and think logically. This intelligence is most often associated with scientific and mathematical thinking. The logical-mathematical intelligence is particularly involved in problem solving and in grasping, drawing out, and showing the implications of an event.

Gardner (1983) suggests that the most successful application of the logical-mathematical intelligence is the scientific method, "the practice of making careful measurements, devising statements about the way in which the universe works, and then subjecting these statements to systematic confirmation" (p. 146). This intelligence deals with logic, numbers, and abstractions. Gardner also supports his definition of logical-mathematical intelligence with ideas from various mathematicians who are leaders in the field of mathematics. Adler (1982), a leader in the field of mathematics whom Gardner
draws on to support his definition, characterizes people with mathematical gifts as possessing a love for abstraction and being a maker of patterns who can skillfully handle long chains of reasoning. Gardner adds to these characteristics by stating that mathematical talent “requires the ability to discover a promising idea and then draw out its implications” (p. 143). He also states that at the center of mathematical talent is the ability to recognize and solve significant problems.

Rotigel and Fello (2004) offer some other characteristics of mathematically gifted and talented students. They say these students can develop answers to a variety of math problems with an unusual speed and accuracy. They can easily identify relationships among concepts without having formal instruction on the specific concepts.

Mathematically gifted and talented students may often skip steps and may not always be able to always explain how they arrived at a correct answer. In addition, these students may demonstrate an uneven pattern of mathematics understanding and mathematics development. They often want to know the reasoning behind mathematics problems and to learn a mathematics concept in depth before moving to a new concept. Like Gardner, Rotigel and Fello (2004) suggest that mathematically gifted and talented students often begin to exhibit signs of their talent during preschool and may demonstrate an understanding of number patterns and relate them to real-life situations. They may exhibit an unusual interest in mathematical concepts and enjoy number games. Many of these students arrive at school with their own ideas and theories on number sense, problem solving, patterns, and even computational strategies. They have a great need to
explore mathematics concepts in depth, need a larger breadth of topics in mathematics to explore, and need open-ended opportunities for solving complex mathematics problems.

Krutetskii (1976) conducted a study on the psychology of mathematical giftedness in school children in Soviet Russia. He came to the following conclusion about the general characteristics of mathematical giftedness: 1) an ability to formalize mathematical material, to isolate form from content, to abstract oneself from concrete numerical relationships and spatial forms, and to operate with formal structure-with structures of relationships and connections; 2) an ability to generalize mathematical material, to detect what is of chief importance, abstracting oneself from the irrelevant and to see what is common in what is externally different; 3) an ability to operate with numerals and other symbols; 4) an ability for sequential, properly segmented logical reasoning, which is related to the need for proof, substantiation and deductions; 5) an ability to shorten the reasoning process, to think in curtailed structures; 6) an ability to reverse a mental process (to transfer from a direct to a reverse train of thought); 7) flexibility of thought and ability to switch from one mental operation to another. 8) freedom from the binding influence of the commonplace and the hackneyed. This characteristic of thinking is important for the creative work of a mathematician.

Mingus (1999) offers another description of mathematically gifted and talented students. Mingus believes that mathematically gifted and talented students can innately: extract formal structure from context of a mathematics problem and operate within that structure; generalize and reasons logically; switch flexibly from one approach to another and identify and avoid nonproductive approaches; operate with symbols and spatial
concepts; visualize and interpret facts and relationships; quickly recognize patterns, similarities, and differences; and achieve clarity, simplicity, economy, and rationality in arguments. While Mingus believes that mathematically gifted and talented students innately possess these characteristics, she also believes that not all mathematically gifted and talented students are willing to work hard or are creative in their mathematics work. Therefore, a child may be mathematically gifted and talented but may not be motivated to work hard in mathematics, demonstrate mathematical giftedness, or be creative with mathematical problem solving.

Greenes (2001) states that mathematically gifted and talented students differ from other students in mathematics in the following abilities: spontaneous formation of problems; flexibility in handling data; mental agility or fluency of ideas; data organization; originality of interpretation; transferring ability; and generalizing concepts. Greenes notes that computational proficiency is never listed as a characteristic of mathematically gifted and talented students, yet it is often the common criterion that is used in elementary school for students to be permitted or expected to learn more challenging or interesting material. Greenes also feels that mathematically gifted and talented students have special needs that demand a math curriculum that is deeper, broader, and faster than what is delivered to other students, even though a common misconception is that mathematically gifted and talented students do not need special services or attention because it is easy for them to learn mathematics.

Hoeflinger (2003) explains that although mathematically gifted and talented students are sometimes difficult to identify, they do share the following characteristics:
an ability to experience true problem-solving tasks by internalizing, reshaping, and questioning; multiple strategies to move forward the process of solving a problem; and a high threshold of acknowledgement of what constitutes a problem. Hoeflinger also suggests that indications of mathematical giftedness occur across the curriculum and not just in the subject of mathematics. She suggests that gifted students tend to synthesize all content via mathematical language and often use logic and sequencing in their work, especially in subjects such as writing. Hoeflinger also notes that mathematically gifted and talented students are often precise in their work and may set up tables to organize data in various subjects.

The literature suggests that mathematically gifted and talented students can be difficult to identify, because they have varying characteristics. Some mathematically gifted and talented students may be high academic achievers and easy to identify, whereas others may have the ability but are unwilling or unmotivated to work. However, common characteristics appear to be their ability to problem solve and their ability to use multiple strategies in the problem-solving process.

Identification of Gifted Students

Sarouphim (2003) investigated the effectiveness of a performance-based assessment (DISCOVER) in identifying gifted minority middle school students. DISCOVER stands for Discovering Intellectual Strengths and Capabilities through Observation while allowing for Varied Ethnic Responses. DISCOVER is a research-based instrument developed in relation to multiple intelligences, student diversity, and problem-solving. Participants are guided through hands-on problem-solving activities
that are designed to measure their problem-solving abilities. The study examined DISCOVER in relation to Gardner’s theory of multiple intelligences (MI) in addition to assessing gender and ethnic differences. Results indicated that DISCOVER and MI theory demonstrated a good fit with each other. Students who were identified as gifted in one intelligence were not necessarily identified as gifted in other intelligences.

Kornhaber (2005) investigated three alternative assessments for identifying gifted students, and each of the three alternative assessments were based on Gardner’s theory of multiple intelligences. The three assessments investigated included DISCOVER, PSA (problem solving assessment), and the gifted model program. DISCOVER is the same assessment described in the previous study. PSA is an assessment that was inspired by DISCOVER, and has a pre-assessment as well as assessment components. Identification using the gifted program model relies on various objective measures, such as standardized tests, and on subjective measures, such as the Renzulli/Hartman teacher checklist (Renzulli & Hartman, 1990) and parent nominations. All of these assessments were designed to increase the identification of various underidentified gifted and talented students.

Callahan et al. (2005) researched Project START, a collaborative three-year research study with the goal to develop and apply gifted identification procedures based on Gardner’s multiple intelligences theory. Specifically, the goals of the mixed-method study were as follows: to develop identification procedures, to identify high-potential primary age students from culturally diverse and/or low economic backgrounds, using the multiple intelligences model; to investigate the reliability and validity of the
identification procedures, and to test the efficacy of specific interventions on student achievement and attitudes.

Haensly and Lee (2002) focus on extending knowledge of the many ways gifted ability in young children from diverse backgrounds is demonstrated in the school and home settings. The school setting was a specialized summer camp conducted by the Institute for the Gifted and Talented at a large southwestern university. The specific data that were obtained focused on variables ranging from play preferences and peer and adult interactions to various intelligences and natural strengths. Gifted abilities and potential in young children were observed and researchers had the opportunity to examine many variables, such as content or symbol system preferences of the children, pace of their exploration, and peer interaction. This study provides more information on the early indicators and potential of mathematical giftedness.

Other studies also focused on early indicators and potential of mathematical giftedness. Stanley (1994) researched early indicators and potential of mathematical giftedness and eventually created a program to identify these students. Stanley (1995) created the Study of Mathematically Precocious Youth at Johns Hopkins University. This study began with the idea of seeking out youth who reasoned exceptionally well mathematically through a talent search. This talent search experimented with a variety of accelerated program options for mathematically gifted and talented students. Eventually, the talent search led to the creation of the Center for Talented Youth (CTY), which today still carries out the mission of identifying and developing talent in youth.
Teaching the Mathematically Gifted

One area that was emphasized in the studies discussed above was the concept of acceleration. The studies found that acceleration is often an effective way to meet the needs of mathematically gifted and talented students and can help these students achieve higher academically. In addition, these studies found that there is no evidence that some of the myths surrounding acceleration are true, such as the idea that accelerants lose interest in the subject area or experience knowledge gaps (Stanley, 2001). Stanley’s studies explored the various forms of giftedness and attempted to define giftedness in several domains. Although gifted students are typically identified through achievement tests, specialists in the field of gifted education searched for other ways to identify giftedness, using methods similar to Gardner’s theory of multiple intelligences. The study suggests that in order to meet the needs of these children, special, supplemental, and accelerative educational abilities matched with their abilities and interests may be the best solution.

Tsai (1997) conducted a study of a pilot program for highly capable primary students based on Renzulli’s enrichment triad. The program focused on curriculum compacting, using human resources, and enhancing creative productivity. Tsai found that students who received curriculum compacting in mathematics performed as well as before, even though they spent less time in the regular mathematics class. Tsai also found that these students were more attentive during the regular mathematics class and that students who did not receive compacting did not have a negative attitude towards the students who received the compacting. Moreover, the teachers in general had a positive
attitude towards compacting. Finally, Tsai found that when students received specific training on using reference materials and developing communication techniques, the training had a significant positive impact on the individual and small-group investigation of real problems and on creativity.

Gari, Kalantzi-Azizi, and Mylonas (2000) conducted a study that explored the motivation and adaptation to school life in relation to the identification of giftedness. The theoretical framework of this study was based on the work of Renzulli. The results of the study indicated that gifted students, depending on whether or not they are identified as gifted by their teachers, feel partially motivated and perform lower than their ability levels at school. This implies that mathematically gifted and talented students who are not identified as mathematically gifted by their teachers may not be motivated and may perform at lower levels than their ability.

Cashion and Sullenger (1996) conducted a study where teachers took a course on teaching gifted and talented students. The course was designed to change beliefs about giftedness as well as to improve teaching practice. Interviews were conducted with participants regarding the course effectiveness. Most participants indicated a deeper understanding of the nature of gifted and talented students along with greater sensitivity to as well as greater recognition of the needs of gifted and talented students. The teachers cited factors that make change in teachers’ practices difficult, such as lack of support from the administrative level, as well as from peers. After the course, teachers implemented changes such as using curriculum compacting, the use of Renzulli’s Type I and Type II activities, along with strategies from Talents Unlimited(**). Talents
Unlimited is a program designed to help improve critical thinking and creativity skills via specific work-related thought processes: productive thinking, communication, forecasting, decision-making, and planning, with academic talent as a base for the five processes. Another change after the course was that teachers provided a differentiated curriculum for gifted and talented students. A differentiated curriculum responds to learners’ needs, and follows three general principles suggested by Tomlinson (1995): respectful tasks, flexible grouping, and ongoing assessment and adjustments. The findings of this study indicate a need for a comprehensive program as well as a professional forum to discuss and share ideas.

Fluellen (2003) conducted a study in conjunction with a Harvard University program to develop each child’s mathematical proficiency in a mixed-ability classroom of 29 African American students. The students ranged from special needs to gifted and talented students. The pilot program was implemented in a fifth-grade classroom in Philadelphia. The facilitator blended Gardner’s multiple intelligence approach, Piaget’s cognitive development theory, a teaching-for-understanding approach, and a set of life values in the curriculum in order to provide a deeper understanding of mathematics, history, science, and literacy. Students were exposed to a wide variety of experiences, and ongoing assessments were used to evaluate the experience. The program helped the children to develop their intelligences further by participating in daily activities that drew on their intelligences. A program like this could help mathematically gifted and talented students develop their gifts even further.
Tomlinson (1994) conducted a qualitative study to examine how student teachers address the needs of diverse learners, including gifted students, in their classrooms. Data collection included interviews and observations. The most common themes reflected in the study were as follows: compromised beliefs in the existence and importance of student differences and needs; ambiguity in the identification of individual differences and needs; incomplete views of differentiating instruction in response to student needs; few or limited instructional strategies for providing differentiation; and the presence of factors that complicate and discourage understanding of student differences and needs. The study concluded with implications for further research on pre-service teachers and their related teacher education curriculum, and on how to make teachers aware of student needs and differences in the classroom.

In addition to a review of the literature related to gifted and talented students in general, a review was also conducted of studies specific to mathematical giftedness. Studies were reviewed in the following areas: identification of mathematically gifted and talented students; current instructional strategies typically used by general education classroom teachers to meet the needs of mathematically gifted and talented students; instructional strategies recommended by gifted education experts to meet the needs of mathematically gifted and talented students in the general education classroom; and challenges teachers face in meeting the needs of mathematically gifted and talented students.

Sriraman (2003) conducted a grounded theory study where high school freshmen were asked to solve non-routine mathematics problems at an increasing level of
complexity over three months. The generalization that characterized the problem solutions was discovered by the mathematically gifted and talented students, but not by the other students. This study validates the hypothesis that there is a relationship between mathematical giftedness, problem-solving, and the ability to generalize. Moreover, this study helps to demonstrate the need for acceleration and differentiation for mathematically gifted and talented students at the high school level. It also addresses the need for identifying mathematically gifted and talented students as well as for using instructional strategies that are recommended by gifted education experts in order to better meet the needs of these students in the general education classroom.

Westberg, Archambault, Dobyns, and Salvin (2000) conducted an observational study for the National Research Center on instructional and curricular practices used with gifted and talented students in the regular third and fourth grader classroom. Structured observations were conducted in 46 third- or fourth-grade classrooms in four regions of the United States. Twenty-six of the schools had a formal gifted program in place, and twenty did not. Trained observers spent two days observing one gifted or high ability student and one average student in each classroom. This observation allows the researchers to compare the curriculum and instruction provided to gifted students and average students in the same classroom. Observers used an instrument that was developed by the researchers, the Classroom Practices Record, to record information about the types and occurrences of instructional and curricular differentiation provided by general education teachers to the students. This study found that little or no differentiation in instructional and curricular practices is provided to gifted and talented
students in the general education classroom in the subjects of reading, language arts, mathematics, science, and social studies. Across all subject areas, gifted and high-ability students experienced no curricular or instructional differentiation in 84 percent of the activities. The study did find the greatest percent of differentiation was in the subject area of mathematics, as gifted and high-ability students received advanced content instruction in 11 percent of the mathematical activities. Gifted students were heterogeneously grouped for the majority of instructional time in all subjects as well. Moreover, no significant differences were found in the level of questions used with gifted and talented students versus other students in the classrooms. However, the study did find that general education classroom teachers provide more wait time for average-ability students than for gifted students.

Mingus (1999) conducted a qualitative study on what constitutes a nurturing environment for the growth of mathematically gifted and talented students. The study described influential forces in the development of mathematically gifted and talented students. Mingus found that creating a nurturing environment for the mathematically gifted and talented required continual effort from parents, teachers, and even the community. These students need to be challenged mathematically, but they also need people who take risks and allow them to grow and learn. This study also addressed the idea that instructional strategies recommended by gifted education experts, such as having gifted students work on meaningful and worthwhile tasks, may be beneficial in meeting the needs of mathematically gifted and talented students in the general education classroom.
Wilgus (2002) conducted a quantitative study with third-grade mathematically gifted and talented students to investigate the relationship of peer collaboration on mathematics homework and academic performance in mathematics. The study found that there was no significant difference in academic performance between students who worked collaboratively on homework and those who did not. This study demonstrates that some mathematical instructional strategies may be more effective than others.

Gifted education experts also describe instructional strategies that meet the needs of mathematically gifted and talented students in the general education classroom. Tomlinson (1999), who is a leader in the area of differentiation, offers many instructional strategies that teachers can use to support differentiation and meet the needs of mathematically gifted and talented students in the classroom. Seven of her recommended instructional strategies will be examined closely. They are: respectful tasks; flexible grouping; ongoing assessment; tiered activities; learning contracts; compacting; and stations.

The instructional strategy of respectful tasks means that the teacher demonstrates respect for each learner and his or her learning differences. According to Tomlinson (1999), the teacher attempts to provide learning options that are a good fit for each student. This strategy requires the teacher to respect the readiness level of each student and to expect all students to grow and to support their continual growth. Respectful tasks also offer students the opportunity to explore concepts and skills at appropriate degrees of difficulty that increase with the students’ readiness. Finally, respectful tasks offer all students tasks that are equally interesting, important, and engaging.
A second instructional strategy is flexible grouping. Tomlinson (2003) defines flexible grouping as “students consistently working in a variety of groups based on readiness, interest, and learning profile, and both homogeneous and heterogeneous in regard to those three elements” (p. 84). Flexible grouping allows teachers to teach to a learner’s needs and readiness. This grouping allows students to experience various contexts and experience instruction in similar instructional readiness groups.

Another instructional strategy, ongoing assessment, is a necessity in the differentiated classroom. Ongoing assessment allows the teacher to have daily data on student readiness and student interests to create a learning profile (Tomlinson, 1999). Ongoing assessment should take place continually, not just at the end of a unit. Ongoing assessment also incorporates the use of multiple types of assessment and should focus on helping students grow rather than focusing on student mistakes.

The instructional strategy of tiered activities is also important in the differentiated classroom. Tiered activities allow teachers to ensure that students work with the same concepts or skills, even if they have different learning needs. While students may be working on the same concepts and skills, the tiered activities are at different levels of complexity, open-endedness, and abstractness (Tomlinson, 1999.) Although there are no set rules for developing tiered activities, Tomlinson provides guidelines for developing tiered activities: select the skills that will be the focus of the activities; keep the needs of the students in mind; create or select an activity; visualize a ladder with the bottom rung representing students with low skill and low complexity of understanding and the top rung representing students with high skill and high complexity of understanding; create
activities for each rung of the ladder; and match a version of the task to each student based on student need and task requirement.

The instructional strategy of learning contracts is another strategy by Tomlinson (1999) recommends. Tomlinson notes that there are many approaches to using the learning contract, but the learning contract allows the student to work somewhat independently on materials that are often teacher-directed. The learning contract gives students some freedom in learning skills that the teacher feels are necessary. Tomlinson suggests that a learning contract have the following components: explanation of skills that will need to be practiced and mastered; specific working conditions to which students must adhere during the contract time; positive consequences; criteria for successful completion and quality work; and the signatures of both teacher and student indicating agreement to the contract.

Compacting is another instructional strategy recommended by Tomlinson, and this strategy allows students who can demonstrate mastery of content or skills to move on to other areas of the content and/or areas of interest. Tomlinson (1999) explains that students who do well on pre-assessments (three-quarters or more correct) should not work on skills or content they already know, and compacting should be considered. A common way to use the instructional strategy of compacting is a three-stage approach. In the first stage, the teacher documents what the student already knows. In the second stage, the teacher plans for how the student will learn what the pre-assessment indicated that the student did not know about the topic. In the final stage, the teacher plans for meaningful and challenging use of the time the student will have.
The final instructional strategy recommended by Tomlinson that will be examined here is the use of stations. Tomlinson (1999) defines stations as “different spots in the room where students can work on various tasks simultaneously” (p. 62). This instructional strategy is effective for differentiation. Stations invite flexible grouping, varied assignments, and a balance of teacher direction and student choice.

Although there is little discussion found in the literature related specifically to meeting the special needs of mathematically gifted and talented students, many of these instructional strategies recommended by Tomlinson would be applicable to mathematically gifted and talented students. For example, mathematically gifted and talented students could be given assignments on their own level that are challenging through the use of stations or flexible grouping. A variety of mathematics assessments could be given in addition to the standard chapter test, such as mathematics portfolios, journals, and projects. In addition, tiered assignments could be created for mathematically gifted and talented students, and individual math assignments, along with group mathematics investigations, could be used.

Sheffield (1994) examined three sets of standards developed by the National Council of Teachers of Mathematics (NCTM) and provided recommendations for teaching, curriculum, and assessment of mathematically gifted and talented students in alignment with the standards. Sheffield notes that identification measures must include alternate methods beyond standardized testing, such as open-ended assessments and portfolios, in order to effectively identify mathematically gifted and talented students. She discusses various program options for these learners, such as differentiation, pull-out
programs, magnet schools, and summer programs. Sheffield notes that the NCTM has
developed a position paper on provisions for mathematically gifted and talented students.
The NCTM (1993) states in their position paper on Provisions for Mathematically Talented and Gifted Students that:
while all students need curricula that develop the students' problem solving, reasoning,
and communication abilities, the mathematically talented and gifted need in-depth and
expanded curricula that emphasize higher order thinking skills, nontraditional topics, and
the application of skills and concepts in a variety of contexts (p. 5)
The NCTM recognizes the need that mathematically gifted and talented students have for
a deeper, more in-depth mathematics curriculum (Greenes, 1981).
Haley and Capraro (2001) discuss the challenges teachers face in the general
education classroom each day. According to Haley and Capraro, the challenges stem
from a diverse society and diverse settings. For example, students often come from
varying cultural and ethnic backgrounds. Moreover, students of varying ability levels are
within one classroom setting, and teachers are expected to meet the needs of all the
learners in the classroom, ranging from special education students to gifted and talented
students. Haley and Capraro express the need for teachers to build a classroom
community and to use diverse instructional strategies to serve the needs of all learners in
the classroom.

Instructional and Curricular Models for Teaching Gifted Learners

Although most of the studies reported above have generally shown that gifted
learners do not receive fair and challenging instruction in the heterogeneous classroom,
some instructional strategies have been shown to increase the chances for gifted learners to meet their potential. The *California Mathematics Framework* (2005) states that any mathematics program must foster both computational/procedural learning and conceptual learning. Instruction must involve direct instruction, investigation, classroom practice/drill, small groups, individualized formats, hands on practice, projects, and the use of technology in order to be comprehensive, equitable, and effective for any type of learner (California Department of Education, 2005).

Research has mainly focused on developing teaching strategies and frameworks that challenge the gifted learner within the general education classroom; therefore, the above components of any mathematics program are critical for the academic and social achievement of gifted learners in heterogeneous classrooms. The following synopsis of these models shows differentiation as the overarching pedagogical approach that allows for rich learning and meaningful experiences in the classroom.

Differentiation refers to the multiple methods of adjusting, modifying, and customizing curricular and instructional practices such that they best attend to the learning needs of students. Curriculum that encourage higher-order thinking and in-depth, inter- and intra-disciplinary, and novel, combined with a variety of instructional approaches such as collaboration, group work, extended time for projects, open-ended activities, inquiry, discovery, and projects are the hallmarks of a differentiated program (Hertzog, 1998; Kaplan, 1986; Reis et al., 1994).

Differentiation is applicable to both average and gifted students. According to the California Gifted and Talented Education (GATE) standards, differentiation of
curriculum has four elements: depth, complexity, novelty, and acceleration (California Department of Education, 2001). Dinnocenti (1998) explains that the “three components that are most notably associated with differentiation are: content—what is being taught; process—how it is being taught; and product—tangible results produced based on students’ interests and abilities” (p. 2).

Differentiated curriculum and instruction, ultimately, provide meaningful educational opportunities for children where they may learn through multiple perspectives, big ideas, novel ideas, and acceleration and enrichment. Some or all of the above tenets of teaching using differentiation may be found in the following leading models for teaching gifted learners, both in homogeneous and heterogeneous classrooms and schools. Each model and its implications for the modification of classroom practices are explained briefly.

*Autonomous Learner Model*

Betts’ *Autonomous Learner Model* (1985) is suitable for teaching gifted learners in that it fosters “independent learning abilities, creativity, or self-awareness” that is often lost when the emphasis in schools for the support of gifted learners is on advanced placement classes, college courses, or acceleration (Maker & Nielson, 1995, p. 25). This model calls for the teacher to become a facilitator of learning, rather than a dictator of activities and expectations, or an organizer of knowledge into conceptual schema. Instructors must teach students how to use learning strategies on their own and transfer them to novel learning situations (Maker & Nielson, 1995). Teachers must possess knowledge and/or training for student collaboration activities, different discussion and inquiry skills, cross-disciplinary activities, and counseling of students, especially for the

The Cognitive and Affective Taxonomies Model

The Cognitive and Affective Taxonomies Model (Bloom, 1956; Krathwohl, et al., 1964) is a combination of Bloom’s Taxonomy and Krathwohl’s Affective Taxonomy. This model calls for instruction that “evokes certain types of thinking and teachers can be reasonably accurate about the underlying processes that go into a particular activity” (Maker & Nielson, 1995, p. 55). Essentially, teachers must break down learning into smaller steps. Such instruction develops basic skills that create opportunity for critical thinking and analysis. This model implies inquiry, variety of activities, complexity, discovery, freedom of choice of activities, grouping and collaboration, and most importantly, the knowledge of specifics that are often ignored in the general education classroom as appropriate classroom modifications for gifted learners (Bloom, 1956; Krathwohl, et al., 1964; Maker & Nielson, 1995; Paul, 1985).

Creative Problem Solving

The Parnes Creative Problem Solving Model (1975) for differentiating curriculum and instruction for the gifted places an “emphasis on generating a variety of alternatives before selecting or implementing a solution” on the part of the student (Maker & Nielson, 1995, p. 129). In this model, which assumes that gifted learners may be more creative than the average learner, the teacher must encourage the deferment of learners’ decisions and judgments until many alternative possibilities for solving a problem situation have
been explored (Parnes, 1975, 1988). Therefore, the types of activities that teachers choose are critical for building problem-solving creativity in gifted learners.

The Enrichment Triad Model

Renzulli’s Enrichment Triad Model (1977) is a framework for differentiation of curriculum and instruction for both gifted and typical students. The model has three components. General exploratory activities and process thinking are the first two components and are appropriate for all learners. The third component, “individual or small-group investigation of real problems, is seen as most appropriate for gifted learners” (Maker & Nielson, 1995, p. 163). In other words, giftedness may be developed through the interaction of students with one another in meaningful and relevant learner settings (Reis & Schack, 1993; Reis & Renzulli, 1985; Renzulli, 1977; Renzulli & Reis, 1985). The School-wide Enrichment Model (SEM) designed for a larger number of students and teachers, calls for instruction for the gifted that is modified in the following two ways: 1) teachers should allow students to pursue self-selected interests to their own desired extent in their own learning styles, and 2) teachers should enrich curriculum by “(1) identifying and structuring realistic, solvable problems that are consistent with the students’ interests; (2) acquiring the necessary methodological resources and investigative skills that are necessary for solving these particular problems; and (3) finding appropriate outlets for student products” (Renzulli, 1977, p. 10).

The Basic Structure of a Discipline—A Framework for Gifted Education

Bruner’s Basic Structure of a Discipline is a framework for instruction that applies to gifted learners. The underlying idea of this framework is that teaching and
curriculum must be organized and structured; the assumption is that if basic concepts are taught first and they are taught in a manner that is considered “good teaching,” then every student will be ready to learn (Bruner, 1960; Maker & Nielson, 1995). In order for teachers to teach well, their philosophy of teaching should be guided by inquiry teaching. Bruner’s *Basic Structure of a Discipline* suggests, hence, that “higher levels of thinking, discovery, open-endedness” are critical in the planning of instruction for gifted learners (Maker & Nielson, 1995, p. 94).

*The Parallel Curriculum Model*

A curricular design for gifted students is the parallel curriculum model (PCM) (Tomlinson, et al., 2002). This heuristic model employs four dimensions, or parallels, that can be used singly or in combination. The parallels are as follows: the core curriculum, the curriculum of connections, the curriculum of practice, and the curriculum of identity. Together, these dimensions strengthen the potential to achieve in gifted and high-ability learners. In the core curriculum, gifted and talented children learn content first in order to be able to extend their knowledge. An implication for teachers when developing curriculum with PCM is that they must be thorough in building basic knowledge so that working memory may be transferred into long-term memory and retrievable for subsequent learning. The mastery of basic skills is a critical part of this curriculum.

The purpose of the curriculum of connections, which is similar to differentiating for depth and complexity, is to enable students to think about and apply knowledge across many mediums (e.g., disciplines, cultures, perspectives, locations). The implication for instruction for gifted learners is that teachers must implement activities
that are interdisciplinary and that do not inhibit harboring and experiencing different perspectives of the content. The curriculum of practice and the curriculum of identity call for instruction that encourages students to practice applying their knowledge in a real-world setting and connecting the discipline to their own experiences. A large part of the education of gifted learners is to help them develop social skills, and these two tenets of the PCM are meant to do just that (Clark, 1997; Purcell, 2002). Instruction in the classroom must facilitate problem solving by making connections to prior experiences.

The parallel curriculum model works for small scale lessons or long term projects—“with a revised or designed unit ‘in hand’, a teacher can move back and forth across [a parallel], some, or all parallels in a single unit. Equally attractive, a teacher might use just one parallel to extend a core unit” (Purcell, et al., 2002, p. 4). High school teachers may find this model more feasible than most other models given the many standards they must cover and the flexibility of the model.

Layered Approach Model

The Layered Approach, developed by Kaplan (2005), emphasizes teachers’ steps towards fostering critical thinking, creativity, and problem-solving skills in gifted learners after they have defined and set the core curriculum in the classroom. Kaplan explains that changing the content, the process, and/or the product components of curriculum enables teachers to differentiate the regular curriculum for advanced learners. It is up to the teacher to decide which one or more of these three components of curriculum to differentiate for gifted students. Successfully designing the curriculum and instruction with altered content, process, and/or product components for gifted learners
depends upon the teacher’s background knowledge of the gifted child and the modifications that are appropriate for him/her (Kaplan, 2005). Implications for teachers of the gifted might be that they must go beyond the textbook to enrichment resources as they cover the content standards set by their state. In the layered approach, the teacher plays a key role in encouraging a gifted child to step towards thinking creatively and analytically.

*Group Investigations Model*

Originally developed for building social relationships among different ethnicities, the *Group Investigations Model* (Sharan & Sharan, 1992) is now used for grouping similar-ability students together for collaboration, cooperative group work, and social interaction in the classroom. Hence, the model, designed for all learners, calls for the homogeneous grouping of gifted learners. According to Maker and Nielson (1995), Group Investigations is designed to incorporate students’ interests, abilities, and past experiences into the planning of small-group activities. In this model, peer collaboration and student choice of projects is emphasized” (p. 199).

According to Group Investigations, teachers must become advisors of the problem-solving process and of the selection of projects and activities (Sharan & Sharan, 1992; Vygotsky, 1978). The “teacher must create a learning environment that stimulates interaction, research, and communication while maintaining an indirect, facilitative style of leadership” (Maker & Nielson, 1995, p. 202). In order for such an environment to be established, Group Investigations suggests teachers’ classroom practices should include
allowing gifted learners more time for projects, allowing them to conduct research about self-selected topics, and encouraging the asking of questions and peer explanations of these questions (Sharan & Sharan, 1992).

**Teaching Strategies Approach**

The *Teaching Strategies Approach* (Taba, 1966) is an organization of teaching strategies meant to help teachers build on student knowledge and potential through discovery and inquiry. The approach includes four strategies: (a) concept development, (b) interpretation of data, (c) application of generalizations, and (d) resolution of conflict (also called interpretation of feelings, attitudes, and values) (Maker & Nielson, 1995).

The most important aspect of the teaching strategies is for teachers to plan lessons with many open-ended questions, teach through patterns and sequences, debrief with students about ideas and solutions to reinforce the learning process, and change the pace of teaching depending on student ability (Taba, 1966).

Taba (1966) believed that all children are capable of learning but that the quality of knowledge acquisition differs depending on student ability. Gifted learners need to develop their intellectual, leadership, and social potentials and hence should be required to reason and explain their solutions, verbalize their findings, work in groups often, make independent judgments about problem solving, and learn through inquiry and discovery. The four strategies of this model require that teachers’ classroom practices be modified for gifted learners by making the teacher more of a facilitator (rather than a dispenser of content knowledge), a listener, and a questioner. Especially with gifted learners, it is important the teachers “extend and lift” discussions to help form patterns and
generalizations. This implies that teachers ask more of gifted students than they do of typical learners. Taba, influenced by Piaget’s work on cognitive development and developmental stages in children, explains that teachers must let the learners begin with a concept, then “lift” the level of thought required to “extend” into the next concept (for example, having the students generate a list about an idea and then having them group the items in the list into categories) (Piaget, 1963; Taba, 1966).

Other Approaches and Teaching Strategies for the Gifted

These approaches “have all been used by schools in their programs for the gifted, [but] the emphasis of curriculum intervention has been at the level of program model, not day-to-day classroom practice” (Van Tassel-Baska, 1997, p. 127). Daily classroom practice, as portrayed by the literature review on the status of gifted education, is what must be further explored and improved for the best possible education of gifted learners. Teachers of mathematics may incorporate one or more of the above models when teaching, and they may be selective with the models depending on the activity. They may enrich, accelerate, or deepen the lesson by bringing in other disciplines, student experience, and group collaboration. The NCTM (1999) recommends that teachers let students become owners of their education by creating problems and explaining them in mathematics, attempting and talking about challenging problems, working with peers, and working on their own. Curriculum must “respect the unique characteristics of the learner,” and instruction must reflect the teachers’ understanding of students’ different learning styles, areas of strength and weakness, and students’ interests (Tomlinson et al., 2002, p.4). Essentially, teachers of mathematically gifted learners must “recognize,
reinforce, and reward greatness. As a member of the classroom’s mathematical community, the teacher must model the same mathematical investigative processes that she wishes to cultivate in her students” (Greenes & Mode, 1999, p. 121). Stepanek (1999) explains that mathematics teachers may effectively develop mathematical promise when participating in such activities as those above through various means. One of those is by using the Problem-Based Learning Model (PBL), where a problem is presented and students are required to solve the problem together. In PBL, students are “presented with an ‘ill-structured’ problem” and they must seek additional information that is missing and decide on an approach to solving the problem (Stepanek, 1999, p. 33). The teacher acts as a coach, rather than the leader of the lesson. Teachers ask students to explain their answers, their solution methods, and what they think they could have done better, which gets to the essence of learning mathematics in a conceptual way.

Another model for learning is Creative Problem Solving (CPS), which has been a part of education since 1953. Treffinger, Isaksen, and Dorval (2000) explain that CPS focuses on teaching students to recognize problem situations and the skills they must have for solving them. Student must first understand the situation, then generate ideas for potentially generating a solution, and finally prepare to take action by forming a list of specific action steps. This approach is also appropriate for gifted learners when learning mathematics because it forces them to conceptualize the mathematics, rather than memorize steps and algorithms. Learning centers and seminars have also been suggested to stimulate students’ interest when learning mathematics (Stepanek, 1999). When a teacher’s goal is to incorporate advanced material into the curriculum, these two
classroom practices are interesting and more student-based methods of doing so than solely relying on the textbook (Stepanek, 1999). Williams (1986) provides a list of strategies for differentiating content and curriculum for gifted learners in the inclusive classroom. Within this list is evaluating problem situations for consequences and effects on other parts of the problem, encouraging students to use their intuition and providing classroom opportunities for students to move forward with their own “hunches,” form examples of habit and create tolerance for exploration and ambiguity in solutions, ask leading questions and provide opportunities to seek answers to those questions, teach the use of paradoxes and discrepancies to test hypotheses, and teach through the use of connections and analogies between subjects. Clearly implied from the recommendations of major organizations for the gifted and for mathematics teaching, the success of gifted students begins with the teacher.

Major themes on Instruction for the Mathematically Gifted

The literature on mathematically gifted and talented students reveals two major themes. One is the need for teachers to understand mathematically gifted students and know best practices for effectively meeting their needs in the classroom. The other is the need for mathematically gifted and talented students to have different instruction than their peers. Both of these themes will be explored in this section.

The first theme is the need for teachers to understand mathematically gifted students and know best practices for effectively meeting their needs in the classroom. Current research (Mingus, 1999; Rotigel & Fello, 2005; Tomlinson, 1994; Winebrenner, 2001) indicates that the needs of mathematically gifted and talented children are
consistently not met in the general education classroom. The Westberg et al. (1993) study from the National Research Center for the Gifted and Talented, mentioned earlier, focused on instructional and curricular practices used in the regular third- and fourth-grade classroom with gifted and talented students. This study found that little or no differentiation in instructional and curricular practices is provided to gifted and talented students in the general education classroom.

Tomlinson (1994) examined how student teachers address the needs of diverse learners, including gifted students, in their classrooms. The results of this qualitative study found that teachers compromise their beliefs about the existence and importance of student differences and needs, express ambiguity in the identification of individual differences and needs, hold incomplete views of differentiating instruction in response to student needs, have few or limited strategies for providing differentiation, and believe factors exist that complicate and discourage understanding student differences and needs. Finally, Cashion and Sullenger (1996) conducted a study where teachers took a course on teaching gifted and talented students. The course was designed to change beliefs about giftedness and improve teaching practices. Following completion of the course, most participants indicated deeper understanding of the nature of gifted and talented students along with greater sensitivity toward and recognition of the needs of gifted and talented students. After the course, teachers implemented many changes in their instruction in order to better meet the needs of students in their classes.

Another theme from the literature is that mathematically gifted and talented students need different instruction than their peers. Rotigel and Fello (2004) note that
these students have a great need to explore mathematics concepts in depth, need to explore a larger breadth of topics in mathematics, and need open-ended opportunities for solving complex mathematics problems. Greenes (1981) holds that mathematically gifted and talented students have special needs that demand a mathematics curriculum that is deeper, broader, and faster than what is delivered to other students, even though a common misconception is that mathematically gifted and talented students do not need special services or attention because it is easy for them to learn mathematics. Stanley’s (1974) studies suggest that to meet the needs of these mathematically gifted and talented children, special, supplemental, and accelerative educational services matched with their abilities and interests may be the best solution. Fluellen (2003) conducted a study in conjunction with a Harvard University program to develop proficiency for children in a mixed-ability classroom. Students were exposed to a wide variety of experiences and were taught according to their dominant intelligence area, as defined by Gardner (1983). The results of this study indicated that certain types of programs can help mathematically gifted and talented students further their abilities in their own intelligence areas. Mingus (1999) conducted a study on what constitutes a nurturing environment for the growth of mathematically gifted and talented students. This study described influential forces in the development of mathematically gifted and talented students. Mingus found that a nurturing environment for the mathematically gifted and talented included continual effort from parents, teachers, and even the community.
Other Studies Related to This Research

Most studies found in the literature deal with high school mathematics or special education students, but a few address mathematically gifted and talented students at the elementary level. For example, Montgomery (1992) conducted a qualitative study using a multiple study approach on the career aspirations and factors influencing career decisions for a group of extremely mathematically precocious females to determine why some enter math/science careers and others do not. The study found that the young women had career goals by age eighteen, and two-thirds of the females chose to work in a mathematics/science-related field. The study also found that career choice was viewed as a reflection of interests, which came from early family influences and various educational opportunities. Lewis (2002) presents two explanatory case studies of highly gifted preschoolers. The study shares pitfalls in providing programs for the highly gifted and warns that acceleration is not enough. The researcher suggests that assessment, flexible scheduling, and counseling are three key components that are critical to the success of any program for children with advanced intellectual gifts. Kronberg et al., (1997) discuss the growing diversity in today’s classrooms and describe ideas for differentiated teaching and learning. Descriptive case studies have been used to investigate multi-age elementary classrooms that use an integrated service delivery model between general and special education to differentiate teaching and learning in the subject of mathematics. The studies illustrate how multi-age elementary classrooms deliver individualized instruction for all students in the subject of mathematics.
These studies show that early experiences and family play an important role in the development of the mathematics interests of mathematically gifted and talented students. In addition, they reveal a need for specialized programs for mathematically gifted and talented students and demonstrate that differentiation can provide challenging instruction for these students.

Sriraman (2003) conducted a grounded theory study where secondary-level mathematics students were asked to solve mathematics problems of increasing complexity and found that mathematically gifted and talented students could discover generalities that characterized problem solutions. The researcher was a full-time teacher, and during the course of a semester, data were collected through student journal writings, clinical interviews, and teacher journal writings. The researcher conducted five rounds of open-ended interviews. Journal writings and transcribed interviews were examined for themes and patterns. The constant comparative method was used to look for patterns. This study validated the hypothesis that mathematical giftedness, problem-solving, and the ability to generalize are related.

An exploratory study was conducted by Mingus (1999) on what constitutes a nurturing environment for the growth of mathematically gifted and talented students. The researcher conducted in-depth interviews and administered surveys and an attitude checklist. The study showed that a nurturing environment for mathematically gifted and talented students required that these students be challenged mathematically and surrounded by people who take risks by allowing them to grow and learn.
Wilgus (2002) conducted a quantitative study using an experimental design with third-grade mathematically gifted and talented students to investigate the relationship of peer collaboration to mathematics homework and academic performance in mathematics. A third-grade class was randomly divided in half and placed in group A or B after taking a pre-test. For the first three weeks, Group A was the control group and this group worked on mathematics homework alone. Group B was the experimental group and was assigned the variable of peer collaboration on mathematics homework. The two groups switched places, and Group A became the experimental group and Group B was the control group. At the end of the six weeks, students took a post-test. The raw scores from the post-test were tabulated and a mean score was found. A paired-sample t-test was used to compare the control and experimental groups’ test scores. The results showed that there was no significant difference in academic performance between students who worked collaboratively on homework and those who did not.

One important study is the ongoing longitudinal research started by Julian Stanley (1974) in 1971, the Study of Mathematically Precocious Youth (SMPY). This study was started at Johns Hopkins University and pioneered the concept of searching for youth who reason exceptionally well mathematically through a talent search. In 1980, others at John Hopkins University extended the talent search to verbally gifted youth. For the identified students, the Study of Mathematically Precocious Youth provided opportunities for curricular acceleration or flexibility and fast-paced academic programs. After the Study of Mathematically Precocious Youth established the need for the talent searches and the associated services and programs, organizations were established at several
universities, such as Duke, Iowa State, Johns Hopkins, and University of Denver, and these centers conduct verbal and mathematics talent searches covering the entire nation. Today, gifted students in seventh- and eighth-grade can participate in these talent searches by taking the College Board's SAT or the ACT. Specifically, the identification of intellectually able students and the impact of various educational options on their development are being studied by SMPY through its planned 50-year longitudinal study. Students who were identified as mathematically gifted through the talent search process were placed into cohorts. Follow-up surveys/questionnaires were periodically sent to research subjects. The surveys included open-ended, multiple choice, and Likert-type responses, as well as requested personal information, such as standardized test scores. The studies found that acceleration is often an effective way to meet the needs of mathematically gifted and talented students and can help these students achieve higher academically. This study also provides information about the development, needs, and characteristics of precocious youth. The long-term goal of SMPY is to identify the key factors that lead to creative work and/or high academic achievement, primarily in mathematics and the sciences. The data collected during SMPY’s first decade have shown that most SMPY students achieve their potential for academic success in high school and college. However, intellectually able students will not necessarily achieve their full potential unless provided with appropriate educational opportunities. According to the study, there is a need to further identify appropriate educational opportunities for mathematically gifted and talented students (Stanley, 1974).
Summary

A review of literature relevant to this study shows that gifted and talented students, particularly mathematically gifted and talented students, have unique characteristics and needs. The literature also suggests that general education teachers can use differentiation and pertinent other instructional strategies to better meet the needs of gifted and talented students. Although the literature demonstrates that a variety of instructional programs currently exist for gifted and talented students, most gifted and talented students spend the majority of their academic career in the general education classroom where these services are not available. However, the general education classroom teacher’s perspectives on the needs of these students are not available. Moreover, the current literature does not explore the general education classroom teacher’s perspectives about why these needs are or are not being met and what some possible solutions could be for meeting the needs of mathematically gifted and talented students in the general education classroom.
CHAPTER 3: METHOD

This chapter provides the rationale for the choice of the research design, data collection approaches, and data analysis. The chapter is categorized according to the following topics: Research Design, Research Participants, Instrumentation, Pilot Study, Data Collection, and Data Analysis. Each section contains a description of the process and procedures used. Approval for surveying research participants was obtained from the Institutional Review Board (IRB) of the University of Nevada, Reno before data were collected.

The purpose of this study was to investigate the perspectives of K-12 teachers on perceived characteristics of mathematical giftedness and talent, as well as what current instructional strategies are being used with mathematically gifted and talented students in the general education classroom. The following research questions were addressed:

1. What student characteristics do K-12 teachers identify as possible indicators of mathematical giftedness/talent?
2. How are K-12 students identified as being gifted/talented in mathematics?
3. What instructional approaches do K-12 teachers suggest to support the learning of mathematically gifted/talented student?

Research Design

A concurrent mixed-method approach was used for this study. This approach integrates both quantitative and qualitative research methods (Gay & Airasian, 2003). There has been some debate on the usefulness of combining qualitative and quantitative research methodologies in the same study (Creswell, 2003; Curlette, 2006; Taskakkori &
Teddlie, 2009; Thomas, 2003). While many scholars hold a binary view of quantitative and qualitative research methods, others advocate a complementary view of these methods. For instance, Curlette (2006) posits that “beliefs from the qualitative aspect of a mixed-method research design can be combined with data from the quantitative side of the research to reach a belief statement about the existence of a finding from the qualitative study” (p. 345). Thus, Curlette asserts that data collected using qualitative techniques can be used to support conclusions reached using quantitative data, and vice versa.

Johnson, Onwuegbumie, and Turner (2007) illustrated the qualitative-quantitative continuum of a mixed-methods research with the diagram in Figure 1. The area in the center of the figure, moving outward in both directions (and excluding the area near the poles), is where mixed-methods research, broadly speaking, falls, with the center representing the strongest or “pure” form. A researcher is likely to have one primary home (out of the three major homes: qualitative research, mixed research, and quantitative research). The area around the center of the continuum, equal status, is the home for the person who self-identifies as a mixed-methods researcher. This researcher takes as his or her starting point the logic and philosophy of mixed-methods research. These mixed-methods researchers are likely to believe that qualitative and quantitative data and approaches will add insights to most, if not all, research questions. Another type of mixed-methods research that results from the continuum shown in Figure 1 is labeled qualitative dominant mixed-methods research. This area on the continuum would fit
qualitative or mixed-methods researchers who believe it is important to include quantitative data and approaches in their otherwise qualitative research projects.

Figure 1: Continuum of different types of mixed-methods research (Johnson, Onwuegbuzie, & Turner (2007)).

Another type of mixed-methods research that results from the continuum shown in Figure 1 is labeled *quantitative dominant* mixed-methods research. This area on the continuum would fit quantitative or mixed-methods researchers who believe it is important to include qualitative data and approaches in their otherwise quantitative research projects.

Based on the argument that two sets of data (qualitative and quantitative) will better explain a phenomenon, this study was conducted using a concurrent mixed-method
design. In order to be effective, mixed designs must be carefully designed following a series of steps.

Basic Steps in Designing a Mixed-Methods Study

Designing a mixed-methods study involves a number of steps. These first include deciding on the purpose of the study, the research questions, and the type of data to collect. Designing a mixed-methods study also involves at least three additional steps: 1) deciding whether to use an explicit theoretical lens, 2) identifying the data collection procedures, and 3) identifying the data analysis and integration procedures (Creswell, 1999; Greene & Caracelli, 1997; Morgan, 1998; Tashakkori & Teddlie, 1998). These steps occur more or less sequentially, with each step informing and influencing the others.

The first step involves deciding whether to use an explicit theoretical lens. The term theoretical lens refers to the philosophical basis or paradigm that underlies a researcher's study and subsequent methodological choices (Crotty, 1998).

The second step involves deciding how data collection will be implemented and prioritized. Implementation refers to the order in which the quantitative and qualitative data are collected, concurrently or sequentially, and prioritizing refers to the weight, or relative emphasis, given to the two types of data, equal or unequal (Creswell et al., 2003; Morgan, 1998). For instance, a researcher could collect data sequentially, first collecting quantitative survey data and then collecting qualitative interview data. The interview data could then be used to corroborate, refute, or augment findings from the survey data. As a result, priority in this example would be unequal. Unequal priority occurs when a
researcher emphasizes one form of data more than the other, starts with one form as the major component of a study, or collects one form in more detail than the other (Morgan, 1998).

The third step involves deciding the point at which data analysis and integration will occur. In mixed-methods studies, data analysis and integration may occur by analyzing the data separately, by transforming them, or by connecting the analyses in some way (Caracelli & Green, 1993; Onwuegbuzie & Teddlie, 2003; Tashakkori & Teddlie, 1998). For example, a researcher could analyze the quantitative and qualitative data separately and then compare and contrast the two sets of results in the discussion. Alternatively, themes that appear in the qualitative data could be transformed into counts or ratings and be subsequently compared to the quantitative data. Another option would be to connect the data analyses. To do this, the researcher could analyze the survey data (which could be quantitative, qualitative, or both), create categorical variables that help explain the outcome variance, and conduct follow-up interviews with individuals who are representative of each of the categories (or not representative of the categories).

Research Design for this Study

Creswell et al. (2003) explain that there are six primary types of mixed-methods research designs: three sequential (explanatory, exploratory, and transformative) and three concurrent (triangulation, nested, and transformative). Each varies with respect to its use of an explicit theoretical/advocacy lens, approach to implementation (sequential or concurrent data collection procedures), priority given to the quantitative and qualitative
data (equal or unequal), stage at which the data are analyzed and integrated (separated, transformed, or connected), and procedural notations.

This study is a concurrent triangulation design. Creswell et al. (2003) argue that, just like sequential mixed-methods research designs, there are three types of concurrent designs: concurrent triangulation, concurrent nested, and concurrent transformative. In concurrent triangulation designs, quantitative and qualitative data are collected and analyzed at the same time. Priority is usually equal and given to both forms of data. Data analysis is usually separate, and integration usually occurs at the data interpretation stage. Interpretation typically involves discussing the extent to which the data triangulate or converge. These designs are useful for attempting to confirm, cross-validate, and corroborate study findings. In concurrent nested designs, like concurrent triangulation designs, quantitative and qualitative data are collected and analyzed at the same time. However, priority is usually unequal and given to one of the two forms of data—either to the quantitative or qualitative data. The nested, or embedded, forms of data are, in these designs, usually given less priority. One reason for this is that the less prioritized form of data may be included to help answer an altogether different question or set of questions. Data analysis usually involves transforming the data, and integration usually occurs during the data analysis stage. These designs are useful for gaining a broader perspective on the topic at hand and for studying different groups, or levels, within a single study. In contrast to the other two concurrent designs, concurrent transformative designs use an explicit advocacy lens (e.g., feminist perspectives, critical theory), which is usually reflected in the purpose statement, research questions, and implications for action and
change. Quantitative and qualitative data are collected and analyzed at the same time. Priority may be unequal and given to one form of data or the other or, in some cases, equal and given to both forms of data. Data analysis is usually separate, and integration usually occurs at the data interpretation stage or, if transformed, during data analysis. Similar to sequential transformative designs, these designs are useful for giving voice to diverse or alternative perspectives, advocating for research participants, and better understanding a phenomenon that may be changing as a result of being studied (Creswell et al., 2003).

Research Participants

The individuals invited to participate in this study were K-12 teachers who teach mathematics to gifted/talented students in the United States. Emails were sent to coordinators of gifted/talented programs to solicit their help with recruiting participants. The coordinators’ contact information is accessible from the National Association of Gifted Children (NAGC) website. The current NAGC database consists of about 6000 members. A second email with a link to the online survey was sent to 25 coordinators who agreed to forward the email to the teachers. The recruitment emails are shown in Appendix C.

One hundred fourteen participants completed the online survey, of which 98 were usable. The remaining 16 were only partially completed by respondents. Table 1 shows the descriptive data about the research participants. Most teachers were female, and two-thirds were over age 45. More were from urban school districts (42.7%) than suburban
(29.3%) or rural (28.0%). About two-thirds had completed ten or more credits in coursework focusing on teaching gifted students.

Table 1

Participant Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years as a G/T Teacher (N = 81)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-2</td>
<td>6</td>
<td>7.4</td>
</tr>
<tr>
<td>3-5</td>
<td>13</td>
<td>16.0</td>
</tr>
<tr>
<td>6-10</td>
<td>19</td>
<td>23.5</td>
</tr>
<tr>
<td>&gt; 10</td>
<td>43</td>
<td>53.1</td>
</tr>
<tr>
<td>Number of Credits Earned in Gifted Education (N = 81)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>11</td>
<td>13.6</td>
</tr>
<tr>
<td>1-9</td>
<td>15</td>
<td>18.5</td>
</tr>
<tr>
<td>10-40</td>
<td>31</td>
<td>38.3</td>
</tr>
<tr>
<td>&gt; 40</td>
<td>24</td>
<td>29.6</td>
</tr>
<tr>
<td>School District (N = 82)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>23</td>
<td>28.0</td>
</tr>
<tr>
<td>Suburban</td>
<td>24</td>
<td>29.3</td>
</tr>
<tr>
<td>Urban</td>
<td>35</td>
<td>42.7</td>
</tr>
</tbody>
</table>
Table 1 (continued)

**Participant Characteristics**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (N = 83)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>7</td>
<td>8.4</td>
</tr>
<tr>
<td>Female</td>
<td>76</td>
<td>91.6</td>
</tr>
<tr>
<td>Age (N = 83)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-25</td>
<td>2</td>
<td>2.4</td>
</tr>
<tr>
<td>26-34</td>
<td>7</td>
<td>8.4</td>
</tr>
<tr>
<td>35-45</td>
<td>19</td>
<td>22.9</td>
</tr>
<tr>
<td>&gt; 45</td>
<td>55</td>
<td>66.3</td>
</tr>
<tr>
<td>Race/Ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Indian/Alaskan Native</td>
<td>2</td>
<td>2.5</td>
</tr>
<tr>
<td>Asian</td>
<td>2</td>
<td>2.5</td>
</tr>
<tr>
<td>White, not of Hispanic Origin</td>
<td>77</td>
<td>95.1</td>
</tr>
</tbody>
</table>

**Instrumentation**

The survey instrument was constructed by Wiest and Ayebo (2009) based on an extensive review of the literature. The survey instrument consists of four sections: 1) characteristics of mathematically gifted/talented students; 2) identification processes; 3) instructional approaches; and 4) demographic information (see Appendix A). In the first part of the first section, participants were asked to indicate the degree to which they
agreed/disagreed with seven statements concerning characteristics of mathematical
giftedness and talent, using a five-point Likert scale (1 = strongly disagree, 2 = disagree,
3 = neutral, 4 = agree, 5 = strongly agree). The second part of the first section consists of
two open-ended questions that ask participants to state any other characteristics of
mathematical giftedness not mentioned, and to indicate whether they considered
mathematical giftedness and mathematical talent to be the same or different.

The quantitative part of the second section consists of five items. Participants
were asked to rate factors according to the order of importance in identifying
mathematical giftedness using a five-point Likert-type scale (1 = low importance; 5 = high
importance). The second part of the second section poses two open-ended questions that
ask participants to provide additional information on identification processes. The third
section of the survey follows the same format as the second, and focuses on instructional
approaches for teaching mathematics to gifted and talented students. Table 2 lists the
three research questions with the survey items intended to help answer those questions.

The fourth section solicited participant demographic information. It consisted of
seven questions pertaining to participants’ years of teaching mathematics to gifted
children, gender, type of community in which their school district was located,
race/ethnicity, and number of credits in coursework focusing on teaching gifted students.
Table 2

*Alignment of Research Questions and Survey Items*

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Survey Items</th>
</tr>
</thead>
</table>
| 1. What student characteristics do K-12 teachers identify as possible indicators of mathematical giftedness/talent? | **Quantitative Questions:**
|                                                                                 | A mathematically gifted/talented student:                                   |
|                                                                                 | is eager to solve challenging math problems and puzzles.                    |
|                                                                                 | organizes data and information to discover mathematical patterns.            |
|                                                                                 | can generate creative solutions to solve math problems.                      |
|                                                                                 | understands new math concepts and processes more easily than other students. |
|                                                                                 | attains very high test scores, including on pretests.                       |
|                                                                                 | perseveres on a task until he/she reaches a solution.                       |
|                                                                                 | displays the same characteristics cross-culturally.                         |
|                                                                                 | **Qualitative Questions:**                                                   |
|                                                                                 | In addition to the possible factors indicated in the previous questions, what student characteristics would you consider to be indicators of mathematical giftedness? |
|                                                                                 | Do you consider mathematical giftedness and mathematical talent to be the same or different? Please explain. |
Table 2 (Continued)

Alignment of Research Questions and Survey Items

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Survey Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. How are K-12 students identified as being gifted/talented in mathematics?</td>
<td><strong>Quantitative Questions:</strong></td>
</tr>
<tr>
<td></td>
<td>Please rank the following factors according to their importance in identifying mathematically gifted and talented students at your school (1 = low importance; 5 = high importance)</td>
</tr>
<tr>
<td></td>
<td>Teacher nomination</td>
</tr>
<tr>
<td></td>
<td>Parent nomination</td>
</tr>
<tr>
<td></td>
<td>Performance on mathematics achievement test(s)</td>
</tr>
<tr>
<td></td>
<td>Mathematics course grades</td>
</tr>
<tr>
<td></td>
<td>Nomination based the following (please state) :</td>
</tr>
<tr>
<td></td>
<td><strong>Qualitative Questions:</strong></td>
</tr>
<tr>
<td></td>
<td>Describe how students in your school are identified as gifted/talented in mathematics. Tell whether you think this is a good approach and why.</td>
</tr>
<tr>
<td></td>
<td>Do you think gifted/talented students might display their mathematical giftedness in different ways? If so, in what way(s)? How might this affect the identification process?</td>
</tr>
</tbody>
</table>
### Table 2 (Continued)

**Alignment of Research Questions and Survey Items**

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Survey Items</th>
</tr>
</thead>
</table>
| 3. What instructional approaches do K-12 teachers suggest to support the learning of mathematically gifted/talented students? | **Quantitative Questions:**

Please rank the following factors according to their importance in teaching mathematically gifted and talented students (1 = low importance; 5 = high importance)

Give pre-assessments so that students can proceed only with material they do not already know.

Carefully choose textbooks and other materials that provide enrichment opportunities.

Use investigative learning approaches that emphasize problems with multiple solutions or multiple paths to solutions.

Provide units, activities, or problems that extend beyond the regular curriculum.

Provide extra opportunities to participate in mathematics (e.g., clubs or contests).

**Qualitative Questions:**

In addition to the practices mentioned above, what do you think can be done to differentiate curriculum, instruction, and assessment for the mathematically gifted?

Reliability and Validity

Reliability is the extent to which an experiment, test, or any measuring procedure yields the same result on repeated trials (Gay & Airasian, 2003). Reliability is usually
calculated using a statistic called the Cronbach’s alpha, a coefficient (a number between 0 and 1) that is used to rate the internal consistency (homogeneity) or the correlation of the items in a test. Cronbach’s, alpha is calculated using the formula \( \alpha = nc / [v+(n-1)c] \), where \( n \) = number of test items; \( c \) = average inter-item covariance among items; and \( v \) = average variance. If a test has a strong internal consistency, most measurement experts agree that it should show only moderate correlation among items (0.70 to 0.90). If correlations between items are too low, it is likely that they are measuring different traits and therefore should not all be included in a test that is supposed to measure one trait. If item correlations are too high, it is likely that some items are redundant and should be removed from the test. In this study, Cronbach’s alpha coefficient for test items was 0.8, indicating that the internal consistency and reliability of the survey instrument was very good.

Validity refers to the degree to which an assessment measures what it is supposed to measure (Kaplan & Saccuzzo, 2001). According to Creswell (2003), one form of validity is “content validity which asks, ‘Do the items measure the content they were intended to measure?’” (p. 157). To address this, the instrument was sent to two experienced teachers of gifted/talented students with a review sheet (see Appendix C) to read through and offer constructive feedback. The reviewers’ feedback was considered in constructing a final version of the survey and interview questions. The feedback mainly addressed the wording and clarity of the questions. For example, survey items 3, 5 and 6 in part 1 were re-worded. Also, a survey item was deleted from part 2 because it was considered unclear and confusing.
Ethical Considerations

The University of Nevada, Reno requires that the researcher complete the Institutional Review Board (IRB) documentation and the Collaborative IRB Training Initiative (CITI) modules. The CITI certification required that the researcher complete all eight modules successfully. As researchers anticipate data collection, they need to respect the participants and the sites for research. Researchers must have their research plans reviewed by the IRB on their college and university campuses. IRB committees exist on campuses because of federal regulations that provide protection against human rights violations (Creswell, 2003). As part of the instructions to the survey, all participants were informed that their responses, as well as any identifying information, would be kept strictly anonymous.

Data Collection

When the NAGC office was contacted for email addresses of its members, the researcher was told that such a request could not be fulfilled for ethical reasons. So, emails were sent to coordinators of gifted/talented programs, soliciting their assistance with forwarding the recruitment emails to the teachers (see Appendix C for emails). To better ensure a good response, the researcher made phone calls to the consenting coordinators in advance to inform them that they would soon receive emails about the survey. After two weeks, a follow-up email was sent to remind the coordinators to forward the recruitment emails to the teachers, if they had not already done so.
Data Analysis

Descriptive statistics and the Chi-square test of independence was used to analyze the quantitative data. The most familiar use of the Chi-square test is when a researcher wants to see if there are statistical differences between the observed (actual) frequencies and the expected (hypothesized) frequencies of two variables presented in a cross-tabulation or contingency table. The larger the observed frequency is in comparison with the expected frequency, the larger the Chi-square statistic is and the more likely the difference is statistically significant (Simon & Francis, 2001). This nonparametric test is particularly useful for analyzing nominal data. Typical are cases where persons, events, or objects are grouped into two or more nominal categories such as “yes-no,” “favor-undecided-against,” or class “A, B, C, or D.” Chi-square is useful in cases of one sample analysis, two independent samples, or \( k \)-independent samples. It must be calculated with actual counts rather than percentages (Cooper & Schindler, 2003).

In order for the Chi-square test to be valid, there had to be a sufficient number of responses in each table cell. For a hypothesis in which two variables are statistically independent, the expected number of responses in each cell is calculated based on the sample size. The expected counts should all be greater than 1, and at least 80% of the cells should have expected counts greater than 5. When all categories were used, there were several cells in the tables with expected counts not large enough for a Chi-square test to be valid. Hence, responses 1 and 2 were re-coded as “Disagree”, and responses 4 and 5 were re-coded as “Agree”. Additionally, the four age categories were re-coded into 2 categories (45 years or less, and more than 45 years); categories for the number of years
spent teaching G/T students were recoded into two (five years or less, and more than five years); and so were categories for the number of credits earned in gifted education (less than ten credits and ten credits or more). When the assumption of a Chi-square test was still not met in some cases, a Fisher exact test was used instead. The Fisher exact test is a non-parametric statistic that is used to determine if there are non-random associations between two categorical variables. The formula for computing the Fisher’s exact test is as follows (Shesin, 2006):

\[
P = \frac{(a+c)!(b+d)!(a+b)!(c+d)!}{n!a!b!c!d!}
\]

where

\[
P = \text{the probability of obtaining the observed frequencies}
\]

\[
a, b, c, d = \text{the categorical frequencies observed}
\]

\[
n = \text{the sample size}
\]

For each of the Chi-square or Fisher’s exact tests conducted in this study, the level of significance was set at \( \alpha = .05 \).

Finally, sums of all responses (strongly disagree = 1, disagree = 2, neutral = 3, agree = 4, strongly agree = 5) for the quantitative survey items were computed in SPSS. A Mann-Whitney \( U \) test was used to compare the participants’ responses across the demographic variables (age, number of years teaching G/T students, and number of G/T
credits received). A Kruskal-Wallis test was used to compare participants’ responses across the three levels of the variable “school district”: rural, suburban, and urban.

Participants’ written responses, which constituted the qualitative data of the study, were first grouped into author-constructed categories or themes. Hayes cited Fowler (1998) that:

When respondents are asked to answer questions in their own words, the range of answers will not be fully predictable ahead of time. For such open-response questions, code development is an interactive process whereby the researcher identifies categories that emerge from the answers, as well as imposing order on the answers that are obtained. The idea is to create categories that group answers that are more analytically similar and to differentiate between answers that are different…One criterion for a good code is that it must unambiguously assign each answer to one and only one code number. The other criterion is that it puts answers in analytically meaningful categories (p.129).

After participants’ comments were categorized, titles were then provided to each group and responses were listed for each theme. The author read over the themes again, and similar themes were merged. The final themes were then discussed and compared with the quantitative data (Glesne, 2006).
CHAPTER 4: RESULTS

The purpose of this chapter is to report the analyzed survey data intended to help develop an understanding of teachers’ views on teaching mathematics to gifted and talented students. Data were analyzed collectively and separately by participants’ age, type of school district, number of years teaching gifted/talented students, and number of credits earned in gifted education. This chapter presents results of the analyses of both the quantitative and qualitative data collected from the participants through an online survey designed by Ayebo and Wiest (2009). This survey was completed by 114 K-12 teachers who teach mathematics to gifted/talented students in the United States and who are members of the National Association for Gifted Children (NAGC).

Quantitative and Qualitative Results

Results for each of the three research questions are presented in the following sections. Descriptive and inferential statistics were used to analyze the quantitative data, whereas content analysis was used to analyze the qualitative data.

Research Question 1: Quantitative Results

Research Question 1: What student characteristics do K-12 teachers identify as possible indicators of mathematical giftedness?

To answer this question, responses to survey 1-7 of Part 1 of the survey instrument were analyzed. Table 3 shows the descriptive statistics for each item. The ratings show that, overall, participants tended to agree with all seven characteristics of mathematical giftedness and talent listed on the survey. However, responses differed among participant demographic groups. Participants most strongly agreed that a
mathematically gifted and talented student understands new mathematics concepts and processes more easily (M = 4.46; S.D. = 0.78). Item 7 (a mathematically gifted/talented student displays the same characteristics cross-culturally) received the lowest rating (M = 3.24; S.D. = 1.01).

Table 3
Mean and Standard Deviation for Part 1a Survey Items: Characteristics of Mathematically Gifted/Talented Students

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>N</th>
<th>M</th>
<th>S D</th>
</tr>
</thead>
<tbody>
<tr>
<td>A mathematically gifted/talented student</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>is eager to solve challenging math problems and puzzles</td>
<td>101</td>
<td>4.11</td>
<td>1.02</td>
</tr>
<tr>
<td>organizes data and information to discover math patterns</td>
<td>101</td>
<td>3.95</td>
<td>0.94</td>
</tr>
<tr>
<td>can generate creative solutions to math problems</td>
<td>99</td>
<td>4.40</td>
<td>0.73</td>
</tr>
<tr>
<td>understands new math concepts and processes more easily</td>
<td>101</td>
<td>4.46</td>
<td>0.78</td>
</tr>
<tr>
<td>attains very high test scores, including on pretests</td>
<td>100</td>
<td>3.50</td>
<td>1.00</td>
</tr>
<tr>
<td>perseveres on a task until he/she reaches a solution</td>
<td>100</td>
<td>3.59</td>
<td>1.01</td>
</tr>
<tr>
<td>displays the same characteristics cross-culturally</td>
<td>99</td>
<td>3.24</td>
<td>1.05</td>
</tr>
</tbody>
</table>

Research Question 1 by Age

Descriptive statistics were calculated for research question 1 by participant age. The categories “Strongly Disagree” and “Disagree” were re-coded into one category, “Disagree,” and the categories “Strongly Agree” and “Agree” were re-coded into a single category, “Agree,” as shown in table 4a. Both younger and older teachers rated items 2, 3 and 5 favorably. For all other items, older teachers tended to agree more with each statement than the younger teachers. In analyzing the data by age, a Chi-square test or
Fisher Exact test revealed that there was no significant difference between younger and older teachers on how survey items 1-7 of part 1 were rated (Table 4b).

Table 4a

*Descriptive Statistics for Research Question 1 by Age*

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Age Category</th>
<th>N</th>
<th>Disagree (%)</th>
<th>Agree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>45 or less</td>
<td>23</td>
<td>17</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>More than 45</td>
<td>51</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>2</td>
<td>45 or less</td>
<td>21</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>More than 45</td>
<td>50</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>3</td>
<td>45 or less</td>
<td>26</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>More than 45</td>
<td>53</td>
<td>2</td>
<td>98</td>
</tr>
<tr>
<td>4</td>
<td>45 or less</td>
<td>27</td>
<td>4</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>More than 45</td>
<td>53</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>45 or less</td>
<td>22</td>
<td>27</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>More than 45</td>
<td>45</td>
<td>26</td>
<td>74</td>
</tr>
<tr>
<td>6</td>
<td>45 or less</td>
<td>22</td>
<td>32</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>More than 45</td>
<td>45</td>
<td>16</td>
<td>84</td>
</tr>
<tr>
<td>7</td>
<td>45 or less</td>
<td>22</td>
<td>45</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>More than 45</td>
<td>40</td>
<td>30</td>
<td>70</td>
</tr>
</tbody>
</table>
Table 4b

Chi-Square/Fisher Exact Test for Research Question 1 by Age

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>d.f.</th>
<th>$X^2$</th>
<th>$p$</th>
<th>Fisher’s Exact Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>A mathematically gifted/talented student is eager to solve challenging math problems and puzzles</td>
<td>1</td>
<td>.85</td>
<td>.36</td>
<td>.45</td>
</tr>
<tr>
<td>organizes data and information to discover math patterns</td>
<td>1</td>
<td>.004</td>
<td>.95</td>
<td>.66</td>
</tr>
<tr>
<td>can generate creative solutions to math problems</td>
<td>1</td>
<td>.50</td>
<td>.48</td>
<td>.67</td>
</tr>
<tr>
<td>understands new math concepts and processes more easily</td>
<td>1</td>
<td>1.99</td>
<td>.16</td>
<td>.34</td>
</tr>
<tr>
<td>attains very high test scores, including on pretests</td>
<td>1</td>
<td>.003</td>
<td>.96</td>
<td>.59</td>
</tr>
<tr>
<td>perseveres on a task until he/she reaches a solution</td>
<td>1</td>
<td>2.36</td>
<td>.12</td>
<td>.20</td>
</tr>
<tr>
<td>displays the same characteristics cross-culturally</td>
<td>1</td>
<td>1.48</td>
<td>.22</td>
<td>.27</td>
</tr>
</tbody>
</table>

Research Question 1 by Number of Credits Earned in G/T Education

Descriptive statistics for research question 1 by number of credits earned in gifted education are shown in table 5a. Items 3 and 4 received the most favorable ratings from both teachers with less than 10 credits and teachers with 10 or more credits. Participants were more divided on all other questions. In analyzing the data by age, a Chi-square test or Fisher Exact test revealed that there was no significant difference between teachers with less than 10 credits and teachers with 10 or more credits on how survey items 1-7 of part 1 were rated (Table 5b).
Table 5a

*Descriptive Statistics for Question 1 by Number of Credits Earned in G/T Education*

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Number of credits earned in gifted education</th>
<th>N</th>
<th>Disagree (%)</th>
<th>Agree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>less than 10 credits</td>
<td>23</td>
<td>13</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td>10 or more credits</td>
<td>49</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>2</td>
<td>less than 10 credits</td>
<td>21</td>
<td>14</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>10 or more credits</td>
<td>48</td>
<td>8</td>
<td>92</td>
</tr>
<tr>
<td>3</td>
<td>less than 10 credits</td>
<td>24</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>10 or more credits</td>
<td>53</td>
<td>2</td>
<td>98</td>
</tr>
<tr>
<td>4</td>
<td>less than 10 credits</td>
<td>26</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>10 or more credits</td>
<td>52</td>
<td>2</td>
<td>98</td>
</tr>
<tr>
<td>5</td>
<td>less than 10 credits</td>
<td>19</td>
<td>16</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>10 or more credits</td>
<td>46</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>6</td>
<td>less than 10 credits</td>
<td>19</td>
<td>21</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>10 or more credits</td>
<td>47</td>
<td>21</td>
<td>79</td>
</tr>
<tr>
<td>7</td>
<td>less than 10 credits</td>
<td>17</td>
<td>35</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>10 or more credits</td>
<td>45</td>
<td>36</td>
<td>64</td>
</tr>
</tbody>
</table>
Table 5b

Chi-Square/Fisher Exact Test for Research Question 1 by Number of Credits Earned in G/T Education

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>d.f.</th>
<th>$X^2$</th>
<th>$p$</th>
<th>Fisher’s Exact Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>A mathematically gifted/talented student is eager to solve challenging math problems and puzzles</td>
<td>1</td>
<td>.13</td>
<td>.72</td>
<td>.70</td>
</tr>
<tr>
<td>organizes data and information to discover math patterns</td>
<td>1</td>
<td>.57</td>
<td>.45</td>
<td>.67</td>
</tr>
<tr>
<td>can generate creative solutions to math problems</td>
<td>1</td>
<td>.46</td>
<td>.50</td>
<td>1.00</td>
</tr>
<tr>
<td>understands new math concepts and processes more easily</td>
<td>1</td>
<td>.51</td>
<td>.47</td>
<td>1.00</td>
</tr>
<tr>
<td>attains very high test scores, including on pretests</td>
<td>1</td>
<td>1.49</td>
<td>.22</td>
<td>.35</td>
</tr>
<tr>
<td>perseveres on a task until he/she reaches a solution</td>
<td>1</td>
<td>0.00</td>
<td>.98</td>
<td>1.00</td>
</tr>
<tr>
<td>displays the same characteristics cross-culturally</td>
<td>1</td>
<td>0.00</td>
<td>.99</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Research Question 1 by Years of Teaching G/T Students

Descriptive statistics for research question 1 by years of teaching G/T students is shown in table 6a. Items 1, 3 and 4 received the most favorable ratings overall from both more experienced and less experienced teachers. For all other items, less experienced and more experienced teachers were somewhat divided on how they rated items. In analyzing the data by age, a Chi-square test or Fisher Exact test revealed that there was no significant difference between less experienced and more experienced teachers on how survey items 1-7 of part 1 were rated (Table 6b).
Table 6a

*Descriptive Statistics for Research Question 1 by Years of Teaching G/T Students*

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Years of teaching</th>
<th>N</th>
<th>Disagree (%)</th>
<th>Agree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5 years or less</td>
<td>17</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>more than 5 years</td>
<td>55</td>
<td>16</td>
<td>84</td>
</tr>
<tr>
<td>2</td>
<td>5 years or less</td>
<td>15</td>
<td>13</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td>more than 5 years</td>
<td>54</td>
<td>9</td>
<td>91</td>
</tr>
<tr>
<td>3</td>
<td>5 years or less</td>
<td>18</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>more than 5 years</td>
<td>59</td>
<td>2</td>
<td>98</td>
</tr>
<tr>
<td>4</td>
<td>5 years or less</td>
<td>19</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>more than 5 years</td>
<td>59</td>
<td>2</td>
<td>98</td>
</tr>
<tr>
<td>5</td>
<td>5 years or less</td>
<td>17</td>
<td>18</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>more than 5 years</td>
<td>48</td>
<td>31</td>
<td>69</td>
</tr>
<tr>
<td>6</td>
<td>5 years or less</td>
<td>14</td>
<td>29</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>more than 5 years</td>
<td>51</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>7</td>
<td>5 years or less</td>
<td>16</td>
<td>38</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>more than 5 years</td>
<td>44</td>
<td>36</td>
<td>64</td>
</tr>
</tbody>
</table>
Table 6b

*Chi-Square /Fisher Exact Test for Research Question 1 by Years of Teaching G/T*

**Students**

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>d.f.</th>
<th>$X^2$</th>
<th>$p$</th>
<th>Fisher’s Exact Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>A mathematically gifted/talented student</td>
<td>1</td>
<td>3.18</td>
<td>.08</td>
<td>.10</td>
</tr>
<tr>
<td>is eager to solve challenging math problems and puzzles</td>
<td>1</td>
<td>.21</td>
<td>.64</td>
<td>.64</td>
</tr>
<tr>
<td>organizes data and information to discover math patterns</td>
<td>1</td>
<td>.31</td>
<td>.58</td>
<td>1.00</td>
</tr>
<tr>
<td>can generate creative solutions to math problems</td>
<td>1</td>
<td>.33</td>
<td>.57</td>
<td>1.00</td>
</tr>
<tr>
<td>understands new math concepts and processes more easily</td>
<td>1</td>
<td>1.16</td>
<td>.28</td>
<td>.36</td>
</tr>
<tr>
<td>attains very high test scores, including on pretests</td>
<td>1</td>
<td>.52</td>
<td>.47</td>
<td>.48</td>
</tr>
<tr>
<td>perseveres on a task until he/she reaches a solution</td>
<td>1</td>
<td>0.01</td>
<td>.94</td>
<td>1.00</td>
</tr>
<tr>
<td>displays the same characteristics cross-culturally</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Research Question 1 by School District Type*

Descriptive statistics for research question 1 by school district are shown in table 7a. Items 3 and 4 received the most favorable ratings from teachers across school district type. Across items, suburban teachers tended to rate the mathematically gifted/talented characteristics more favorably than the other two groups. Ratings indicating weakest agreement were assigned by urban teachers for items 6 and 7 (task perseverance, cross cultural characteristics). In analyzing the data by school district, a Chi-square test
revealed that there were no significant differences among teachers on how survey items 1-7 of part 1 were rated (Table 7b), although item 6 approached significance.
Table 7a

*Descriptive Statistics for Question 1 by School District*

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>School District</th>
<th>N</th>
<th>Disagree (%)</th>
<th>Agree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rural</td>
<td>19</td>
<td>21</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>Suburban</td>
<td>23</td>
<td>9</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>31</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>2</td>
<td>Rural</td>
<td>19</td>
<td>16</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Suburban</td>
<td>21</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>30</td>
<td>13</td>
<td>87</td>
</tr>
<tr>
<td>3</td>
<td>Rural</td>
<td>21</td>
<td>5</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Suburban</td>
<td>24</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>33</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>Rural</td>
<td>22</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Suburban</td>
<td>24</td>
<td>4</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>33</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>Rural</td>
<td>16</td>
<td>31</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>Suburban</td>
<td>18</td>
<td>22</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>32</td>
<td>28</td>
<td>72</td>
</tr>
<tr>
<td>6</td>
<td>Rural</td>
<td>19</td>
<td>21</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>Suburban</td>
<td>20</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>27</td>
<td>33</td>
<td>67</td>
</tr>
<tr>
<td>7</td>
<td>Rural</td>
<td>14</td>
<td>29</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>Suburban</td>
<td>18</td>
<td>28</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>29</td>
<td>41</td>
<td>59</td>
</tr>
</tbody>
</table>
Table 7b

Chi-Square Test for Research Question 1 by School District Type

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>d.f.</th>
<th>$X^2$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>A mathematically gifted/talented student</td>
<td>2</td>
<td>1.82</td>
<td>.40</td>
</tr>
<tr>
<td>is eager to solve challenging math problems and puzzles</td>
<td>2</td>
<td>3.41</td>
<td>.18</td>
</tr>
<tr>
<td>organizes data and information to discover math patterns</td>
<td>2</td>
<td>2.75</td>
<td>.25</td>
</tr>
<tr>
<td>can generate creative solutions to math problems</td>
<td>2</td>
<td>2.32</td>
<td>.31</td>
</tr>
<tr>
<td>understands new math concepts and processes more easily</td>
<td>2</td>
<td>.37</td>
<td>.83</td>
</tr>
<tr>
<td>attains very high test scores, including on pretests</td>
<td>2</td>
<td>8.10</td>
<td>.06</td>
</tr>
<tr>
<td>perseveres on a task until he/she reaches a solution</td>
<td>2</td>
<td>1.19</td>
<td>.55</td>
</tr>
<tr>
<td>displays the same characteristics cross-culturally</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mann-Whitney and Kruskal-Wallis Test on Research Question 1

A Mann-Whitney $U$ test indicates that participants’ responses to the survey part 1 (characteristics of mathematical giftedness and talent) differ significantly between younger and older teachers ($U = 543, p = .046$). The older teachers rated items in part 1 more favorably than the younger teachers. Participant responses do not differ significantly by number of credits earned in gifted education ($U = 536.5, p > .05$) or number of years teaching gifted and talented students ($U = 487, p > .05$). A Kruskal-
Wallis test indicates that participants’ responses do not differ significantly by school district type ($p > .05$).

**Research Question 1: Qualitative Results**

In this section, participants’ written responses that accompanied each of the seven Likert survey questions, as well as the two open-ended questions, were analyzed. Major themes across all the responses were summarized.

*Research Question 1: What student characteristics do K-12 teachers identify as possible indicators of mathematical giftedness?*

This question was answered in two parts. First, participants’ comments explaining their ratings for the survey questions were examined. Second, participants’ responses to the open-ended questions in part 1 were analyzed for themes. These questions were: “In addition to the possible factors indicated in the previous questions, what student characteristics would you consider to be indicators of mathematical giftedness?” (Part 1b Question 1), and “Do you consider mathematical giftedness and mathematical talent to be the same or different? Please explain.” (Part 1b Question 2). The number of written comments that accompanied participants’ ratings ranged among survey items from 37 (33%) to 71 (62%). Responses to the open-ended questions ranged from 73 (64%) to 77 (68%) (see Table 8).
Table 8

*Participant Response Numbers for Written Portions of Survey Instrument Part 1*

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Number of Written Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part 1a (Likert-type Items)</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>71 (62%)</td>
</tr>
<tr>
<td>2</td>
<td>68 (62%)</td>
</tr>
<tr>
<td>3</td>
<td>55 (48%)</td>
</tr>
<tr>
<td>4</td>
<td>48 (42%)</td>
</tr>
<tr>
<td>5</td>
<td>52 (46%)</td>
</tr>
<tr>
<td>6</td>
<td>50 (44%)</td>
</tr>
<tr>
<td>7</td>
<td>37 (33%)</td>
</tr>
<tr>
<td><strong>Part 1b (Open-Ended Items)</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>77 (68%)</td>
</tr>
<tr>
<td>2</td>
<td>73 (64%)</td>
</tr>
</tbody>
</table>
Participants’ Comments Explaining Ratings

*Item 1*: A mathematically gifted/talented student is eager to solve challenging math problems and puzzles.

Seventy-one participants wrote comments explaining their rating for survey item 1. Most wrote that this statement is true only if the students are sufficiently challenged. Others mentioned that mathematically gifted/talented students easily get frustrated if they do not get perfect answers. Sample comments include:

- Most [mathematically gifted/talented] students like to be challenged.
- They love the challenge but sometimes get frustrated if their answers are not perfect!
- If only [the lessons] are presented in a valued and exciting manner.

One participant however disagreed with the statement, stating that “[mathematically gifted] students do not always exhibit eagerness toward math”, and another participant simply said, “They are lazy”.

*Item 2*: A mathematically gifted/talented student organizes data and information to discover mathematical patterns.

Sixty-eight participants wrote comments on this item. Most participants who wrote comments stated that although mathematically gifted students can discover mathematical patterns, they only do so in their head. Sample written comments include:

- Mostly that’s true. However, the student may only do this in his head!
- They tend to do everything in their brains and prefer not to work info out.
Based on my classroom observations, not all my mathematically gifted students will organize their data. Many are able to make leaps of intellect, imagination, mathematical intuition. If they are confident in their skill, then often, their conclusion is correct.

Item 3: A mathematically gifted/talented student can generate creative solutions to mathematics problems.

Fifty-five participants wrote comments on this item. Most participants indicated that while this statement is mostly true of all mathematically gifted/talented students, individual differences and experiences also played a role. For example, one participant noted: “It depends on their prior experiences and their comfort level with risk-taking behavior.” Another participant wrote: “Some students are only abstract thinkers. You have to take into consideration the fact that some gifted students are just plain black and white, while others view problems through a colored kaleidoscope.” Still another wrote, “Some [mathematically gifted/talented students] are process oriented, while others think outside the box.”

Item 4: A mathematically gifted/talented student understands new math concepts and processes more easily than other students.

Forty-eight participants wrote comments on this item. Most participants concurred with the statement, as exemplified by comments such as: “Because they really understand the math, not just a rote method of doing problems, gifted math students understand and process new information more quickly and easily” and “I often spend one to two days on a new concept with a spiral review. Regular classes may spend up to a week or more on
the same concept.” Another participant mentioned that this can be more evident when mathematically gifted/talented students are allowed to work on their own in a non-threatening environment, as this reduces the pressure from competition with their peers. She wrote: “When allowed to work in a non-threatening environment with direct guidance. One on one attention is extremely beneficial to these students. They tend to become competitive and insecure in groups of GT peers, especially at 4th-8th grade levels.”

*Item 5*: A mathematically gifted/talented student attains very high test scores, including on pretests.

Fifty-two participants wrote comments on this survey item. Participants opinions were divided on this item. Those who agreed argued that because mathematically gifted/talented students are mostly perfectionists, they would do everything possible to excel on all tests. Participants who disagreed with the statement pointed out that although a person may be gifted and talented in mathematics, if he/she lacks motivation and/or test-taking skills, he/she will not necessarily perform well on tests. For example, one participant wrote: “Mathematically gifted students who are motivated by grades will do well, while others, to whom grades don’t matter, or those who aren’t particularly stimulated by the tested area, won’t always attain high scores.”

*Item 6*: A mathematically gifted/talented student perseveres on a task until he/she reaches a solution.

Fifty participants wrote comments on this survey item. The general consensus from participants was that this statement was mostly true for mathematically
gifted/talented students, unless they are stretched to beyond their limit. One participant wrote:

- I mostly agree, but I would qualify my answer with the following: students who have learned how to attack problems will persevere. Many mathematically gifted/talented students have never had to learn to solve problems; they just know.
- It is not unusual for those students, faced with an entirely new challenge, to come to a screeching halt, because they haven’t learned how to learn.

Another participant stated that rather than persevere and take a chance on getting the problem wrong, some mathematically gifted/talented students would not do the problem at all. She wrote:

I think only a small portion of gifted children do this at the age I teach (grades 8-10). Because math comes easily to them, they haven’t developed the coping skills to persevere through something that is challenging. If it’s too hard, they will shut down, because to them, not doing it is better than the chance of being wrong.

Item 7: A mathematically gifted/talented student displays the same characteristics cross-culturally.

Thirty-seven participants wrote comments on this survey item. Most participants were unsure about the answer to this item, because their classrooms were not diverse. Some agreed with the statement, with comments such as:

- A truly mathematically gifted student will have many of the same characteristics no matter what their culture is. However, some have grown up in cultures that did
not value mathematics, or education in general, as much as other cultures.

Likewise, some cultures put much more emphasis on success in education and mathematics specifically. Even within one culture, there are variations of characteristics in mathematically gifted students.

Other participants had a strong opinion that mathematically gifted students do not display the same characteristics cross-culturally. Sample comments are:

- Culture is a huge factor on how mathematical talent is expressed.
- Characteristics such as persistence in solving problems is often affected by culture. There are differences in performance that are related to cultural factors such as race and socio-economic environment.
- Mathematical talent can be displayed in different ways due to cultural influences.

Open-Ended Questions on Part 1

The first open-ended question posed in Part 1 was: “In addition to the possible factors indicated in the previous questions, what student characteristics would you consider to be indicators of mathematical giftedness?” Participants’ written comments produced the following themes: problem solvers, independent learners, and high-level thinkers.

Problem Solvers: In describing the traits of mathematical giftedness, most participants mentioned that mathematically gifted students tend to be problem solvers and always strive to relate what they learn to the real world. The following sample participants’ comments illustrate this point:
• Mathematical giftedness is the ability to comprehend basic number sense early and easily and...connect math to real world solutions – to see the connections and transfer what they learn in class to other situations.

• …application of critical thinking skills in the problem solving process, unique responses and problem solving strategies, applies new concepts to different learning situations.

• …mathematical solutions applied to all areas of life.

• …ability to see/make connections between things (even outside of math that aren’t immediately obvious and that other students might not see until it is explained to them. Being able to transfer complex concepts to other situations.

The ability to investigate new ways of solving a problem.

• Creative problem solvers.

Independent learners: Independence was another trait that was used to describe mathematically gifted students. Some written comments are shown below:

• Mathematically gifted students are generally much more inquisitive about things but prefer to do independent investigation rather than be fed or led to the answer.

• Mathematically gifted students tend to like to work by themselves.

High-level thinkers: The majority of participants stated that mathematically gifted students are high-level thinkers. Sample comments include:

• They think outside the box.

• They ask high level questions about the problem and seek to go above and beyond to be challenged.
The second open-ended question was: “Do you consider mathematical giftedness and mathematical talent to be the same or different?”

Participants were divided on whether or not being mathematically gifted and being mathematically talented meant the same thing but tended toward seeing them as being different. Of the 77 participants who answered this question, 24 (32%) thought mathematical giftedness and mathematical talent were the same, and 53 (68%) said they were different. Those who said mathematical giftedness and mathematical talent were the same argued that it was only a question of the degree of being gifted that separated the two and that the two terms could be used interchangeably. For instance, Participant 7: “I think of someone who possesses high degrees of mathematical talent to be mathematically gifted. The two terms are for the most part interchangeable.” Participants who said mathematical giftedness and mathematical talent are different stated that a gifted person is one who has in-born mathematics potential, whereas a talented person is one who excels in math by virtue of hard work and discipline. Sample comments from these participants are shown below:

- Giftedness requires more innate ability and talent can be learned…Math giftedness implies creative thinking and ability to see relationships/patterns, while talent indicates ability to do math.
- I believe that talent covers a larger population. These students are high performers in learning and doing. They are your typical high achievers that do very well. The giftedness is a smaller population. These students may or may not be high performers, but they naturally see things that the average person does not see.
They look at math in a way that would be confusing to the majority. They may have behavior and social problems. These students are the ones where you will see new inventions created and answers to problems that have stumped us for many years.

Summary of Results for Research Question 1

Quantitative analysis: Seven survey items were analyzed in order to answer Research Question 1: “What student characteristics do K-12 teachers identify as possible indicators of mathematical giftedness?” Participants’ ratings were reported collectively, and by age, number of credits earned in gifted/talented education, number of years teaching gifted/talented students, and school district. A Chi-square test of independence and Fisher Exact test were computed for all survey items, using SPSS for Windows. An alpha level of .05 was used to determine whether there were significant differences among subgroups for each survey item. No statistically significant differences were found in any of the seven survey questions by age, number of credits earned in gifted education, number of years teaching gifted/talented students, or school district type.

Qualitative analysis: The number of written comments that accompanied participants’ ratings ranged from 37 (33%) to 71 (62%). Participants’ written responses to the open-ended questions ranged from 73 (64%) to 77 (68%). In addition to possible descriptors offered in the survey for mathematically gifted/talented students, participants suggested that these students are problem solvers, independent learners, and high-level thinkers. They were divided on whether mathematical giftedness and talent are the same but tended to see them as different.
Research Question 2: Quantitative Analysis

Research Question 2: How are K-12 students identified as being gifted/talented in mathematics?

To answer this question, responses to survey items 1-4 of Part 2 of the survey instrument were analyzed. Table 9 shows the mean and standard deviation for each item. Participants tended to rate performance on mathematics achievement tests as the best way of identifying mathematically gifted/talented students (M = 4.15, S.D. = 1.07), while parent nomination was rated lowest (M = 2.84, S.D. = 1.20).

Table 9

*Mean and Standard Deviation for Part 2a Survey Items: Characteristics Mathematically Gifted/Talented Students*

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification of mathematically gifted students</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher nomination</td>
<td>95</td>
<td>3.69</td>
<td>1.16</td>
</tr>
<tr>
<td>Parent nomination</td>
<td>94</td>
<td>2.84</td>
<td>1.20</td>
</tr>
<tr>
<td>Performance on mathematics achievement test(s)</td>
<td>93</td>
<td>4.15</td>
<td>1.07</td>
</tr>
<tr>
<td>Mathematics course grades</td>
<td>94</td>
<td>3.24</td>
<td>1.10</td>
</tr>
</tbody>
</table>

Research Question 2 by Age

Descriptive statistics for research question 2 by age are shown in Table 10a. Most participants tended to agree with all identification procedures for mathematically gifted/talented students except for item 2: parent nomination. Older teachers tended to agree that parent nomination was important in identifying mathematically gifted/talented students, whereas younger teachers disagreed. In analyzing the data by age, a Chi-square test or
Fisher Exact test revealed that there was a significant difference between younger and older teachers on how they rated survey item 2 of Part 2 (parent nomination), \((p < .05)\), but no significant difference was found on how items 1, 3 and 4 were rated (see Table 10b).

Table 10a

*Descriptive Statistics for Research Question 2 Survey Items by Age*

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Age Category</th>
<th>N</th>
<th>Disagree (%)</th>
<th>Agree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>45 or less</td>
<td>21</td>
<td>29</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>more than 45</td>
<td>41</td>
<td>12</td>
<td>88</td>
</tr>
<tr>
<td>2</td>
<td>45 or less</td>
<td>21</td>
<td>71</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>more than 45</td>
<td>33</td>
<td>39</td>
<td>61</td>
</tr>
<tr>
<td>3</td>
<td>45 or less</td>
<td>24</td>
<td>4</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>more than 45</td>
<td>45</td>
<td>9</td>
<td>91</td>
</tr>
<tr>
<td>4</td>
<td>45 or less</td>
<td>20</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>more than 45</td>
<td>31</td>
<td>32</td>
<td>68</td>
</tr>
</tbody>
</table>
Table 10b

*Chi-Square/Fisher Exact Test for Research Question 2 by Age*

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>d.f.</th>
<th>$X^2$</th>
<th>$p$</th>
<th>Fisher’s Exact Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher nomination</td>
<td>1</td>
<td>2.55</td>
<td>.11</td>
<td>.16</td>
</tr>
<tr>
<td>Parent nomination</td>
<td>1</td>
<td>5.28</td>
<td>.02*</td>
<td>.02*</td>
</tr>
<tr>
<td>Performance on math test(s)</td>
<td>1</td>
<td>.52</td>
<td>.47</td>
<td>.65</td>
</tr>
<tr>
<td>Math course grades</td>
<td>1</td>
<td>0.03</td>
<td>.87</td>
<td>1.00</td>
</tr>
</tbody>
</table>

* $p < .05$

*Research Question 2 by Years of Teaching G/T students*

Descriptive statistics for research question 2 by years of teaching gifted/talented students are shown in Table 11a. With the exception of item 2, where participants were split on their ratings, the majority of participants for both categories (less than five years of teaching experience and five years or more teaching experience) tended to agree with the listed items as effective identification procedures. In analyzing the data by years of teaching gifted/talented students, a Chi-square test or Fisher Exact test revealed that there was no significant difference between more experienced and less experienced teachers on how they rated survey item 2 of Part 2 (see Table 11b).
### Table 11a

*Descriptive Statistics for Research Question 2 Survey Items by Years of Teaching G/T students*

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Years of teaching</th>
<th>N</th>
<th>Disagree (%)</th>
<th>Agree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5 years or less</td>
<td>15</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>more than 5 years</td>
<td>46</td>
<td>17</td>
<td>83</td>
</tr>
<tr>
<td>2</td>
<td>5 years or less</td>
<td>14</td>
<td>57</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>more than 5 years</td>
<td>39</td>
<td>49</td>
<td>51</td>
</tr>
<tr>
<td>3</td>
<td>5 years or less</td>
<td>14</td>
<td>7</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>more than 5 years</td>
<td>54</td>
<td>7</td>
<td>93</td>
</tr>
<tr>
<td>4</td>
<td>5 years or less</td>
<td>11</td>
<td>27</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>more than 5 years</td>
<td>39</td>
<td>33</td>
<td>67</td>
</tr>
</tbody>
</table>

### Table 11b

*Chi-Square /Fisher Exact Test for Research Question 2 Survey Items by Years of Teaching G/T students*

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>d.f.</th>
<th>$X^2$</th>
<th>$p$</th>
<th>Fisher’s Exact Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher nomination</td>
<td>1</td>
<td>.05</td>
<td>.82</td>
<td>1.00</td>
</tr>
<tr>
<td>Parent nomination</td>
<td>1</td>
<td>.29</td>
<td>.59</td>
<td>.76</td>
</tr>
<tr>
<td>Performance on math test(s)</td>
<td>1</td>
<td>.00</td>
<td>.97</td>
<td>1.00</td>
</tr>
<tr>
<td>Math course grades</td>
<td>1</td>
<td>0.15</td>
<td>.70</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Research Question 2 by Number of Credits Earned in Gifted Education

Descriptive statistics for research question 2 by number of credits earned in gifted education is shown in Table 12a. Majority of all participants tended to agree with all four identification methods. In analyzing the data by number of credits earned in gifted education, a Chi-square test or Fisher Exact test revealed that there was no significant difference on how all four items were rated (see Table 12b).

Table 12a

Descriptive Statistics for Research Question 2 Survey Items by Number of Credits Earned in Gifted Education

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Number of credits earned in gifted education</th>
<th>N</th>
<th>Disagree (%)</th>
<th>Agree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>less than 10 credits</td>
<td>18</td>
<td>22</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>10 or more credits</td>
<td>43</td>
<td>16</td>
<td>64</td>
</tr>
<tr>
<td>2</td>
<td>less than 10 credits</td>
<td>18</td>
<td>8</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>10 or more credits</td>
<td>34</td>
<td>44</td>
<td>56</td>
</tr>
<tr>
<td>3</td>
<td>less than 10 credits</td>
<td>21</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>10 or more credits</td>
<td>46</td>
<td>7</td>
<td>93</td>
</tr>
<tr>
<td>4</td>
<td>less than 10 credits</td>
<td>36</td>
<td>6</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>10 or more credits</td>
<td>36</td>
<td>17</td>
<td>83</td>
</tr>
</tbody>
</table>
Table 12b:

Chi-Square /Fisher Exact Test for Research Question 2 Survey Items by Years of Teaching G/T Students

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>d.f.</th>
<th>$X^2$</th>
<th>$p$</th>
<th>Fisher’s Exact Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher nomination</td>
<td>1</td>
<td>.30</td>
<td>.58</td>
<td>.72</td>
</tr>
<tr>
<td>Parent nomination</td>
<td>1</td>
<td>.98</td>
<td>.32</td>
<td>.39</td>
</tr>
<tr>
<td>Performance on math test(s)</td>
<td>1</td>
<td>.19</td>
<td>.66</td>
<td>.65</td>
</tr>
<tr>
<td>Math course grades</td>
<td>1</td>
<td>.39</td>
<td>.70</td>
<td>.51</td>
</tr>
</tbody>
</table>

Research Question 2 by School District Type

Descriptive statistics for research question 2 survey items by school district type are shown in Table 13a. The majority of participants tended to agree with all four identification methods with the exception of item 2, where teachers who teach in urban schools tended to disagree. Also, teachers who teach in rural schools were evenly split on items 2 and 4. In analyzing the data by school district type, a Chi-square test or Fisher Exact test revealed that there was no significant difference among participant groups on any of the four items (see Table 13b).
Table 13a

*Descriptive Statistics for Research Question 2 Survey Items by School District Type*

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>School District</th>
<th>N</th>
<th>Disagree (%)</th>
<th>Agree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rural</td>
<td>16</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Suburban</td>
<td>18</td>
<td>28</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>27</td>
<td>19</td>
<td>22</td>
</tr>
<tr>
<td>2</td>
<td>Rural</td>
<td>16</td>
<td>50</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Suburban</td>
<td>18</td>
<td>44</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>19</td>
<td>63</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>Rural</td>
<td>21</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Suburban</td>
<td>23</td>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>24</td>
<td>8</td>
<td>22</td>
</tr>
<tr>
<td>4</td>
<td>Rural</td>
<td>12</td>
<td>50</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Suburban</td>
<td>16</td>
<td>19</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>23</td>
<td>7</td>
<td>16</td>
</tr>
</tbody>
</table>
Table 13b

*Chi-Square /Fisher Exact Test for Research Question 2 by School District*

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>d.f.</th>
<th>$X^2$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher nomination</td>
<td>2</td>
<td>6.66</td>
<td>.26</td>
</tr>
<tr>
<td>Parent nomination</td>
<td>2</td>
<td>1.37</td>
<td>.50</td>
</tr>
<tr>
<td>Performance on math test(s)</td>
<td>2</td>
<td>.48</td>
<td>.79</td>
</tr>
<tr>
<td>Math course grades</td>
<td>2</td>
<td>3.13</td>
<td>.21</td>
</tr>
</tbody>
</table>

*Mann-Whitney/Kruskal-Wallis Test on Research Question 2*

A Mann-Whitney U test indicates that participants’ responses to items on part 2 of the survey instrument do not differ significantly between teachers by age ($U = 605$, $p > .05$); number of credits earned in gifted education ($U = 537.5$, $p > .05$); and number of years teaching gifted and talented students ($U = 515.5$, $p > .05$). A Kruskal-Wallis test indicates that participants’ responses do not differ significantly among school districts ($p > .05$).

Research Question 2: Qualitative Analysis

*Research Question 2*: How are K-12 students identified as being gifted/talented in mathematics?

This question was answered in two parts. First, participants’ comments explaining their ratings to the survey questions were examined. Second, participants’ responses to the open-ended questions in part 2 were analyzed. The number of written comments that accompanied participants’ ratings ranged from
65 (57%) to 68 (60%) across Part 2 survey items. Responses to the open-ended questions ranged from 74 (65%) to 77 (68%) (see Table 14).

Table 14

Participant Response Numbers for Written Portions of Survey Instrument Part 2

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Number of written comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part 2a (Likert-Type Items)</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>65 (57%)</td>
</tr>
<tr>
<td>2</td>
<td>68 (60%)</td>
</tr>
<tr>
<td>3</td>
<td>68 (60%)</td>
</tr>
<tr>
<td>4</td>
<td>67 (59%)</td>
</tr>
<tr>
<td><strong>Part 2b (Open-Ended Items)</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>74 (65%)</td>
</tr>
<tr>
<td>2</td>
<td>77 (68%)</td>
</tr>
<tr>
<td>3</td>
<td>77 (68%)</td>
</tr>
</tbody>
</table>

Participants’ Comments Explaining Ratings

*Teacher Nomination*

Participants commented that teacher nomination is often but not always an effective way of identifying mathematically gifted/talented students, as some students try
to please the teacher in order to be nominated. One participant wrote: “Typical classroom teachers often nominate the ‘teacher pleasers’ and those referred to in the literature as ‘bright’, but not necessarily ‘gifted’ due to their typical compliant behaviors in the classroom.” Another participant concurred: “Teachers tend to be slow to nominate a student for gifted programs because he/she may not be your typical ‘good’ student. They think they should be the high performers with no behavior problems.” A teacher also noted, “An experienced teacher who understands the difference between ‘teacher pleasers’ and giftedness is an excellent authority.” Other participants mentioned that teachers usually identify students who are disciplined and hardworking, although these students might not necessarily be gifted/talented in mathematics.

*Parent Nomination*

Most participants contended that relying solely on parent nomination is not always helpful in identifying truly gifted/talented students in mathematics, as these parents do not necessarily have the training to identify mathematical giftedness. For example, one participant wrote: “Parents, while good at noting differences in their children, may sometimes overlook math because of the early focus on reading; also, many parents do not have good math backgrounds and need help assisting their children with math homework.” Another participant stated, “Parents know their children, although they may not know the parameters that indicate giftedness…They don't recognize mathematical giftedness unless they are mathematically gifted themselves,” and another wrote: “Many parents do not really have the context to evaluate their children's true abilities.”
A few participants, however, thought parent nomination was among the best methods for identifying mathematically gifted/talented children. For instance, one parent stated: “Parents are actually more accurate, much more than teachers in identifying mathematical giftedness in their children.”

**Performance on Mathematics Tests**

The majority of participants who wrote comments on this item reported that mathematics test scores were the predominant criterion used in identifying mathematically gifted/talented students in their schools. They noted, however, that performing well on a mathematics test does not necessarily mean a student is gifted. They said some gifted students will intentionally fail to do well on a mathematics test in order to mask their abilities. Typical comments follow:

- Tests are not always a good judgment of ability.
- Most achievement tests only measure mastery of a certain number of skills. They assess the lowest orders of thinking and make little attempt to measure higher order thinking.
- This is an important part of the battery, but not the sole determinant; it also depends upon which test is used.
- Students may be able to perform well on a test because they have good test-taking skills and a basic knowledge of math. Other students who truly know how to solve the problems may have test anxiety—or be sick the ONE day of the test. It requires more than one observation and/or performance to decide that a student is truly gifted mathematically.
• This depends on whether the student was doing his/her best. In some environments, gifted students will purposely mask abilities in order to fit better with the norm.

• Unless there is some reason to believe the child is averse to testing, there is validity. One of my outstanding math students is also highly ADHD. He still tests at the 99th percentile.

*Mathematics course grades*

Most participants commented that mathematics course grades are not an effective way of identifying mathematically gifted/talented students because these students are not typically motivated to perform well on such tests, especially if they feel bored in class. Other participants noted that some mathematically gifted/talented students are disorganized or lack commitment to perform well on such tests, leading to poor performance. Typical comments are as follows:

• Classes are typically not aimed at finding or encouraging divergent thinkers, or those who process in different ways. Typical classes discourage rather than encourage the outstanding child. Grades show compliance rather than capacity.

• Sometimes they are not challenged in their regular courses resulting in boredom and lack of commitment to their studies.

• Some of these students are disorganized, don't turn in homework, are not motivated to do well, etc.
Once again, this would have to be looked at along with other indicators. Many truly gifted students are bored by the regular classroom work and will put forth little effort as a result. In other words, I know I can do it, so why waste my time.

Many gifted students are bored and do not do routine assignments; therefore they do not have good grades.

Open-Ended Questions on Part 2

The first open-ended question posed in Part 2 was: “Describe how students in your school are identified as gifted/talented in mathematics. Tell whether you think this is a good approach and why.”

Most participants who wrote comments for this item reported that test scores and teacher nomination were the primary methods used in identifying mathematically gifted/talented students in their schools. Most participants were not very happy about the methods of identification, arguing that such methods did not usually reflect the actual abilities of students who are truly gifted. Other participants noted that gifted children are identified through a general intellectual aptitude test, such as the Cognitive Abilities Test (CoGAT), rather than testing specifically in mathematics. They contended that such methods of identification are ineffective, because not all gifted children are necessarily gifted in mathematics. Typical comments are as follows:

- The students in our district were ranked based on CoGAT testing. I think this is an unfair way to rank because it does not take into account actual classroom performance in mathematics.
• We do a poor job. We identify gifted students by ability, observations and performance. We do not use high math ability indicators well or at all.

• Students qualify for gifted program based on psychological exam, statement of need and gifted characteristic checklist. Students qualify for advanced math based upon standardized testing, grades and teacher and/or parent recommendation.

• Students are NOT identified for purposes of adding mathematics to their gifted Educational Placement (EP) in our school district. Their performance on placement tests, state standardized tests, and classroom performance are used for math level placement in middle and high schools.

• Once a teacher or parent has nominated a student, they are given two tests. One will be verbal, the other is nonverbal. We also look at a teacher inventory and a parent inventory. Finally, test scores are taken into consideration as well. I think this process is fair. It's enough information to make the best decisions.

The second open-ended question asked: “Do you think gifted/talented students might display their mathematical giftedness in different ways? If so, in what way(s)? How might this affect the identification process?” In response to this question, an overwhelming majority of participants who wrote comments (about 97%) stated that they thought gifted/talented students usually display their mathematical giftedness differently. The reasons given were organized according to the following themes: communication difficulties, boredom/behavior issues, and student diversity.

Communication difficulties: About two-thirds of all participants who wrote comments in this section stated that mathematically gifted/talented students are unable to
communicate their thoughts effectively. This, they contend, contributes to mathematically gifted/talented students’ inability to show their work on written tests, which might affect their performance. Typical comments are as follows:

- Yes, some students can give me answers orally but cannot work it out on paper or explain to you how they got their answer.
- Yes - some students need the order of showing and developing the process of math while others can't explain the process but can get correct results.
- Some students intuitively solve problems, but cannot always explain the process.
- They think outside the box. Many gifted students see the answer to a problem, but don't show any of their work, or can't explain how they came up with their answer.

Boredom/behavior problems: Some participants listed boredom as a trait of mathematically gifted/talented students, especially if they are presented with material that is not challenging enough to arouse their natural curiosity. This is sometimes misinterpreted as lack of paying attention in class by teachers who do not understand gifted students. Typical participants’ comments follow:

- They are often bored by the "textbook math" and will take their mastery of skills and concepts to a higher level before the teacher, textbook, or rest of the class are able to follow their reasoning. I have seen mathematically gifted students punished for not sticking to the prescribed text, problems or approach. Some teachers will recognize that these students demonstrate superior ability, but others will view them as trouble-makers.
• When teachers don't challenge gifted math students, they may not be aware of their potential. Also, when G/T students are bored or act out, teachers may react negatively based on their behavior.

• Truly gifted students tend to think laterally. They do not always comply with what the teacher might consider the norm, especially if they consider the class material to be boring. Many of our advanced students cannot be identified as gifted and many of our gifted students are not placed in our advanced classes. At the middle school level, the work ethic has not been fully developed and the intuitive responses are not appreciated.

• Many of them just don’t show their giftedness because they are not challenged; so there is no opportunity.

*Student diversity:* Over sixty percent of participants who responded to this open-ended question explained that mathematically gifted/talented students are very diverse, and so there is no one-size-fits-all approach to identifying them. This, they noted, makes it even more difficult to identify and meet their needs. The following comments illustrate:

• Mathematically gifted/talented students may display their talents in different ways. Cultural and social factors or learning disabilities may change how students exhibit their giftedness. During the identification process, it is important to realize that all gifted kids do not act the same way. As long as test scores are high and students meet most of the characteristics of a gifted child, it is fine that they do not display all characteristics.
• I think some students do not test well, but that does not mean they are not gifted in a particular area. I think using a multi-criteria approach is best.

The third open-ended question was: “Research shows that racial/ethnic minorities are under-identified as mathematically gifted/talented students. Why do you think so?”

The written responses were organized according to the following themes: poor test scores, lack of support, test/teacher bias, and language barrier.

**Poor test scores:** Some participants stated categorically that most racial/ethnic minority students are just not good at mathematics and so do not get high enough test scores to qualify as gifted/talented students. Sample comments include:

• I think these students tend to score lower on state standardized tests, and are less likely to be placed in advanced classes where gifted/talented students are often identified.

• They do not traditionally get high enough scores on the placement tests and little/no teacher input is used.

• They score lower on standardized tests.

**Lack of support:** Participants suggested lack of home support and low socioeconomic status as possible reasons for the low representation of racial/ethnic minority students in gifted/talented programs. Participants noted that students from these populations typically do not receive the needed challenge and encouragement at home to work on mathematics problems. They further indicated that these students also tend to face economic challenges, thus denying them access to study materials and opportunities
for serious academic work. Lack of school/teacher support and awareness was suggested to a lesser degree. Typical participant comments are as follows:

- For the same reasons racial/ethnic minorities are doing more poorly in math in regular class. Lack of practice, home support, early stimulation, lack of access to materials, learning strategies, etc. More low SES than race/ethnicity and Asians are the opposite--often identified in math.

- I don't think there is enough resource and support in the schools to identify these students or afford them the opportunity to express their gifts and talents. Often it is their socio-economic background that is a roadblock to their success in math. Early identification, community involvement, parental involvement and support is greatly needed to help identify these students.

- Children are very sensitive to what is expected of them. If their peers and home life tell them that it is inappropriate to show academic skills, many will choose to fit into their community rather than stand out.

- I feel African Americans and Hispanics are under-identified due to social economics issues-parents may not know about other programs. Transportation problems to gifted schools.

- I believe there are a lot of reasons for that, one of the most compelling reasons to me is underachievement and apathy.

- Parents are not concerned about giftedness and therefore don't push it. Upper middle class and upper-class promote the idea of giftedness so their child seems more unique.
• [Lack of] support and early academic preparation and encouragement in some areas.

*Test/teacher bias:* Participants stated that one reason why racial/ethnic minority students typically do not get selected as mathematically gifted/talented is because teachers tend to be biased towards them. This bias is grounded in the stereotype that students from such populations are not supposed to be gifted/talented in mathematics, especially African American and Latino students. Participants made it clear that Asian students do not fit this stereotype. They also suggested that some of the tests used to identify gifted students are biased in the sense that racial/ethnic minority students find it difficult to identify with the context of most of the problems. Selected comments include:

• I think that racial bias sometimes plays a part in this. I also think that gifted classes are sometimes not taken advantage of by some racial groups because of distance from their home (travel difficulties because of parent employment), language barriers, and fear of leaving their home community. I have seen less of this in recent years especially in our community. (thank goodness!)

• Their culture is not adequately normed into gifted identification processes or the tests are biased.

• Culturally biased tests and teachers that don't investigate the students’ behaviors.

• Many times teacher recommendation is the primary source for identifying gifted students. Teacher bias could play a part.

• We often use culturally biased tests. One of the best tests we used that was not language/culture based has now been taken off the market. What a shame.
Part of this might have to do with racism, even if it is subconscious. Also, I think some ethnic groups emphasize learning in different ways. Parents and social groups may place more of an emphasis on the arts or writing than math.

*Language barrier:* Participants also proposed a language barrier as one reason why racial/ethnic minority students typically do not qualify as mathematically gifted/talented. Participants explained that because many racial/ethnic minority students come to the United States from different countries, adapting to the U.S. culture, learning the English language, and coping with the mathematics content at the same time presents enormous challenges. Additionally, these students are unable to express themselves well, and this lack of self-expression is often interpreted by inexperienced teachers indicating low intelligence. Typical participant responses include:

- In the case of English language learners, their limited English proficiency might hamper their ability to understand or express their mathematical ability (a good argument, I think, for promoting heritage language math instruction). In the case of racial minority students, I think we have to deal with a lot of cultural misperceptions. On the student side, there is peer-pressure and the fear of being seen as "acting white," while on the school side, there are often lowered expectations of children of diverse racial backgrounds or lower socio-economic levels.
- Because they don't understand the vocabulary in the test questions
- There may be a cultural custom that inhibits the expression of knowledge, as well as language barriers.
• Some are because English isn't their first language. These students get overlooked because teachers tend to think that they are good just to learn English. However, they very well may be gifted, but it's masked by not speaking English well. That's where we really need to improve on identifying these kids. Also, I don't see many nominations from parents who are an ethnic minority. Is it because they don't recognize it, or they just don't want to pursue it? I don't know. Maybe they feel that since the teachers are the professionals, they should be the one to identify the student.

• Could it be a language barrier? Perhaps the tester is not in tune with the particular culture of the child. Perhaps the culture does not encourage achievement and the students do not feel they can show their true thoughts.

• Because of the linguistic/language issues. Many tests are written and given in English, not in the child's first language. I teach in two schools with high Hispanic populations, and I see this all the time!

• Language barriers, experiences are different, textbooks may focus on typical American experiences, students may have started later in learning and not have progressed as far as others their age.

Summary of Results for Research Question 2

Quantitative analysis: Four survey items were analyzed in order to answer Research Question 2: “How are K-12 students identified as being gifted/talented in mathematics?” Participants’ ratings were reported collectively and by teachers’ age, number of credits earned in gifted/talented education, number of years teaching
gifted/talented students, and school district type. A Chi-square test of independence and Fisher Exact test were computed for all survey items. An alpha level of .05 was used to determine whether there were significant differences among subgroups for each survey item. No statistically significant differences were found within number of credits earned in gifted education, number of years teaching gifted/talented students, and school district. However, differences were found in survey item 2 in part 2, parent nomination as a preferred method for identifying mathematically gifted/talented students. Older teachers tended to agree that parent nomination was important in identifying mathematically gifted/talented students, whereas younger teachers tended to disagree.

Qualitative analysis: The number of written comments that accompanied participants’ ratings ranged from 65 (57%) to 68 (60%). Most participants contended that relying solely on parent nomination is not always helpful in identifying truly gifted/talented students in mathematics because these parents do not necessarily have the training to identify mathematical giftedness. Participants also noted that while performance on mathematics tests was the predominant criterion in identifying mathematically gifted/talented students in their schools, performing well on mathematics test does not necessarily mean a student is gifted. On mathematics course grades, participants commented that this was not an effective way of identifying mathematically gifted/talented students because these students are not typically motivated to perform well on such tests, especially if they feel bored in class.

Participants’ written responses to the open-ended questions ranged from 74 (65%) to 77 (68%). The dominant themes constructed from the written responses to the open-
ended question, “In addition to the possible factors indicated in the previous question, what student characteristics would you consider to be indicators of mathematical giftedness?” were descriptions of students as problem solvers, independent learners, and high-level thinkers. Themes constructed from responses to the question: “Do you think gifted/talented students might display their mathematical giftedness in different ways? If so, in what way(s)? How might this affect the identification process?” were communication difficulties, boredom/behavior issues and student diversity. Finally, themes constructed from responses to the question “Research shows that racial/ethnic minorities are under-identified as mathematically gifted/talented students. Why do you think so?” were poor test scores, lack of support, test/teacher bias, and language barrier.

Research Question 3: Quantitative Analysis

Research Question 3: What instructional approaches do K-12 teachers suggest to support the learning of mathematically gifted/talented students?

To answer this question, responses to items 1-5 of Part 3 of the survey instrument were analyzed. Table 15 shows the mean and standard deviation of participant ratings for each item. Overall, participants rated all five items very highly, with item 3 receiving the highest rating (M = 4.19, S.D. = 1.16), and item 1 the lowest (M = 3.86, S.D. = 1.28).
### Table 15

*Descriptive Statistics for Research Question 3 Survey Items*

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Instructional Approaches</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Give pre-assessments so that students can proceed only with materials they do not already know</td>
<td>84</td>
<td>3.86</td>
<td>1.28</td>
</tr>
<tr>
<td>Carefully choose textbooks and other materials that provide enrichment opportunities</td>
<td>85</td>
<td>3.89</td>
<td>1.31</td>
</tr>
<tr>
<td>Use investigative learning approaches that emphasize Problems with multiple solutions/paths to solutions</td>
<td>84</td>
<td>4.19</td>
<td>1.16</td>
</tr>
<tr>
<td>Provide units, activities, or problems that extend beyond the regular curriculum</td>
<td>85</td>
<td>4.13</td>
<td>1.32</td>
</tr>
<tr>
<td>Provide extra opportunities to participate in mathematics (e.g., clubs or contests)</td>
<td>84</td>
<td>3.82</td>
<td>1.34</td>
</tr>
</tbody>
</table>

*Research Question 3 by Age*

Descriptive statistics for research question 3 Survey items are shown by age category in Table 16a. Most participants tended to agree with all five instructional approaches listed for mathematically gifted/talented students. In analyzing the data by age, a Chi-square test and Fisher Exact test revealed that there was no significant difference on how participants rated each item (see Table 16b).
Table 16a:

Research Question 3 Survey Items by Age

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Age Category</th>
<th>Total</th>
<th>Disagree (%)</th>
<th>Agree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>45 or less</td>
<td>26</td>
<td>15</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>More than 45</td>
<td>42</td>
<td>19</td>
<td>81</td>
</tr>
<tr>
<td>2</td>
<td>45 or less</td>
<td>27</td>
<td>15</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>More than 45</td>
<td>45</td>
<td>24</td>
<td>76</td>
</tr>
<tr>
<td>3</td>
<td>45 or less</td>
<td>25</td>
<td>8</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>More than 45</td>
<td>47</td>
<td>15</td>
<td>85</td>
</tr>
<tr>
<td>4</td>
<td>45 or less</td>
<td>25</td>
<td>16</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>More than 45</td>
<td>50</td>
<td>16</td>
<td>84</td>
</tr>
<tr>
<td>5</td>
<td>45 or less</td>
<td>23</td>
<td>13</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td>More than 45</td>
<td>43</td>
<td>23</td>
<td>77</td>
</tr>
</tbody>
</table>
Table 16b:

*Chi-Square/Fisher Exact Test for Research Question 3 by Age*

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>$d.f.$</th>
<th>$X^2$</th>
<th>$p$</th>
<th>Fisher’s Exact Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>.15</td>
<td>.70</td>
<td>.76</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>.95</td>
<td>.33</td>
<td>.38</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>.71</td>
<td>.40</td>
<td>.48</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>.99</td>
<td>.32</td>
<td>.52</td>
</tr>
</tbody>
</table>

*Research Question 3 by Years of Teaching G/T students*

Descriptive statistics for research question 3 by years of teaching gifted/talented students is shown in Table 17a. The majority of the participants in both categories (participants with less than five years of teaching experience and those with more than five years’ experience) agreed with all five instructional approaches. In analyzing the data by age, a Chi-square test or Fisher Exact test revealed that there was significant difference between more experienced and less experienced teachers on how items 4 and 5 were rated (see Table 17b).
Table 17a

*Descriptive Statistics for Research Question 3 Survey Items by Years of Teaching*

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Years of teaching</th>
<th>N</th>
<th>Disagree (%)</th>
<th>Agree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5 years or less</td>
<td>17</td>
<td>12</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>more than 5 years</td>
<td>50</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>2</td>
<td>5 years or less</td>
<td>18</td>
<td>17</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>more than 5 years</td>
<td>53</td>
<td>23</td>
<td>77</td>
</tr>
<tr>
<td>3</td>
<td>5 years or less</td>
<td>16</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>more than 5 years</td>
<td>54</td>
<td>17</td>
<td>83</td>
</tr>
<tr>
<td>4</td>
<td>5 years or less</td>
<td>17</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>more than 5 years</td>
<td>56</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>5</td>
<td>5 years or less</td>
<td>16</td>
<td>38</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>more than 5 years</td>
<td>49</td>
<td>14</td>
<td>86</td>
</tr>
</tbody>
</table>
Table 17b

*Chi-Square /Fisher Exact Test for Research Question 3 by Years of Teaching G/T students*

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>d.f.</th>
<th>$X^2$</th>
<th>$p$</th>
<th>Fisher’s Exact Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>.59</td>
<td>.44</td>
<td>.72</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>.29</td>
<td>.59</td>
<td>.76</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>3.06</td>
<td>.08</td>
<td>.11</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>3.93</td>
<td>.05</td>
<td>.06</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>4.06</td>
<td>.04</td>
<td>.07</td>
</tr>
</tbody>
</table>

*Research Question 3 by Number of Credits Earned in Gifted Education*

Descriptive statistics for research question 3 by number of credits earned in gifted education is shown in Table 18a. Most participants tended to agree with all five items. In analyzing the data by number of credits earned in gifted education, a Chi-square test and Fisher Exact test revealed that there are no significant differences on any of these item ratings (see Table 18b).
Table 18a  
*Research Question 3 Survey Items by Gifted Credits Earned*

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Number of credits earned in gifted education</th>
<th>N</th>
<th>Disagree (%)</th>
<th>Agree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>less than 10 credits</td>
<td>17</td>
<td>18</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>10 or more credits</td>
<td>49</td>
<td>18</td>
<td>82</td>
</tr>
<tr>
<td>2</td>
<td>less than 10 credits</td>
<td>24</td>
<td>17</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>10 or more credits</td>
<td>47</td>
<td>23</td>
<td>77</td>
</tr>
<tr>
<td>3</td>
<td>less than 10 credits</td>
<td>20</td>
<td>5</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>10 or more credits</td>
<td>50</td>
<td>16</td>
<td>84</td>
</tr>
<tr>
<td>4</td>
<td>less than 10 credits</td>
<td>22</td>
<td>5</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>10 or more credits</td>
<td>51</td>
<td>22</td>
<td>78</td>
</tr>
<tr>
<td>5</td>
<td>less than 10 credits</td>
<td>19</td>
<td>21</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>10 or more credits</td>
<td>46</td>
<td>20</td>
<td>63</td>
</tr>
</tbody>
</table>
Table 18b

*Chi-Square /Fisher Exact Test for Research Question 3 Survey Items by Gifted Credits Earned*

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>d.f.</th>
<th>(X^2)</th>
<th>p</th>
<th>Fisher’s Exact Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>.00</td>
<td>.95</td>
<td>1.00</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>.43</td>
<td>.51</td>
<td>.76</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1.54</td>
<td>.21</td>
<td>.43</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>3.24</td>
<td>.07</td>
<td>.09</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>0.02</td>
<td>.89</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Research Question 3: Qualitative Analysis

*Research Question 3:* What instructional approaches do K-12 teachers suggest to support the learning of mathematically gifted/talented students?

This question was answered in two parts. First, participants’ written comments that accompanied their ratings to the survey questions were examined. Second, participants’ responses to the open-ended question in part 3 were analyzed. The number of written comments that accompanied participants’ ratings ranged from 57 (50%) to 65 (57%). The total number of responses to the open-ended question in part 3 was 73 (64%) (see Table 19).
Table 19

*Participant Response numbers for Part 3 of Survey Instrument*

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Number of written comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part 3a (Survey questions)</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>65 (57%)</td>
</tr>
<tr>
<td>2</td>
<td>60 (53%)</td>
</tr>
<tr>
<td>3</td>
<td>57 (50%)</td>
</tr>
<tr>
<td>4</td>
<td>57 (50%)</td>
</tr>
<tr>
<td>5</td>
<td>57 (50%)</td>
</tr>
<tr>
<td><strong>Part 3b (Open-ended)</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>73 (64%)</td>
</tr>
</tbody>
</table>

Participants’ Comments Explaining Ratings

*Item 1*: Give pre-assessments so that students can proceed only with material they do not already know.

Participants noted mathematically gifted/talented students tend to be bored easily if the material involves lots of repetition and does not challenge the students. Thus, the material should be interesting and engaging, without repetition. However, they also noted
that the material must be mastered in some breadth before moving to new material.

Despite endorsing this strategy overall, participants acknowledged that some teachers do not implement it. Typical responses are:

- This is definitely true because if they are bored, they will mentally check-out or find other ways in which to entertain themselves, including disrupting others around them.
- Generally yes - students should be accelerated through content they have already mastered; however, they might also be given work they have mastered to do two things - bolster self-esteem (which can be an issue) and also because they can be creative with inventing new solutions or ways of manipulating concepts already mastered; this, of course, would depend a great deal on teacher who is planning and facilitating.
- They give pre-assessment tests and teach the same old things anyway! They are so "under-the-gun" with testing that the teachers are afraid to not go over and over everything on the tests!
- Students get bored when they waste time doing something they already know and become frustrated.
- If this is done, we must be sure that the student truly understands the material completely. They may be able to solve particular problems if they are presented in the manner in which they are familiar, but not if questions are approached from a different viewpoint.
Item 2: Carefully choose textbooks and other materials that provide enrichment opportunities

Participants noted that it is the duty of teachers of gifted/talented students to ensure that the textbooks and other materials they use have appropriate materials to provide much-needed enrichment. Typical comments are shown below:

- They must be real-world and intriguing to the mathematically gifted student. Topics are interesting to them.
- Enrichment may be the only place where real learning takes place. The material needs to engage the heart as well as the mind. In other words, the child needs to care about the outcome.
- Challenging, interesting materials are crucial to the success of mathematically gifted students.
- Yes, in my school, we confer together as a group to assess textbooks that have enrichment or challenge activities presented, as well as supporting material. I have realized that if it is there and the teachers do not have to look for it, differentiation can happen.

Item 3: Use investigative learning approaches that emphasize problems with multiple solutions or multiple paths to solutions.

Participants generally acknowledged the need for engaging gifted/talented students with problems that lend themselves to multiple paths to solutions. Some participants noted, however, that while this is a laudable idea, it is not often practiced in schools because of limited time and the focus on completing the school curriculum and
preparing students to take tests, rather than having an in-depth understanding of mathematics concepts. Typical participant comments are shown below:

- Problem-based learning is fantastic with gifted students of all kinds...it's out of the box thinking at its best!
- Many students are afraid when they must investigate a solution. They often prefer direct teaching methods where they feel confident in the solution. They are afraid of "making a bad grade" when they are asked to investigate. Teachers need to understand that investigation should not be graded but applauded so that students are willing to risk!
- Students should understand that it's okay for them to derive an answer in a different way. This should be encouraged and respected and valued.
- In a more perfect world this would happen on a regular basis. It is too bad that students and parents--and many teachers--are so concerned with things other than education that NO ONE wants students to spend time outside of class investigating and learning.
- That kind of high level thinking is what gifted math students need to thrive and grow.

*Item 4:* Provide units, activities, or problems that extend beyond the regular curriculum.

Participants welcomed the idea of finding creative ways to engage gifted students in mathematics outside of the classroom. Participants explained that such activities should be very engaging while providing gifted students with a chance to explore their creative potential. This is difficult for the classroom teacher to pull out of her hat.
• Extend beyond and incorporate other subject areas.
• I would likely skip the curriculum and go directly to real-life applications.
• They easily get bored with the regular curriculum, so any extensions and challenging opportunities are desirable.
• That would be great! It's sad that many in education--along with parents and students--do not think that students should have anything beyond what is the minimum--many of our gifted students have dropped out of the gifted program because it "requires extra work."

Item 5: Provide extra opportunities to participate in mathematics (e.g., clubs or contests).

Participants noted that providing extra opportunities for mathematically gifted/talented students gives them the platform to explore mathematics concepts in greater depth at a more relaxed atmosphere, and also helps them to interact with peers and share ideas. Some participants, however, contended that such extra opportunities are unnecessary if the students already have a challenging curriculum. Typical comments are as follows:

• Yes, field trips and guest speakers, mentors and internships.

• If the curriculum is challenging, there may be no need for extra opportunities. Otherwise, yes.

• Experience with Odyssey of the Mind, and Future Problem Solvers have had great results.
• This would be useful if the student were in a general education environment so that the student can interact with others with similar interests. It's less important in a school for gifted children where they do this continually.

Open-ended Questions in Part 3

The open-ended question posed in Part 3 was: “In addition to the practices mentioned above, what do you think can be done to differentiate curriculum, instruction, and assessment for the mathematically gifted?” Themes that were constructed from participants’ response to this question were: multiple approaches and teacher preparation/lack of time.

*Multiple approaches:* By virtue of the fact that mathematically gifted/talented students were perceived to be a very diverse population, participants said teachers should use multiple approaches to teaching. For example, one participant wrote that she always attempts to incorporate all the learning modalities into her activities. She wrote:

> In all of the assignments I give, I try to incorporate all of the different modalities. The kids can pick and choose. You have to provide a variety of opportunities for learning. Use a wide variety of strategies. I use strategies that use scaffolding to build on prior knowledge and a lot of visual aids, games and manipulatives to represent the content material.

Another participant noted that she offers higher level thinking questions as a form of differentiation, where the gifted kids get to process something that is a little tougher. It is real easy for me to give them an 8th grade algebra concept that is really just an expansion of what they
have learned in 7th grade. This gives them a taste of what they will be doing next year. Something different and new, versus the same old, same old stuff.

*Teacher preparation/Lack of time:* Participants noted that teachers need to be especially trained to meet the needs of gifted/talented students. In addition to being trained to understand and effectively teach mathematically gifted students, participants commented that teachers of the gifted need to be strong in the mathematics content themselves. For example, one participant wrote:

> Mathematically gifted students need teachers who are enthusiastic about mathematics and who can infect students. Teachers who have a solid preparation, both in content and pedagogy. Most elementary teachers aren’t very good with math, and yet are given the job of teaching gifted students. Too many kids, too much testing, not enough time to differentiate.

Commenting on why she was unable to differentiate her lessons, one participant noted:

> “The main problem most of us tend to face is the lack of time. There is simply not enough time to plan and prepare effectively to teach those kids.” Another participant wrote:

> When you have too many kids like I have in my class, it is very difficult to differentiate the lesson to meet each child’s unique needs. I feel we need some training or professional development. Then also, it would help if the class sizes were much smaller. I would also suggest having a full-time assistant in each classroom.
Summary of Results for Research Question 3

Quantitative analysis: Five survey items were analyzed in order to answer Research Question 3: “What instructional approaches do K-12 teachers suggest to support the learning of mathematically gifted/talented students?” Participants’ ratings were reported collectively, as well as by age, number of credits earned in gifted/talented education, number of years teaching gifted/talented students, and school district. A Chi-square test of independence and Fisher Exact test were computed for all survey items. An alpha level of .05 was used to determine whether there were significant differences between subgroups for each survey item. No statistically significant differences were found for any of the five survey questions.

Qualitative analysis: The number of written comments that accompanied participants’ ratings ranged from 57 (50%) to 65 (57%). The total number of responses to the open-ended question in part 3 was 73 (64%). Participants expressed the need to make lessons engaging with less repetition. Themes constructed from responses to the question “In addition to the practices mentioned above, what do you think can be done to differentiate curriculum, instruction, and assessment for the mathematically gifted?” were: multiple approaches and teacher preparation/lack of time.

Chapter Summary

This chapter reports analyzed results for each of the three research questions. Descriptive / inferential statistics and content analyses were used in analyzing both the quantitative and qualitative data. The next chapter presents a discussion of the findings of the study, as well as implications for practice and recommendations for future research.
CHAPTER 5: DISCUSSION

Introduction: Purpose of the Study

The purpose of this mixed methods study was to explore the perspectives of K-12 teachers on perceived characteristics of mathematical giftedness and talent, as well as what current instructional strategies are being used with mathematically gifted and talented (G/T) students in the general education classroom. This study also explored the reasons that K-12 teachers give for being able or unable to meet the needs of G/T learners, and it examined the research literature in order to determine exemplary instructional strategies in mathematics that general education classroom teachers might employ to meet the needs of mathematically gifted and talented students.

Summary of the Research Findings

Based on this study, K-12 teachers of gifted and talented students report they are using a wide variety of instructional strategies to teach mathematics, including strategies that have been supported by the literature as effective for gifted and talented students, such as use of visual aids, manipulative materials, and games. This study also reveals that classroom teachers report they are not able to meet the needs of mathematically gifted and talented students in the general education classroom and have difficulty differentiating instruction. Possible solutions offered by the participants concerning how general education classroom teachers could more effectively meet the needs of mathematically gifted and talented students in the classroom include more time to plan, smaller class sizes, training on how to manage differentiation in the classroom, and a full-time assistant. Repeated themes in this study include the following: a lack of teacher
knowledge and training on mathematically gifted and talented students, an inability to
differentiate instruction as much as teachers would like due to obstacles such as a lack of
planning time, too many students in the classroom, a lack of knowledge and training
about how to manage differentiation, and needing a full-time classroom assistant.

Interpretation of Findings

The conceptual framework for this study is grounded in the works of Piaget,
Gardner, Renzulli, Tomlinson, and Winebrenner. Each of these experts in the field of
gifted education has contributed toward a definition of gifted and talented students as
well as defining the characteristics of these students. Moreover, instructional strategies
for meeting the needs of gifted and talented students are offered by each expert. In
addition, each expert has contributed unique ideas about gifted and talented students that
have made an impact on the field of gifted education. Therefore, the findings of this study
are closely related to the conceptual framework of this study and will be described
through the following research questions that guide this study.

1. What student characteristics do K-12 teachers identify as possible indicators of
   mathematical giftedness/talent?

   The results of the data analysis in chapter 4 revealed that, overall, teachers
considered mathematically gifted/talented students to be a diverse population with a wide
range of characteristics. Participants rated the following characteristics of mathematically
gifted/talented students very highly: eagerness to solve challenging mathematics
problems and puzzles possessing an understanding of new mathematics concepts and
processes more easily than other students, and attaining very high test scores, including
pretests. This is consistent with Hoeflinger’s (2003) assertion about mathematically
gifted/talented students discussed in Chapter 2. Hoeflinger explains that although
mathematically gifted and talented students are sometimes difficult to identify, they do
share the following characteristics: an ability to experience true problem-solving tasks by
internalizing, reshaping, and questioning; multiple strategies to move forward the process
of solving a problem; and a high threshold of acknowledgement of what constitutes a
problem.

Another interesting point was the fact that in responding to the statement “A
mathematically gifted/talented student displays the same characteristics cross-culturally”,
most participants reported having little experience with teaching gifted students from
racial/ethnic minority populations, especially African-American and Latino students. It
may well be that the low representation of these students in gifted programs is due to a
variety of reasons, including the stereotype that gifted/talented students are mostly White,
or Asian and middle class.

Other characteristics of mathematically gifted/talented students participants
suggested were: problem solvers, independent learners, and high-level thinkers. Again,
these characteristics are consistent with those mentioned by Diezmann (2001), as
discussed in chapter 2. Diezmann contends that mathematically gifted students’
capabilities and interests in mathematics can be many years ahead of their age peers.
These students require challenging tasks to provide scope for learning and the use of
metacognitive skills. Tasks that is too simple for particular students can be modified to
increase the level of challenge. Diezmann further notes that a task can be problematized
by including more complex numbers in the task, by adding obstacles to solution, by requiring students to engage in novel solution processes, or by requiring students to use particular representations (Diezmann & Watters, 2000). In contrast to many of their age peers, gifted students express an explicit preference for difficult mathematical tasks (Diezmann & Watters, 2000). Gifted students may need tasks that introduce them to mathematical ideas beyond those typically addressed for their age group. For example, while most children in their first year at school learn about one digit numbers, gifted students of the same age may seek to develop multi-digit number sense to understand the quantitative information they encounter about topics such as space travel (Diezmann & English, 2001). Diezmann goes on to suggest that open-ended investigatory tasks can provide rich learning opportunities for gifted students. These tasks require the application of mathematical knowledge, can be cross-disciplinary, and provide scope for creativity (Diezmann, English, & Watters, 2001).

Participants also described mathematically gifted students as complex individuals with unique needs to support their strengths and weaknesses. It was interesting to note how participants mentioned that, even among gifted students, each individual is very different. Thus, a one-size-fits-all approach would not work for them. Teachers must strive to understand each gifted child and respond to their needs accordingly.

2. How are K-12 students identified as being gifted/talented in mathematics?

The results from this study indicate that most teachers tend to use test scores to identify mathematically gifted/talented students, followed by teacher nomination. An important point that was noted in the qualitative responses to this question was that
although most of the participants acknowledged using test scores as the main indicator of mathematical giftedness, they added that it was not the most efficient method, because there are multiple dimensions of giftedness that cannot be identified by scores on a test. For example, one participant stated that some mathematically gifted students are simply not good test takers or are not motivated enough to perform well on tests. Thus, most participants stated that while test scores should still be used to identify mathematically gifted students, the identification should not be based solely on the scores. Other factors should be taken into consideration.

Analysis of participants’ written comments found that significantly fewer racial/ethnic minority students are often nominated into gifted programs. In some schools, participants mentioned that they have never had a minority student in their gifted programs. The research literature shows that inequities based on race/ethnicity and other characteristics do exist in the process of identifying gifted students (Clark, 2002; Feldhausen & Jarwan, 2000). Therefore, ensuring an equitable demographic representation of students in gifted programs should be a matter of great concern to all stakeholders.

3. What instructional approaches do K-12 teachers suggest to support the learning of mathematically gifted/talented students?

The data analysis revealed that strong teacher preparation and the use of audio/visual materials and manipulatives were the instructional strategy deemed as most effective for mathematics instruction in meeting the needs of high-ability mathematics students. However, teachers also recommended the use of computer programs, peer
tutors, small groups or centers, and more challenging mathematics problems. This supports the position of Tomlinson (1999), who recommends seven instructional strategies that should be used with mathematically gifted and talented students: respectful tasks, flexible grouping, ongoing assessment, tiered activities, learning contracts, compacting, and stations. In fact, the data analysis results of this study reveal that general education classroom teachers state that they are using flexible grouping, stations, and respectful tasks most often in order to meet the needs of mathematically gifted and talented students. For example, of centers is similar to stations, and the instructional strategies of more challenging mathematics problems and computer programs used at a student’s own level could be considered as similar to respectful tasks. However, Winebrenner (2001) deems the use of gifted students as peer tutors inappropriate for use with gifted and talented students, but it is an instructional strategy that some cited in their work with mathematically gifted/talented students.

The data also suggests that most teachers do not differentiate instruction due to lack of training or staff development. Participants cited a lack of knowledge and training about gifted and talented students with the exception of personal experience in the classroom. Participants also expressed a desire for training in which not only characteristics of gifted and talented students were taught but also strategies for challenging gifted and talented students and how to manage the differentiated instruction for these students in the general education classroom. Participants also cited class size as an obstacle to differentiation. However, two other obstacles to differentiation were presented by all cases that were not previously considered: lack of time to plan and the
need for a full-time assistant in the classroom in order to differentiate instruction effectively. Teachers stated that a lack of training, large class sizes, not enough planning time, and not having a full-time assistant were reasons why differentiated instruction was difficult to provide in the general education classroom. Participants also stated that support from administration and ability to get the needed resources for differentiated instruction was a factor.

Implications for Social Change

In terms of implications for social change, this study revealed that K-12 teachers believe they are using some effective instructional strategies in order to teach mathematics and that they are attempting to meet the needs of mathematically gifted and talented students in the classroom. However, teachers also report that there are many obstacles to implementing differentiated instruction in their classrooms. Even though the current research does not always share this perspective, this study seeks to give the classroom teacher a voice through the survey data. This research investigates why the needs of gifted and talented students are not being met in the classroom from the perspective of teachers who are actually attempting to meet the needs of these students. Teachers want to meet the needs of G/T students, but they believe that several obstacles, as noted, prevent them from doing so as effectively as they should. Because this study seeks to provide a voice to the K-12 teacher, improvements can be made in the field of education in the area of meeting the needs of all students if the education community can hear and actually listen to that voice. From this study, educators can gain first-hand knowledge about why teachers struggle with meeting the needs of mathematically
gifted/talented students. Educators can then develop possible solutions once they understand the obstacles that teachers face.

On a larger scale, these study findings might apply to any special population of students found in the general education classroom by providing possible solutions concerning how general education classroom teachers can better meet the wide range of student needs in the general education classroom. Other specific student populations that could benefit from this study besides gifted and talented students are students with learning disabilities and English Language Learners. According to several research studies, differentiated instruction is primarily designed to increase learning in the general education classroom for all students.

Tomlinson (1999), who is a leader in the area of differentiation, offers many instructional strategies that every classroom teacher can use to meet the needs of all students in the general education classroom. Tomlinson’s strategies are designed to be respectful of each, individual learner and his or her learning needs. Haley and Capraro (2001) conducted another study that supports the idea that differentiated instruction increases learning for all students in the general education classroom. They explored the challenges teachers face in the general education classroom every day. According to Haley and Capraro, these challenges stem from a diverse society. Students often come from varying cultural and ethnic backgrounds. Students of varying ability levels are also found within one classroom setting, and teachers are expected to meet all these learning needs ranging from special-needs students to gifted and talented students.
Haley and Capraro (2001) express the need for teachers to build a classroom community and to use diverse instructional strategies in order to face the challenge of meeting the needs of all learners in the classroom. Fluellen (2003) also conducted a study that supports the idea that differentiated instruction benefits all students in a general education classroom. Fluellen’s study sought to develop proficiency for each child in a mixed-ability classroom of 29 African-American students. The students ranged from special needs to gifted and talented students. The pilot program was implemented in a fifth-grade classroom in Philadelphia. The facilitator blended Gardner’s multiple-intelligence approach, Piaget’s cognitive development theory, a teaching-for-understanding approach, and a set of life values in the curriculum in order to provide a deeper understanding of mathematics, history, science, and literacy. Ongoing assessments were used to evaluate the experience, and students were exposed to a wide variety of experiences. The program helped the children to develop their own unique intelligences by participating in daily activities that used their special intelligences. The literature review in this study clearly indicates that learning in the general education classroom for all students must be improved. However, in order for learning to improve, it is imperative that all classroom teachers receive training about how to differentiate instruction in the general education classroom in order to improve student learning in general.

The main reason differentiated instruction is a necessity in the general education classroom today is the growing diversity of the general education classroom in today’s public schools. Learning must be improved for each individual student. Teachers must be able to differentiate and individualize to some extent in order to meet the needs of all
students in their classrooms. In this study, teachers have indicated that they feel some pressure to have all of their students meet the requirements of the state standards and that this is becoming an increasingly difficult task with the growing student diversity. Teachers need a plan, such as differentiated instruction, that will improve student learning. In addition, teachers need support from administrators in working with large classes. Cashion and Sullenger (2000) found that teachers reported that large class size was a factor that impeded their ability to differentiate for gifted and talented students because teachers were resistant to providing individualized instruction for each student in the classroom. If teachers are trained in how to differentiate instruction and supported by administrators in how to work with large class sizes, teachers may be more successful in meeting the needs of all students in the general education classroom.

Teachers have many resources available to meet student needs, but without time to plan, without training about best instructional practices, and without support from administrators, teachers will not be able to successfully meet the needs of all students in the general education classroom. From this study, it is clear that teachers demonstrate a willingness to meet the needs of all students in their classrooms, but feel that they are unable to do so. Teachers must be provided with every possible opportunity to feel successful and capable of meeting the needs of every student in their classroom in order for student learning to improve. If teachers believe that they are capable of meeting the needs of their students, they are more likely to attempt to improve their instruction.

When instruction has improved within the general education classroom, all students will be learning and achieving at their own learning levels and maximizing their
learning potential. If every student can maximize their learning potential, this would have a positive impact on society at large.

Recommendations for Action

The recommendations for action based on the findings of this study are as follows:

1. The results of this study should serve as a springboard for discussion among teachers and principals about how the needs of mathematically gifted and talented students can be met in the general education classroom setting.

2. Based on the findings of this study, staff development or teacher training should be developed to educate teachers about how to identify mathematically gifted and talented students within the classroom and how to develop and use effective instructional strategies for meeting the needs of these students. These strategies should be based on the work of Tomlinson (1999), who recommends many instructional strategies that teachers can use to effectively meet the needs of mathematically gifted and talented students in the classroom. As stated earlier, these instructional strategies include respectful tasks, flexible grouping, ongoing assessment, tiered activities, learning contracts, compacting, and stations. Further, the training also needs to provide strategies for teachers on how to manage differentiation in the classroom.

3. Administrators should take the results of this study into account and provide teachers with collaborative planning time to integrate these strategies into their instructional delivery. Administrators should be trained in understanding the same instructional strategies that teachers will use so that they can observe implementation of these
strategies in the classroom. Administrators will be more likely to provide more collaborative planning time and collaborative planning if they believe there is a benefit in doing so, such as improved student learning.

4. A more precise assessment of students’ mathematics knowledge should be developed so that more appropriate curriculum and instruction can be implemented for those students who demonstrate mastery of grade-level standards. More appropriate curriculum means curriculum that truly allows students to learn at their maximum potential, not just certain standards that they may have already mastered. Appropriate instruction means instruction that allows students to be challenged and receive instruction that is appropriate for their needs. All students, no matter what their mastery level may be, have a right to receive appropriate curriculum and instruction that will challenge them as well as maximize learning.

5. Policy makers and all stakeholders should develop a better identification process that identifies a broad range of G/T student. That is, the new policy should aim at identifying students from margin who don’t exhibit traditional markers.

Limitations

This study contains several limitations. As stated earlier, the purpose of this study was to investigate the perspectives of K-12 teachers on perceived characteristics of mathematical giftedness and talent, as well as what current instructional strategies are being used with mathematically gifted and talented students in the general education classroom. This research is focused on mathematically gifted and talented students and is not necessarily generalizable to gifted and talented students in other subject areas.
Because the researcher used surveys as the method to collect data, the researcher cannot assume that the participants reported accurate data versus data that they thought the researcher wanted to hear. Another limitation to the study is the fact that the researcher had to rely on coordinators of gifted/talented programs in recruiting participants, thus seriously reducing the number of potential participants and therefore the sample size and possibly the representativeness of the sample. Also, it would have been useful to have more information on the teachers, such as the grade level(s) they teach, types of programs they teach in (G/T only, G/T pull-out, general education, etc), their instructional approaches to G/T (enrichment, acceleration, etc). It would also have been good to distinguish more clearly between when teachers were reporting perspectives about themselves versus about the schools/colleagues at large. Finally, participants were all registered members of the National Association of Gifted Children. Thus these results are only generalizable to other samples with similar demographics as the one used in the study. In spite of these limitations, this study does lend support to other studies conducted on teaching mathematics to gifted/talented students.

**Recommendations for Further Study**

The recommendations for further study are as follows:

a) Further studies should be conducted that include general education teachers’ perspectives about why they are able or unable to meet the needs of mathematically gifted and talented students in the general education classroom. Currently, there are few studies on this topic presented from the teacher’s perspective. Additional research focusing on the teacher’s perspective would provide deeper insight into why teachers feel
that they are or are not able to meet G/T students’ needs within the general education classroom.

b) Further studies should be conducted to examine factors that contribute to teachers’ decisions to use or not use the various strategies mentioned in the literature for teaching mathematics to gifted/talented students.

c) Further studies should explore the role of gender in the teaching of mathematics to gifted/talented students.

e) Further study is needed to explore the various factors that affect the identification of students who are low-income and/or ethnic/linguistic minority gifted/talented students.
REFERENCES


Clark, B. (2002). Growing up gifted: Developing the potential of children at home and at


Classrooms: Strategies for Meeting the Needs of All Students. Minneapolis, MN: Institute on Community Integration. (ERIC Document Reproduction Service No. ED418538)


APPENDIX A: ONLINE QUESTIONNAIRE

Teachers Perspectives on Teaching Math to Gifted/Talented

1. Instructions

Dear Teacher of gifted/talented student:

I am a doctoral candidate in the Department of Educational Specialties at the University of Nevada, Reno. I am conducting a study to find out more about teachers' perspectives on teaching mathematics to elementary gifted/talented students. Although there are no direct benefits of this study, results from the study may offer helpful suggestions to education professionals and scholars on how to effectively teach mathematics to gifted/talented students. Thank you for volunteering to participate in this survey. Your responses are confidential and will not be shared with anyone. You may ask about your rights as a research subject or you may report any comments, concern, or complaints to the University of Nevada, Reno Social Behavioral Institutional Review Board, telephone number (775) 327-2368, or by addressing a letter to the Chair of the Board, c/o UNR Office of Human Research Protection, 205 Ross Hall / 331, University of Nevada, Reno, Reno, Nevada, 89557. You may also contact the researchers (Dr. Lynda R. Wiest, wiest@unr.edu, 775-682-7868; or Abraham Ayebo, ayebo@unr.edu, 775-250-7618) if you have any questions or concerns about the study.

Please indicate your response concerning your perception about mathematically gifted and talented students in relation to the teaching and learning of mathematics. Give your opinion by clicking on the check box next to your answer, and write an explanation for your choice. There is a phone-interview section which constitutes the second part of my study. If you are willing to participate in this optional phone interview, please indicate by providing your name and contact information at the end of the survey. Eight (8) teachers who indicate their consent to participate in the phone-interview will be randomly chosen for a follow-up phone interview.

Please note that servers housing survey applications record and collect incoming IP addresses for system administration and record keeping. These data are analyzed only in aggregate; no connection is made between participants and their computers’ IP addresses. These servers also use cookies to recognize visitors and more quickly provide personalized content, grant unimpeded access to the website, and to track usage behavior and compile data, in aggregate form only, for website improvement purposes. If you are using a computer in a public domain, please close the Internet browser immediately after completing the survey to limit access to your survey responses.

If, after exiting the survey, you wish to remove the cookies from a personal computer, please obtain instructions for deleting cookies from the help menu or contact your Internet provider.

1. Do you agree to participate in this study?

☐ Yes

☐ No
Teachers Perspectives on Teaching Math to Gifted/Talented

2. Part 1a: Characteristics of mathematically gifted/talented students.

Please indicate the extent to which you agree or disagree with each statement.

1. A mathematically gifted/talented student is eager to solve challenging math problems and puzzles.
   - Strongly Disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly Agree

   Explain:

2. A mathematically gifted/talented student organizes data and information to discover mathematical patterns.
   - Strongly disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly Agree

   Explain:

3. A mathematically gifted/talented student can generate creative solutions to solve math problems.
   - Strongly Disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly Agree

   Explain:
Teachers Perspectives on Teaching Math to Gifted/Talented

4. A mathematically gifted/talented student understands new math concepts and processes more easily than other students.
   - Strongly Disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly Agree
   Explain:

5. A mathematically gifted/talented student attains very high test scores, including on pretests
   - Strongly Disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly Agree
   Explain:

6. A mathematically gifted/talented student perseveres on a task until he/she reaches a solution
   - Strongly Disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly Agree
   Explain:
Teachers Perspectives on Teaching Math to Gifted/Talented

7. A mathematically gifted/talented student displays the same characteristics cross-culturally.

☐ Strongly Disagree
☐ Disagree
☐ Neutral
☐ Agree
☐ Strongly Agree

Explain:
1. In addition to the possible factors indicated in the previous questions, what student characteristics would you consider to be indicators of mathematical giftedness?

2. Do you consider mathematical giftedness and mathematical talent to be the same or different? Please explain.
Teachers Perspectives on Teaching Math to Gifted/Talented


Please rank the following factors according to their importance in identifying mathematically gifted/talented students in your school (1=low importance; 5=high importance).

1. Teacher nomination
   - 1
   - 2
   - 3
   - 4
   - 5
   Explain:

2. Parent nomination
   - 1
   - 2
   - 3
   - 4
   - 5
   Explain:

3. Performance on mathematics achievement test(s)
   - 1
   - 2
   - 3
   - 4
   - 5
   Explain:
4. Mathematics course grades

☐ 1
☐ 2
☐ 3
☐ 4
☐ 5

Explain:

5. Nomination based on the following (please state and indicate rank):
### Teachers Perspectives on Teaching Math to Gifted/Talented

**5. Part 2b: Identification of mathematically gifted students.**

1. Describe how students in your school are identified as gifted/talented in mathematics. Tell whether you think this is a good approach and why.

2. Do you think gifted/talented students might display their mathematical giftedness in different ways? If so, in what way(s)? How might this affect the identification process?

3. Research shows that racial/ethnic minorities are under-identified as mathematically gifted/talented students. Why do you think so?
Teaching Perspectives on Teaching Math to Gifted/Talented

6. Part 3a: Instructional Approaches

Please rank the following factors according to their importance in teaching mathematically gifted/talented students in your school (1=low importance; 5=high importance).

1. Give pre-assessments so that students can proceed only with material they do not already know.
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4
   - [ ] 5

   Explain:

   [ ]

2. Carefully choose textbooks and other materials that provide enrichment opportunities.
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4
   - [ ] 5

   Explain:

   [ ]

3. Use investigative learning approaches that emphasize problems with multiple solutions or multiple paths to solutions.
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4
   - [ ] 5

   Explain:

   [ ]
Teachers Perspectives on Teaching Math to Gifted/Talented

4. Provide units, activities, or problems that extend beyond the regular curriculum.
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4
   - [ ] 5

   Explain: ____________________________

5. Provide extra opportunities to participate in mathematics (e.g., clubs or contests).
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4
   - [ ] 5

   Explain: ____________________________
1. In addition to the practices mentioned above, what do you think can be done to differentiate curriculum, instruction, and assessment for the mathematically gifted?
### Teachers Perspectives on Teaching Math to Gifted/Talented

#### Part 4: Demographics

**1. School District:**
- Rural (population of less than 2000)
- Sub-urban (population of between 2000 and 8000)
- Urban (population of more than 8000)

**2. Gender**
- Male
- Female

**3. Age**
- 18-25
- 26-34
- 35-45
- Over 45

**4. Race/Ethnicity**
- American Indian/Alaskan Native
- Black, not of Hispanic origin
- Hispanic
- Asian
- Native Hawaiian or Pacific Islander
- White, not of Hispanic origin
- Other (please specify)

**5. How many total years have you been teaching gifted/talented students?**
- 0-2
- 3-5
- 6-10
- More than 10
Teachers Perspectives on Teaching Math to Gifted/Talented

6. How much gifted/talented training have you received?
   - None
   - 1-9 credits
   - 10-40 credits
   - More than 40 credits

7. If you answered anything other than "none" in the previous question, where did training mostly occur? Check all that apply.
   - Graduate school course
   - Completed graduate program (masters/doctorate)
   - Practicum/internship
   - In-service professional development credits
   - Other (please specify)
APPENDIX B: RECRUITMENT EMAILS

*Email to Coordinators of Gifted Programs*

Dear ____________:

I am a doctoral candidate in the Department of Educational Specialties at the University of Nevada, Reno. I am conducting a study to find out more about teachers’ perspectives on teaching mathematics to elementary gifted/talented students. I have developed an online questionnaire. I was wondering if you would help me reach the teachers who teach mathematics in your gifted program by forwarding my message to them (I will send the invitation email separately). I would really appreciate your help.

Sincerely,

Abraham Ayebo

(Doctoral Candidate, Dept of Educational Specialties, University of Nevada, Reno).
Invitation Letter to Teachers of Gifted/Talented Students

Dear teacher of gifted/talented students:

I am a doctoral candidate in the Department of Educational Specialties at the University of Nevada, Reno. I am conducting research to find out more about the perspectives of K-12 teachers on perceived characteristics of mathematical giftedness and talent, as well as on effective mathematics instruction for gifted/talented students. I have developed an online questionnaire which can be accessed from the following link: http://www.surveymonkey.com/s/HSP8GTR.

I would really appreciate if you would complete the questionnaire. Your responses are confidential and will not be shared with anyone. You may refuse to participate or withdraw from the study at any time. There will be no cost to you nor will you be compensated for participating in this research study. There is also a phone-interview section which constitutes the second part of my study. If you are willing to participate in this optional phone interview, please indicate by providing your name and contact information at the end of the survey. Eight (8) teachers who indicate their consent to participate in the phone-interview will be randomly chosen for a follow-up phone interview. You may ask about your rights as a research subject or you may report any comments, concern, or complaints to the University of Nevada, Reno Social Behavioral Institutional Review Board, telephone number (775) 327-2368, or by addressing a letter to the Chair of the Board, c/o UNR Office of Human Research Protection, 205 Ross Hall / 331, University of Nevada, Reno, Reno, Nevada, 89557.

Thank you for your cooperation.

Sincerely,

Abraham Ayebo

(Doctoral Candidate, Department of Educational Specialties, University of Nevada, Reno).
Email to prospective Interview Participants

Dear______________:

Thank you for taking time to complete the online survey that I sent to you a few weeks ago. I would like to conduct a phone interview with you as a follow up to the survey. I am asking you to participate in the phone interview because I feel your outlook will be a valuable addition to the data I have collected already collected.

I will provide you with a set of interview questions ahead of time, so that you will know what types of information I am seeking. The interview will be conducted at a time that is convenient for you, and will last for between 30 and 45 minutes. The interviews will be audio-taped and transcribed by me. Your responses are confidential and will not be shared with anyone. You may refuse to participate or withdraw from the study at any time. You may ask about your rights as a research subject or you may report any comments, concern, or complaints to the University of Nevada, Reno Social Behavioral Institutional Review Board, telephone number (775) 327-2368, or by addressing a letter to the Chair of the Board, c/o UNR Office of Human Research Protection, 205 Ross Hall / 331, University of Nevada, Reno, Reno, Nevada, 89557.

I hope you will consider being interviewed for my study.

Thank you.

Sincerely,

Abraham Ayebo

(Doctoral Candidate, Department of Educational Specialties, University of Nevada, Reno).
APPENDIX C: PILOT TEST REVIEW SHEET

Thank you for accepting to review and complete this questionnaire. Your answers will only be used for pilot analysis. I appreciate your help to improve this questionnaire. Here is a list of some common problems in most questionnaires. If you see any of these problems or any other problems, please write a note next to the corresponding questions and statements.

1. For individual questions

   The question is

   a) vague

   b) unnecessary or irrelevant

   c) very hard to answer or impossible to answer

   d) too long

   e) redundant

   f) biased

   g) offensive/ invasive

   h) likely to be left blank

   The answer choices are

   a) unnecessary

   b) not enough
2. For overall questionnaire:

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>The questionnaire is too long</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not all necessary questions have been included</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The questionnaire is boring</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The directions are hard to follow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There are problems with the order and the flow of the questions</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note:* Please ignore the formatting problems of the questionnaire. The format will be different when it is online.
Appendix D: IRB APPROVAL LETTER

Certification of Approval
Social Behavioral, Panel B
Institutional Review Board

Date: May 13, 2010
To: Lynda R. Wiest, PhD
Department of Educational Specialties / 0299
CC: Abraham Ayebo
Department of Educational Specialties / 0299

UNR Protocol Number: SB09/10-147
Protocol Title: Teachers' Perspectives on Teaching Mathematics to Elementary Gifted / Talented Students
Sponsor Protocol Number: No
Sponsor:
VA Research: No
UNR Assurance Number: FWA00002306
IRB Number: IRB00003498
Action Item: New Protocol: Social Behavioral
Level of Review for Action: Expedited
Expeditoed Category: 6 & 7
Review Period: 12 months
Final Approval Date: May 13, 2010
IRB Action Date: April 28, 2010
Expiration Date: April 28, 2011

This approval is for:
Protocol application, as revised, 05/12/10
Recruitment email, as submitted, no date
Invitation letter, as revised, no date
Interview recruitment email, as revised, no date
Waiver or alteration of consent: Online information sheet, as revised, May 12, 2010
Research survey, as revised, May 12, 2010
Interview questionnaire, as submitted, no date

PI responsibilities
- Continuing projects must be reviewed and approved prior to the expiration date.
- Proposed changes must be reviewed and approved by the IRB prior to initiation, except when necessary to eliminate apparent immediate hazards to subjects. Such exceptions must be reported to the IRB at once.
- Any unanticipated problems which may increase risks to human subjects or unanticipated adverse events must be reported to the IRB within 10 days of becoming aware of the issue.
- When the project has been completed, please submit a closure request to the IRB.

Please reference the protocol number above on all related correspondence with the IRB. If you have any questions, please contact Valerie Smith at 775.327.2368.

[Signature]
Chair, Vice-Chair, of OHRP Director
Susan Ford Publicover, MA, CIP, Director

Cert_exp