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Comparing Differences in Math Achievement and Attitudes Toward Math in a Sixth Grade Mathematics Enrichment Pilot Program

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Comparing Differences in Math Achievement and Attitudes

Toward Math in a Sixth Grade Mathematics

Enrichment Pilot Program

by

Tamara Tow

A Dissertation submitted to the Education Faculty of Lindenwood University

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Declaration of Originality

I do hereby declare and attest to the fact that this is an original study based solely upon my own scholarly work here at Lindenwood University and that I have not submitted it for any other college or university course or degree here or elsewhere.

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Signature: Tamara Tow Date: 3/11/2011

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Abstract

High-stakes assessments have encouraged educators to ignore the needs of the top performers. Therefore, the Oakwood School District decided to implement a mathematics pilot enrichment program in order to meet the needs of the advanced mathematics students. As a result, this study used quantitative data to determine if there was a significant change in the academic achievement and attitudes over the course of the year of sixth-grade students in the enrichment math pilot program. The curriculum for the pilot program centered on the same topics as the regular program, however, it involved more application of the basic concepts and of mathematical reasoning in order to solve multistep problems.

Twenty-two students were eligible for this program because they scored at the 90th percentile or higher in mathematics on the state achievement test during their third through fifth grade years. Students in the program were male (55%), female (45%), Asian (35%), White (65%), and Gifted and Talented (45%).

There were no significant changes from fall to spring in students' responses to all of the survey questions but one, concerning how often they get good grades in math. Students indicated that they do not find math to be easy and that they do consider themselves to be proficient at math. However, there was a significant change on the advanced assessment which measured how well the students could utilize math skills in order to solve multistep problems and most of the questions discriminated well between higher and lower performing students.

Finally, the regression analysis revealed that the best prediction of students' final scores on the advanced assessment could be made with five measures: post-test raw

scores on the district common assessment, pre-test scores on the advanced math assessment, the students' percentile ranks on the Scholastic Reading Inventory, their scale scores from the fifth grade MAP math assessment, and whether or not they were qualified for the gifted program. These five variables together were strongly correlated with the post-test advanced math assessment results (multiple $R = 0.887$), and this relationship was definitely statistically significant ($F [5, 14] = 10. 305$, $p < 0.0005$). This study was limited to the 22 students in the enrichment class and there was no opportunity to study a control group. Since completion of the study, all five middle schools in the district have implemented an enrichment math program for the sixth grade. Therefore, the researcher suggests that more investigations be completed on the program now that the sample size has grown.

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Chapter One: Introduction

When the No Child Left Behind Act (NCLB) was passed in 2002, it created a sense of urgency regarding accountability for educators across the nation. Since then, school leaders have been attempting to show how they are improving education for all students. There has been a discrepancy, however, in this attempt. The focus has been not on all students, but on the underperforming students. Research has focused heavily on strategies and the overall achievement of students who are below grade level. High-stakes assessments have essentially allowed educators to ignore the needs of the top performers because teachers are more concerned with contributing to the school's annual yearly progress. Therefore, the upside potential for improvement with the lower students is greater than with the already proficient students. As a result, educators focus more on the underachieving students and do not monitor the improvement of students who are "proficient" or "advanced." Therefore, this study will focus on the academic achievement and attitudes of sixth-grade students who are placed in an enrichment math pilot program. The researcher was curious whether this type of program made a difference in the way students felt about mathematics, whether they felt challenged, or whether their interest in math increased as a result of the enrichment program. Since this was the only pilot program being offered at the time of this study, the researcher chose to analyze it.

Background of the Study

Since 1995, when the sixth grade moved from the elementary schools to the middle schools in the Oakwood School District, sixth-grade students have been grouped heterogeneously for all subjects. Teachers were expected to differentiate the curriculum in order to meet the needs of all students in their classrooms. In the seventh and eighth grades, the math program provided a “challenge” course, which covered more subject matter at a faster pace than the regular course. Challenge courses are different from the gifted program in that they focus specifically on accelerating the academic focus area of that course. Whereas, the gifted program is an enrichment program which focuses on meeting the academic, social, and affective needs of the gifted learner in three major areas including communication, nature, and civilizations. However, students who completed the challenge courses in middle school were eligible to enroll in geometry as a high school freshman which placed them on a faster, higher level track for mathematics. Students do not have to be labeled “gifted” in order to take challenge classes. In 2008, Oakwood decided to pilot an “enrichment” mathematics program in the sixth grade at one middle school. To be eligible for this program, students had to score at the 90th percentile or higher on the SAT10 Mathematics Problem Solving and Total Mathematics sections during their fourth- and fifth-grade years. They also had to be at the proficient or advanced level on their Missouri Assessment Program (MAP) in both the third and fourth grades. A total of 22 students qualified for the program. Being labeled “gifted” did not affect their placement in the program. Although some students in the pilot were also in the gifted program, not all students in the gifted program were in the pilot.

The Oakwood philosophy maintained that “in order to be effective citizens in the 21st century,” students required a thorough understanding of mathematics skills and concepts (Parkway School District Board of Education, 2010, p. 1). Oakwood educators believed “students must encounter problem situations which require reasoning, computation, and communication” at all levels (Hudson, 2009, p. 1). By emphasizing the most efficient methods for reaching solutions and examining different solution methods, the pilot program differed from the traditional approach of teaching mathematics. The traditional approach introduced one concept at a time and assessed those concepts individually, whereas the pilot program assumed the students already had a basic knowledge of certain concepts and then demanded the students apply several of these concepts at the same time in order to solve more difficult problems. In theory, students in the pilot program would develop more flexible problem-solving skills than those practiced in the regular math program. While the pilot focused on introducing the same enduring understandings in mathematics (number sense and algebraic thinking, decimals, fractions, measurement and statistics, data representation, rations, proportions, and percentages, geometric figures, and perimeter and area) as those in the regular sixth-grade math program, the pilot curriculum emphasized more math reasoning and multistep problem solving. The pilot stressed higher ordered thinking and application skills.

The Oakwood School District needed to determine if this program was successful. Oakwood seeks to discover whether the students in the pilot program, based on previous performance and other available information, increased their academic performance. Did the pilot program "add value" to the education of students? How will the program affect students' attitudes towards math? Should the pilot program be implemented in every middle school throughout the district on a broader scale?

Statement of Problem

High-stakes assessments have essentially allowed educators to ignore the needs of the top performers. When attention is focused on students at the "bottom of the achievement distribution, NCLB is surely encouraging schools to neglect high achievers. After all, schools face consequences for failing to move low achieving students to proficiency" (Thomas B. Fordham Institute, 2007, p. 14). *The 2001 Brown Center Report on American Education* (Loveless, 2001) "found that although scores in math are rising, they are less than reported in the prior year," which indicates that progress may be slowing, especially in the elementary grades (p. 8). According to the *Highlights from the Trends in International Mathematics and Science Study (TIMSS)*, there were "no measurable gains in the average mathematics scores of U.S. fourth-graders between 1995 and 2003" (National Center for Education Statistics, 2004, p. 24). The Thomas Fordham Institute (2007) reported that "while the nation's lowest-achieving youngsters make rapid gains from 2000 to 2007, the performance of top students was languid. Children at the tenth percentile of achievement have shown solid progress in fourth-grade math …since 2000, but those at the 90th percentile have made minimal gains" (p. 2). The National Assessment of Education Progress (NAEP) reported in 2004 that "the average score in mathematics at age 9 was higher in 2004 than in any previous year" (National Center of Educational Statistics, 2005, p. iv). However, from 1973 to 1999 "there was no measurable difference in the average" scores of 17-year-old students (National Center of Educational Statistics, 2005, p. iv). NAEP also reported that although 9-year-olds and 13-year-olds showed overall gains in their performance of moderately complex procedures and reasoning, between 2004 and all the previous assessment years there was no measurable change of 17-year-olds' ability to solve multistep problems (National Center of Educational Statistics, 2005, p. 23). In summary, "Only about one in four American elementary and middle school students is proficient in math" (Haycock, 2002a, p. 3). Curriculum tends to spiral. So it is logical that in order for students to continue growing in their knowledge they must make gains in the lower years. If educators want to see students improve academically when students are in high school, then interventions must be made in the elementary and middle school years in order to foster growth. Therefore, this study will focus on the academic achievement and attitudes of sixth-grade students who were placed in an enrichment math pilot program for the first time in the district.

Research Questions and Hypothesis

This study examined four overarching questions involving achievement in an enrichment pilot math program and attitude changes towards math as a result of the program.

RQ1: Will the students in the pilot math enrichment program show improvement on an advanced post-assessment?

$H1_0$: There will be no relationship between student scores on the advanced pre-assessment and student scores on the advanced post-assessment.

RQ2: Will there be a relationship between student scores on the advanced pre/post-assessments and the district post-tests?

$H2_0$: There will be no relationship between student scores on the advanced pre/post-assessment and the district's common assessment.

$H3_0$: There will be no relationship between student scores on the advanced pre/post-assessment and the MAP scores.

RQ3: Will there be a difference in student response when comparing results for students who scored in the top half on the total advanced pre/post-assessments and those who scored in the bottom half on the total advanced pre/post-assessments?

$H4_0$: There will be no difference in student response when comparing results for students who scored in the top half on the total test and those who scored in the bottom half on the total advanced pre/post-assessments.

RQ4: How does the enrichment pilot program affect students' attitudes towards math?

$H5_0$: There will be no significant change from pre to post responses on any individual survey item.

$H6_0$: There will be no relationship between the student responses on the complete survey and student scores on the district's common assessment.

$H7_0$: There will be no relationship between the student responses on the complete survey and student scores on the advanced post-assessment.

Purpose of Study

Oakwood School District incorporated the enrichment program into the School Improvement Plan for school year 2008-09 in response to failure to improve math scores for all students on the MAP as predicted. Other interventions were implemented for students who were below grade level. If the pilot math enrichment program succeeded in improving math achievement at one middle school, then the district planned to implement the program district-wide. One possible benefit of this study would be to utilize the data from the fall and spring survey in order to positively impact the methods used to teach the students. The fall and spring survey could indirectly help teachers improve their instruction and, as a result, improve student learning. Correlations run between the district's common assessment and the advanced assessment could show a relationship between attitude and achievement. By asking certain questions related to the survey at the beginning of the year instead of waiting for academic assessment results, educators could determine which students might need additional help immediately in order to increase their academic achievement. It would be beneficial to educators and students to find a correlation between achievement and attitude.

This study could possibly benefit the district by showing that the students learn information better using the new curriculum. As a result, the new curriculum could be implemented in part or in whole into the regular sixth-grade mathematics curriculum in order to benefit all students. This study could possibly benefit all math instructors in the district and possibly all teachers in general by showing how the use of surveys could positively influence instruction if the survey can be correlated significantly to the achievement tests.

Definition of Terms

The following terms used in the gifted/advanced field of education are important in order to fully comprehend the meaning of the study.

Enrichment is defined as providing children with extra cognitive stimulation. This term is used to “refer to any supplementary activity, intervention, or opportunity added to a child’s daily life experiences” (Children with Challenges, 2009, p. 1). Enrichment refers to activities “that add or go beyond the existing curriculum” (National Association for Gifted Children, 2008, p. 19). Kulik and Kulik (1992) provided their own definition of enrichment in the article “Meta-analytic Findings on Grouping Programs.” They explain that enrichment classes are those in which “students who are high in aptitude receive richer, more varied educational experiences than would be available to them in the regular curriculum for their age level” (Kulik & Kulik, 1992, p. 74). For the purposes of this study, these activities will occur in a setting separate from the regular classroom.

The term *acceleration* should be defined separately from enrichment. In accelerated classes, “students who are high in academic aptitude receive instruction that allows them to proceed more rapidly through their schooling or to finish schooling at an earlier age than other students” (Kulik & Kulik, 1992, p. 74). VanTassel-Baska (1992) pointed out that “acceleration should refer to the rapid rate of a child’s cognitive development, not the educational intervention provided” (p. 68).

The term *ability grouping* will be used to refer to “a class or group assignment based on observed behavior or performance. Ability grouping is not the same as tracking” (National Association for Gifted Children, 2008, p. 1). Feldhusen and Moon (1992) clarified the difference between these two terms: Tracking implies assignment “to a special sequence or program of classes with other students of similar general ability” for a relatively long period of time, whereas ability grouping is a flexible process based “on prior achievement levels in particular curricular areas” (p. 65). Movement in and out of the special group is possible at almost any time as the students show new abilities or fail to perform. VanTassel-Baska (1992) defined ability grouping “as the organizational mechanism by which students at proximate ability levels within a school curriculum are put together for instruction” (p. 68).

Homogeneous grouping is another term used to refer to the grouping of students by need, ability, or interest (National Association for Gifted Children, 2008). When children are grouped homogeneously, rapid and advanced instruction can occur which will correspond to the abilities and skills of the more advanced students. Kulik and Kulik (1992) have spent years researching homogeneous and ability grouping. They continue to promote the use of homogeneous grouping for gifted students in enrichment programs.

The National Association for Gifted Children (1991) explained that the abandonment of the "proven instructional strategy of grouping students for instruction at a time of educational crisis in the U.S. will further damage our already poor competitive position with the rest of the world, and will renege on our promise to provide an appropriate education for all children" (p.5). The terms ability grouping and homogeneous grouping will be used interchangeably throughout this paper.

The term *heterogeneous grouping* refers to students who are mixed by ability or readiness levels. A heterogeneous classroom is "one in which a teacher is expected to meet a broad range of student needs or readiness levels" (National Association for Gifted Children, 2008, p. 22).

The term *common assessment* refers to the district-wide proprietary achievement test administered to all students at each grade level twice a year. The common assessments were created by teachers with the help of the mathematics curriculum coordinator from the district. They include both multiple choice type questions as well as open-ended answers. The term *advanced pre/post-assessment* refers to a proprietary mathematics achievement test designed specifically for the math enrichment pilot program by the researcher and the mathematics curriculum coordinator for the district. The assessment was based on multiple step problem solving questions.

The *Standford Achievement Test, Tenth Edition* (SAT10) is a multiple-choice norm-referenced achievement test used from kindergarten through 12th grade. The SAT10 provides scaled scores, national and local percentile ranks and stanines, grade equivalents, and normal curve equivalents (Pearson Education, 2010b).

The *Otis-Lennon School Ability Test* (OLSAT) (Pearson Education, 2010a) assessed abilities that are related to school success and evaluated skills such as finding similarities and differences, recall, following directions, classification, sequence of events, and analogies. The OLSAT tested students' ability to reason and think logically.

The *DOMINIE* (Williams, 2009) reading assessment tested a variety of oral and written skills related to reading. The assessment consisted of short-answer, fill-in-the-blank, multiple-choice and read aloud.

The *Scholastic Reading Inventory* assessment (SRI) "is a reading comprehension test which assess students' reading levels, tracks students' reading growth over time, and helps guide instruction according to students' needs" (Scholastic, 2010).

The Sixth Grade Enriched Math Pilot at Oakwood School District is a pilot program which contains the same curriculum as the general mathematics program (Appendix A), but with greater depth and application (Appendix B). Both the general mathematics program and the enrichment math pilot program use the textbook *Math 1* (Larson, Boswell, Kanold, & Stiff, 2007) and the *Connected Mathematics* (Lappan, Fey, Fitzgerald, Friel, & Phillips, 2006) text. However, students are assigned different types of problems accordingly. For example, the students in the pilot program would be assigned the challenge problems whereas the regular students would not be required to complete them.

Value-added analysis is "a statistical method used to measure teachers' and schools' impact on students' academic progress rates" from year to year (ASPIRE, 2008, p. 1). Value-added

> uses a student's own academic performance as a basis for determining his or her academic growth and is not related to a student's socioeconomic status or other personal characteristics that typically confound achievement based measures. To dampen the error of measurement from any one single test, value-added uses all student test data simultaneously within the calculation. (HSID, 2010, p. 1)

Dr. William Sanders, director of the Value-Added Research and Assessment Center in Knoxville, Tennessee, is the founder of value-added analysis. He is a statistician and has been analyzing data for nearly 30 years. Sanders explained that "the value-added assessment process is quite different from NCLB. Value-added assessment involves following the same student throughout the grades" (New York State Educational Conference Board, 2004, p. 4). Three criteria must be met in value-added analysis. First, the curricular objectives being assessed must be correlated to the tests. Second, there needs to be a sufficient stretch in order to measure different student abilities. Finally, many different types of data on individual students need to be included from multi-discipline areas. What makes value-added assessment so different from other assessments is that it permits each individual student to serve as his or her own control (New York State Educational Conference Board, 2004). In other words, students are not compared to other students. They are compared to themselves, therefore, each child's progress is monitored individually in order to see if they have improved. It also allows growth to be followed over time. This type of analysis differs significantly from the norm-reference tests typically used to compare students to each other at one moment in time. Value-added analysis shows variability among students, schools, and individual classrooms.

This research study uses value-added analysis throughout chapter 4. Data will be continually evaluated using this method.

VanTassel-Baska (2003) defines a *differentiated* curriculum in her writing. She describes it as one that

> is tailored to the needs of the groups of gifted learners or individual students and provides experiences sufficiently different from the norm to justify specialized intervention [and is] delivered by a trained educator of the gifted using appropriate instructional and assessment processes to optimize learning. (p. 175)

Limitations

Limitations are described as potential weaknesses or problems in a study. Some examples of weaknesses may be sample size, errors in measurement, different instructors' teaching styles, or the types of instruments being used to gather data. The research study was designed to investigate the enrichment pilot mathematics class at one middle school. Because this was a pilot program and the only one being implemented, one major limitation was the sample size. For example, there were only 22 students in the sample. Also, since this was the only class being offered at the time, there was no opportunity to study a control group. Therefore, another limitation was that this class could not be compared to any other enrichment group. Students in the regular mathematics class could not be used as a control since they did not meet the original qualifications for the sample nor did they take the initial pre-advanced assessment. The sample was also limited by the specific instructor teaching the class. Again, since the pilot enrichment mathematics class was the only one of its kind available, there was only one instructor assigned to teach it. Because this study reviewed one school year, time was another limitation. A longitudinal study would have provided more information.

Finally, the assessment tools used in this study could also be viewed as limitations. The achievement test scores of the enrichment group were a limitation. Given the fact that the students in this class needed enrichment to begin with, it was understandable that their test scores would be high. In fact, the MAP scores and common assessment scores of the students were so high that they showed little room for growth. Therefore, other data were needed to evaluate the program and so the researcher and the mathematics curriculum coordinator for the district created an advanced pre/post-assessment. That assessment could also serve as a limitation. The director of program evaluation and the researcher generated the fall and spring survey based on a core of questions used in former surveys by the district and several other local school districts over the past 10 years. The survey itself was a valid and reliable tool, however, another limitation regarding the survey was the fact that only data was gathered from only 22 students.

Conclusion

Recent research has focused heavily on strategies and the overall achievement of students who are below grade level in response to NCLB. Essentially the needs of the students who were considered “proficient” or “advanced” had been ignored. Therefore, this study will focus on the academic achievement and attitudes of sixth-grade students who are placed in an enrichment math pilot program. The pilot was based on best practices in the teaching of mathematics. Since this was the first time for the district to offer this type of program, it needed to analyze the effectiveness of the program.

This research examined how student achievement on a common assessment and an advanced pre/post-assessment for sixth-grade students was affected by a one-year pilot mathematics enrichment program. The researcher used nine different types of demographic data in a multiple regression equation to predict the post-test measures using a value-added analysis. Finally, a fall and spring survey was collected and analyzed in order to determine how student attitudes towards math were affected as a result of this pilot math enrichment program.

The following chapter will summarize information regarding the improvement of American students and their struggle with mathematics. It will explore the inconsistencies in achievement rates of students in the United States and how they compare to other countries. The review will discuss topics including the national assessments and mathematics curriculum. It will also explore theories and ideas surrounding the social and emotional impact on ability grouping. Finally, it will investigate the significance of enrichment and differentiation opportunities.

Chapter Two: Review of the Literature

This literature review will synthesize information concerning the progress of American students and their struggle with mathematics. It will explore the inconsistencies in achievement rates of students in the United States. The review will discuss topics including the national assessments, curriculum, and social and emotional impact on ability grouping. Finally, it will investigate other studies which focused on enrichment and differentiation opportunities as well as the influence of ability grouping. The pilot is based on best practices in the teaching of mathematics. The researcher will compare the pilot to the literature in this chapter.

National and International Assessments

The NCLB legislation was mandated to ensure that all children in the United States were making educational gains. In one aspect, the program is working as designed, and "the bottom 10 percent of students have made solid gains in fourth-grade reading and math and eighth grade math since 2000" (Thomas B. Fordham Institute, 2007, p. 2). However, the progress of the top students has been mediocre. In addition, teachers report feeling the need to focus more on the under achievers even though they believe that all children deserve equal attention (Thomas B. Fordham Institute, 2007). Part of the reason the high achievers have been ignored is that NCLB standards are tied to "proficiency," not to percentiles. Percentiles are used to compare how students rank relative to other students on the same assessment. The word "proficiency" simply means above grade level. The federal government has allowed each state the flexibility to determine what it means to be "proficient." Therefore, each individual state has a different definition of the word. This type of vagueness in definition has impacted the way assessment results are interpreted and will be discussed in the following paragraph. Since all states are required to show yearly progress and to eventually show that all students are proficient in mathematics and communication arts, teachers have more incentive to focus on the under-achieving students since they are the ones who are not yet proficient. As a result, the gaps between test scores between high achievers and underachievers have narrowed. Although this is an important accomplishment, it also shows that high achievers have not flourished in the NCLB era. The "nation has a strong interest in developing the talents of its best students to their fullest to foster the kind of growth at the top end of the achievement distribution that has been occurring at the bottom end" (Thomas B. Fordham Institute, 2007, p. 35). That kind of growth among high achievers could help ensure that American students are able to compete internationally.

According to the NAEP's 2009 report (Sciences, 2010), Missouri fourth-grade students did not score significantly higher than the average public school student in the nation. The MAP scores supported NAEP's results because according to the MAP students in Missouri scored 241 and the average score for the nation was 239. Eighth-grade students in Missouri, however, did score higher than other students in the nation, with the average score for Missouri students being 286 and the average score for the nation being 282. It is important to note that the MAP scores are used to determine proficiency which looks different for every state.

In fact, it appears so different that Peterson and Lastra-Anadon (2010) assigned each state a grade depending on how well the state test compared to the national assessment. Peterson and Lastra-Anadon explained how they "computed the difference between the percentage of students who were proficient on the NAEP and the percentage reported to be proficient on the state's own tests for the same year" (2010, p. 14). Then they determined the standard deviation for the difference and figured how many standard deviations each state was above or below the average difference. Each state was then assigned a grade based upon how many standard deviations they were from the norm.

Table 1 compares fourth graders in Missouri to fourth graders in states which scored higher in mathematics in 2009. Table 2 compares eighth graders in Missouri to eighth graders in states which scored higher in mathematics in 2009. It is important to note that 24 states reported better fourth grade scores than Missouri and 22 states reported better eighth grade scores than Missouri. All of those states claim to have fewer students at or below basic and more students at the proficient or advanced level than in Missouri.

Yet, Table 3 shows the grade given to each state in 2009 by Peterson and Lastra-Anadon (2010). Missouri and Massachusetts were the only states to receive an A in mathematics in both the fourth and the eighth grades.

Table 1

2009 Grade 4 Average State Scores in Mathematics

Order	Jurisdiction	All students average scale scores	All students below basic	All students at basic	All students at proficient	All students at advanced
6	Kansas	245	11	43	40	6
7	North Dakota	245	9	47	40	5
8	Connecticut	245	14	39	38	8
11	Maryland	244	15	41	35	9
12	North Carolina	244	13	43	35	8
13	Ohio	244	15	40	38	8
14	Pennsylvania	244	16	39	38	8
15	Wisconsin	244	15	40	37	8
17	Virginia	243	15	43	35	7
19	Iowa	243	13	45	36	5
21	South Dakota	242	14	44	37	5
23	Florida	242	14	46	35	5

24	Idaho	241	15	44	36	5
25	Missouri	241	17	42	35	6

Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2009 Mathematics Assessment.

Table 2

2009 Grade 8 Average State Scores in Mathematics

Order	Jurisdiction	All students average scale scores	All students below basic	All students at basic	All students at proficient	All students at advanced
4	North Dakota	293	14	43	36	7
8	South Dakota	291	17	41	34	7
10	Connecticut	289	22	38	30	10
11	Kansas	289	21	40	31	8
12	Maryland	288	25	35	28	12
13	Pennsylvania	288	22	38	30	10
14	Wisconsin	288	21	40	31	8
16	Idaho	287	22	40	30	8
19	Texas	287	22	41	28	8
22	Virginia	286	24	41	27	8
23	Missouri	286	23	41	29	7

Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2009 Mathematics Assessment.

Table 3

Strength of State Mathematics Proficiency Standards, 2009

State	Grade 4	Grade 8
Massachusetts	A	A
Missouri	A	A
Washington	A	B+
New Hampshire	B	B-
Vermont	B	B-
Maine	B-	C+
Minnesota	B-	C+
Montana	B-	C+
New Jersey	B-	C+
Indiana	C	C
Ohio	C	C
Florida	C	C-

Pennsylvania	C	C-
South Dakota	C	C-
Wisconsin	C	C-
Wyoming	C	C-
North Dakota	C-	C-
Connecticut	C-	D+
Iowa	C-	D+
Kansas	C-	D+
North Carolina	C-	D+
Colorado	C+	C+
Idaho	D	D
Maryland	D	D
Texas	D	D-
Virginia	D+	D

Source: "State Standards Rise in Reading, Fall in Math," by P. Peterson and C.X. Lastra-Anadon, 2010, *Education Next*, *10* (4), 12-16.

Figures 1 and 2 show the relationship between the average scaled scores for fourth and eighth graders in Missouri and the nation from the year 1990 to 2009. The graphs show a steady increase in the national average score, with Missouri scores falling just above or just below the national average. Missouri has made improvement over time consistent with the rest of the nation.

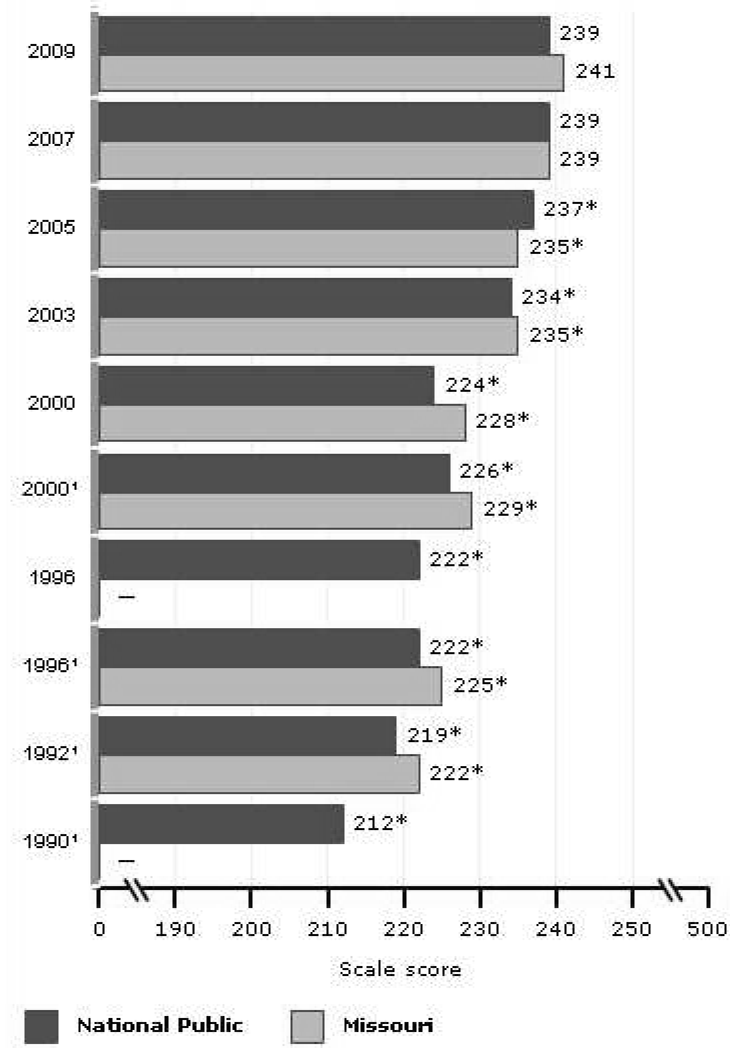


Figure 1. Average scaled scores for mathematics, fourth grade by year
Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1990, 1992, 1996, 2000, 2003, 2005, 2007, and 2009 Mathematics Assessments.
- Not available,
*Significantly different (*p*<.05) from 2009,
[1]Accomodations were not permitted for this assessment.

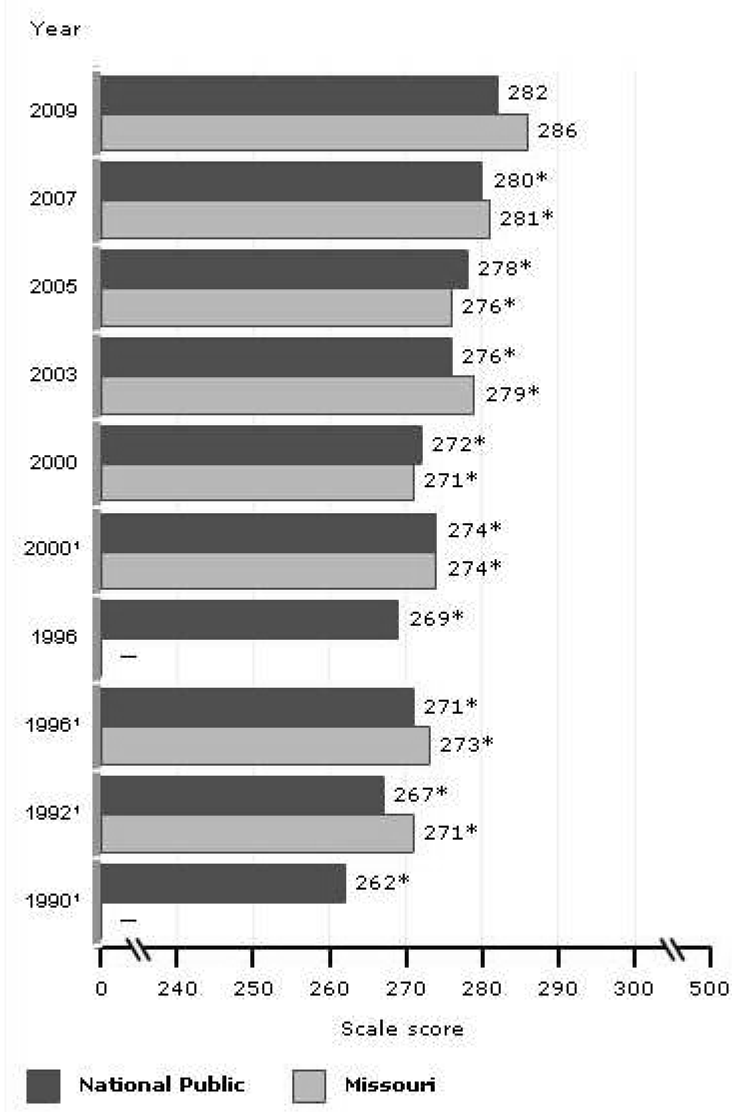


Figure 2. Average scaled scores for mathematics, eighth grade by year
Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1990, 1992, 1996, 2000, 2003, 2005, 2007, and 2009 Mathematics Assessments.
- Not available,
*Significantly different (p<.05) from 2009,
[1]Accomodations were not permitted for this assessment.

The data from these mathematics assessments show that although Missouri was making progress in raising test scores, the state consistently performed better than only half of the other states. As previously mentioned, each state was responsible for establishing its own method of assessment and what constitutes proficient. This raises the question of whether or not all assessments were equal in difficulty. The answer is no. According to Time.com (Time Inc., 2010), not all state assessments were the same. When compared to the national assessment, all state assessments were less difficult, and many were far less difficult. Missouri was the only state whose assessment was rated within two percentage points relative to the national test. In fact, Missouri ranks second in the nation in difficulty when compared to the other states.

One international organization, the Organization for Economic Cooperation and Development (OECD) (2010), conducted extensive research on a wide range of topics including education. The organization formed after World War II in order to help rebuild Europe. OECD's Programme for International Student Assessment (PISA) assesses life skills in reading, mathematics, and scientific literacy (2010). PISA administered between 4,500 and 10,000 standardized assessments to 15-year-olds in each of over 30 participating countries in one year. Figure 3 shows the ranking of the United States in mathematics in 2006 when compared to 21 other countries and the OECD average.

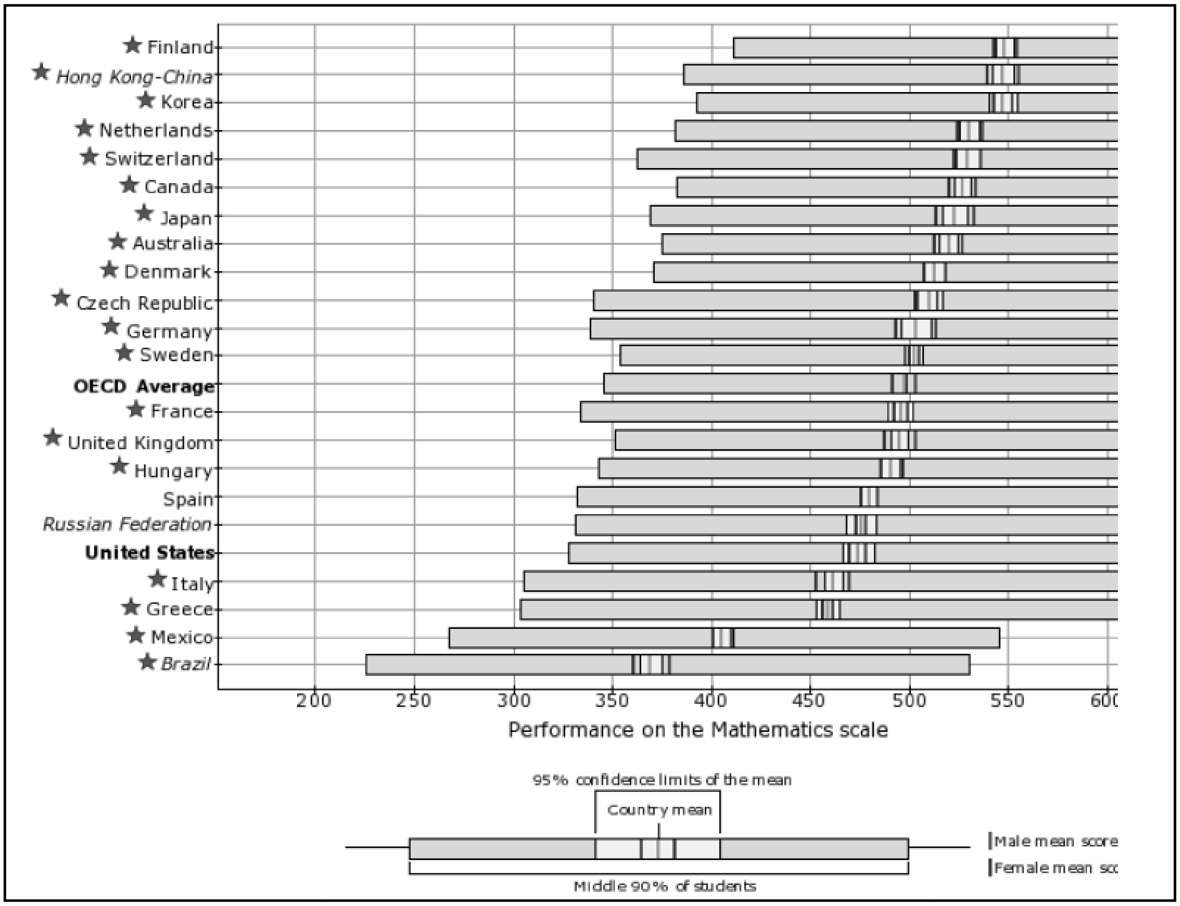


Figure 3 Ranking of the countries in mathematics in 2006
Source: PISA 2006 database. http://pisacountry.acer.edu.au/

The 2001 Brown Center Report on American Education (Loveless, 2001) "found that although scores in math are rising, they are less than reported in the prior year," which indicates that progress may be slowing, especially in the elementary grades (p. 8). According to the *Highlights from the Trends in International Mathematics and Science Study (TIMSS)*, there were "no measurable gains in the average mathematics scores of U.S. fourth-graders between 1995 and 2003" (National Center for Education Statistics, 2004, p. 24). Yet, U.S. eighth graders increased their mean mathematics scores from 1995 to 2003 on the national assessment. The inconsistency between state, national, and international assessment scores continues to be debated by researchers. This indicates the importance of using multiple assessments.

Mathematics Curriculum

Perhaps one reason U.S. students' mathematics scores plateau in the upper grades is the curriculum alignment. Haycock (2002a) discussed the discrepancies between high school and college mathematics curricula. She pointed out that the "fastest growing part of the high school curriculum during the 1980s and the 1990s was in Advanced Placement or other" college-type courses (Haycock, 2002a, p. 1). This information might lead to the assumption that students were improving in the area of mathematical thinking. However, Haycock is quick to explain that during the same time period the "fastest growing part of the college mathematics curriculum was in remedial" courses (2002a, p. 1). The discrepancy between the levels of courses continues to raise concern among educators. Algebra is taught to students at the top level in high school but it is also taught at the lowest level in college. One possible explanation for students being "misplaced" is because of the way they are grouped together. Another explanation for the discrepancy could also be the way the curriculum is designed. Both of these issues will be discussed in the following paragraphs.

Despite the constant changes in the nation's approaches to teaching mathematics, American students continue to learn. However, they are not learning at the same rate as their competitors in other countries. Haycock (2002a) pointed out that "while our K-12 students know more mathematics now than they did in 1990, so do their peers in other countries," and therefore, American students did not make adequate improvement to escape the current average position (p. 1). She also reflected upon NAEP and explains that between 1996 and 2000 high school performance actually *declined* by a statistically significant 3 points (Haycock, 2002b, p. 5). U.S. students struggle to compete with students of other countries in the field of mathematics. There must be something the American education system can do differently to increase mathematics achievement.

The 1999 TIMSS study revealed that the amount of time spent on *mathematical procedures* was not the reason other countries were achieving at higher rates than the United States (National Center for Education Statistics, 2004). Stein, Remillard, and Smith (2007) explained that U.S. classrooms seldom spend time occupied in the fundamental analysis of mathematical concepts. They further explained that other countries spent more time making connections between the mathematical functions and their applications. Haycock (2002b) affirmed this idea by explaining how, in comparison to other countries, the United States covers many more math themes from one year to the next. In other words, the curriculum becomes a “mile wide” and an “inch deep,” which is why the United States cannot compete internationally (Haycock, 2002b, p. 9). Haycock added that, because American textbooks are too long, teachers are forced to curtail the curriculum as needed by determining what they believe is important to teach. This piecemeal approach to the curriculum could be the cause of the inconsistency in the mathematics curriculum and provides one possible explanation of the lack of depth of knowledge.

According to Stein, Remillard, and Smith (2007), students most likely do not simply develop more or less knowledge but rather acquire knowledge, beliefs, and understandings that differ in important ways, including how they become available for use at later points (p. 361). Stein et al. advocated the need for investigations to further explore the forms of knowledge and understanding that students develop. *The 2001 Brown Center Report on American Education* found that "emphasizing reasoning and problem solving seems to be related to high math achievement" (Loveless, 2001, p. 11). Therefore, not only is the curriculum itself important, but also the way it is delivered. Students need an opportunity to relate information they learn to higher forms of problem solving in order to completely understand how to utilize a concept. The Oakwood School District's sixth-grade enriched math pilot program was designed to do just that.

Teachers who encourage and use problem-based and inquiry strategies instead of the usual skill-and-drill strategies develop deeper mathematical essential understandings among gifted math students. Several researchers (de Lange, 2007; Sheffield, 1999; Usiskin, 1987; VanTassel-Baska, 2003) have found evidence to support teaching mathematics using higher level thinking skills as a more in-depth approach to the curriculum. Research repeatedly emphasizes the need for students to have opportunities to explore the concepts of different standards by using their higher level thinking skills. De Lange (2007) specifically explained that in mathematics, for example, students should not be required to complete simple calculations in isolation but should instead make mental constructions with more reflections by solving more "real-world" problems (p. 1124). The enrichment math pilot program was designed to challenge the students with higher level thinking opportunities while meeting the set standards. It contains the same curriculum as the general sixth-grade mathematics program, but offers greater depth and application.

The research from TIMSS and NAEP has had a direct influence on the types of curricula schools use in their programs. The National Council of Teachers of

Mathematics (NCTM) and the National Science Foundation (NSF) advocate a standards-based curriculum. Stein et al. (2007) discussed the importance of standards-based curricula, writing that these curricula embody an approach to learning that focuses on students' active construction of important ideas and concepts while more conventional curricula present content directly and expect the teacher to explicitly teach students the skills, concepts, and procedures that are the goal of the lesson (p. 360). A standards-based learning environment was associated with higher performance on an assessment of thinking, reasoning, and problem solving regardless of the curriculum (Stein et al., 2007, p. 359). Stein et al. (2007) explained how "students taught using standards-based curricula tended to hold their own on tests of computational skills and to outperform students taught with conventional curricula on tests of thinking, reasoning, and conceptual understanding" (p. 360). Students taught using standards-based curriculum understood more of the actual concepts and could perform at higher levels in regards to problem solving (Stein et al., 2007). The sixth-grade enriched math pilot program was developed using a standards-based curriculum guideline. The types of problems which the students are expected to solve involve multi-step procedures and an application of several different concepts.

Stein et al. (2007) explained that Project 2061 was one of the first systematically documented analyses of the mathematical content of curricula. The project, conducted by the American Association for the Advancement of Science (AAAS), examined middle school textbooks and found only four standards-based textbooks that were satisfactory. *Connected Mathematics* (Lappan, Fey, Fitzgerald, Friel, & Phillips, 2006) was one of those four and is the same textbook being used in the Oakwood pilot program. In 1999, the U.S. Department of Education conducted a review of mathematics curricula to identify promising and exemplary curricula. *Connected Mathematics* was one curriculum that was labeled promising. The AAAS gave the *Connected Mathematics* curriculum a high rating for its engagement of students, development of mathematics concepts, and support of teachers (Stein et al., 2007). The *Connected Mathematics* curriculum is a standards-based curriculum and was used in the pilot program.

The NCTM *Administrator's Guide* (Mirra, 2003) explained the importance of mathematical literacy and the need to understand and be able to use mathematics in everyday life. The guide emphasized how the use of mathematics in the workplace has never been greater and will continue to increase. Mathematics is no longer viewed as a course to complete in high school. Today mathematics is a part of everyday life, which is why it is so important to meet the demands for all students. In order for this goal to be accomplished, the curricular expectations for every student must change. Each student should be exposed to a rigorous curriculum. In fact, the Oakwood School District included this concept in their mission statement, which reads, "To ensure all students are capable, curious, and confident learners who understand and respond to the challenges of an ever-changing world" (Parkway School District Board of Education, 2010, p. 1).

The district maintained that providing a rigorous curriculum is part of their mission. For example, one of the goals of Oakwood is to develop and implement specific programs and strategies in order to more effectively meet the academic requirements of all students (Parkway School District Board of Education, 2010). One of the district's focus areas was to increase academic achievement and engagement for all students

(Parkway School District Board of Education, 2010). The enrichment pilot program met these goals.

Another focus area of Oakwood is to provide learning environments necessary for success in a competitive, "ever-changing world" (Parkway School District Board of Education, 2010, p. 1). In the book *Making Mathematics Curriculum Count*, Richardson (2007) explained that most parents do not understand the important role mathematics will play in the future competitive and technical global society. Richardson further explained that in order for the American society to be successful it must change the culture of current mathematics courses by implementing a rigorous mathematics curriculum and allowing students to enroll in accelerated courses. In fact, Rose and Betts (2001) found that the selection of a rigorous curriculum which requires that students complete annual mathematics courses in elementary through high school leads to increased student success at the university level and in the labor market. Picker and Berry (2001) explained that students need to have a realistic sense of mathematical applications in real-life contexts in order to visualize pursuing courses in advanced mathematics or eventually choose careers related to mathematics. As mentioned previously, Haycock (2002a) explained that the typical mathematics curriculum in the United States is too broad. American education tends to value the quantity of topics instead of the quality of content. Oakwood's pilot program is attempting to provide the depth of content today's students need.

Haycock (2002b) explained that not only is the curriculum too broad, the way it is taught also contributes to the ongoing problem. She described "a cross-country analysis of mathematics" which "suggests that American lessons are taught at a much lower level than those in either Japan or Germany" (2002b, p. 9). As mentioned at the beginning of this chapter, the level or pace at which the curriculum is taught is also a concern. However, this is a not just an academic concern but also an emotional one.

The Social and Emotional Impact of Ability Grouping

Rogers (2007) explained how talented students exhibit a "rise in psychological distress, stress, and boredom when [they] cannot [progress] forward" at their pace (p. 382). In fact, Csikszentmihalyi, Rathude, and Whalen (1993) also conducted research which supported the notion that talented teenagers experienced feelings of stress and boredom when they felt that they could not "move forward" either individually or in a group situation in their area of expertise. Csikszentmihalyi et al. (1993) found that not only did gifted learners experience higher levels of stress when they were placed in unchallenging classrooms but they also experienced reduced stress when they were exposed to elevated levels of complexity. Therefore, providing students with a challenging environment seems to be just as important as excluding them from one that is not challenging.

Sternberg (1986) emphasized how educators must provide intellectually advanced students with opportunities to believe they are progressing in their education. He describes the types of problems these students will encounter, including reticence to take cognitive risks, underachievement, lowered academic self-esteem, and social and behavioral maladjustments. By avoiding less demanding situations and continually challenging the high-ability students, educators are preparing students to be life-long learners and self-sustaining citizens, meeting the overall goal of the educational system.

In order to make a comparison between gifted students and high achievers, one must understand the difference in these two types of learners. A high-achieving student is one who completes assignments on-time, correctly, and neatly. They try to ascertain what the teacher most wants in order to gratify the teacher's objectives (Kingore, 2003). A gifted learner interprets an assignment in their own way and then creates an end product with their interests in mind instead of meeting the teacher's original requirements. When a teacher asks a question, the high achiever is pleased because he or she knows the answer. A gifted learner, on the other hand, ponders the question being asked and considers multiple perspectives before offering an answer. Gifted learners think with more abstract, complex, and diverse viewpoints (Kingore, 2003).

One study interestingly found that children who were identified as gifted were no different from their high-achieving peers (Bain & Bell, 2004). Bain and Bell (2004) studied "the social self concept, social attributions and peer relationships of gifted students in the fourth, fifth and sixth grade" (p. 167). Both groups were equally vulnerable to socially related self-concept problems. However, Bain and Bell did explain that their research was limited to upper elementary students and that more research was needed in the middle school area. They also qualified their research by explaining that identification and placement as gifted may provide an influence on positive social self-concept, particularly for children who are placed in pull-out enrichment programs.

Not all of the research is in agreement, however, and there have been many discrepancies in the studies completed on the social realm of gifted students. Brody and Benbow (1986) researched general self-esteem and social functioning of high achievers and gifted learners. Their results showed no differences between the two groups on the self-esteem measure. Yet Pyryt and Mendaglio (1994) reported a significant difference on the social domain of a survey they distributed to ninth graders. Of the students who were found to have a high self-esteem, roughly half were identified as gifted and the others were not.

Other researchers argue that placement influences the self-concept of gifted children for the better, and still others argue it influences them for the worse. For example, Colangelo and Davis (1991) found that external recognition, or in other words, being identified as gifted, improved the students' self-concept. However, Coleman and Fults (1985) suggested that grouping gifted students together causes a devaluation of their abilities which might lead to a decline in their self-concept. Clearly, being homogeneously grouped is not the best situation for all learners. This does not mean, however, that ability grouping should be discouraged. Rather, this type of grouping simply may not be appropriate for every student. The research supports individual evaluation of each student in order to determine the correct placement. The math enrichment pilot program takes each child into consideration in order to place them in the most effective learning environment. For example, the district's mathematics curriculum coordinator ranks the students according to their national, state, and district assessment scores. The teachers provide information regarding the social, emotional, and academic readiness of the students. Finally, the district asks for the parental permission before placing students in the enrichment program.

Adams-Byers, Squiller Whitsell, and Moon (2004) investigated student perceptions of gifted youth who were grouped homogeneously. Overall, the students perceived homogeneous grouping more positively with respect to academic outcomes.

However, the students had mixed feelings about whether the homogeneous or the heterogeneous setting best met their social needs. One interesting finding is that a few of the students preferred the heterogeneous classes because they were easier and allowed them to earn a high class ranking with little work. Yet, the lack of depth in the curriculum was blamed for the low ranking of the nation's students. However, students are allowed to remain unchallenged in order to earn good grades. Perhaps a change in priorities from grades to rigor will help solve this problem.

Feldhusen and Moon (1992) explained that when new learning tasks are either too easy or too difficult, motivation suffers. They stress that gifted learners need instruction that is more complex and abstract than other learners can handle. Therefore, if the more able learners are forced to learn at a slower rate designed for the average learner, then the more able learners tend to become bored and unmotivated. Rogers (2007) found that gifted students had higher test performance as well as improved self-efficacy and motivation when they "were provided with a challenging, articulated curriculum" (p. 385). In fact, Rogers explained that students in pull-out programs have more positive attitudes toward school and are more positive in general in regards to their particular area of study. Furthermore, Gamoran (1990) concluded that the achievements of high-ability students actually decline when they are grouped heterogeneously.

One study explored the perspectives of parents and teachers in regards to their gifted students' social and emotional needs. Henderson (2007), writing about the importance of grouping students with like abilities together, explains that "gifted children differ from their age-peers emotionally as well as intellectually" and that "it is their sense of feeling different that can make gifted students vulnerable to negative social and emotional development" (p. 63). In fact, the parent responses from Henderson's study describe how their children were socially happy and more confident as a result of homogeneous grouping. Both parents and teachers felt that the creative, challenging, and faster-paced curriculum was extremely positive and academically advantageous. Therefore, Henderson recommended grouping students in homogeneous classes in order to meet their social and emotional needs. This research complemented the findings of Rogers (2007) who stated, "It is clear that grouping has positive effects whether full-time or part-time, although logically the more time this occurs for gifted children, the more positive the effects on them, socially and emotionally" (p. 389).

Silverman (1993) found additional support for grouping students. She explained advanced children think in a unique way and feel differently from their peers (p. 3). Her research showed that these feelings are increased as the level of giftedness increases. Another researcher, Gross (2000), found that "the problems of social isolation, peer rejection, loneliness and alienation which afflict many extremely gifted children arise not out of their exceptional intellectual abilities but as a result of society's response to them" (p. 188). This research suggested that gifted students need opportunities to learn and socialize with their like-minded peers. However, it is not only the gifted students who benefit from interactions with students of like abilities.

Rogers (1998) has completed extensive research in this area and has found that both "high-ability and gifted students tend to benefit most from like-ability grouping because the strategy provides them with the opportunity to access more advanced knowledge and skills and to practice deeper processing" (p. 43). Her research found that the feeling of being different was minimized when students of like ability were given opportunities to work exclusively with each other. The link among grouping, enrichment, and differentiation is crucial to the achievement of high-ability students. As Henderson (2007) explained, “It is only when the provision of a differentiated curriculum and the quality of the instruction and learning environment within the grouped classroom matches the needs of the gifted students that significant benefits are achieved” (p. 66). The sixth-grade enriched math pilot program provides advanced learners with a differentiated learning environment where they can feel comfortable yet challenged.

The Importance of Differentiation and Grouping

Most educators agree that there is a broad range in the abilities of their students and that meeting their individual needs can be challenging. Rogers (2007) advocated some type of regrouping in order to manage the difference of abilities. She offers a variety of ways to regroup, including “whole class ... like-performing cluster groups, or a like-peer dyad or like-ability cooperative group” (p. 383). Rogers further added that if it is impossible to offer this type of grouping, then a separate program must be put into place to provide “advanced exposure to content beyond expected age or grade level” (p. 383). She believed that academic gains will continue from year to year as long as a daily challenge is provided to these students. Over 40 studies cited in Rogers’s research showed that students who were offered a demanding program in several different areas indicated significantly higher test performance and improved self-efficacy and motivation when they were grouped together. Rogers also found research which indicated that “their levels of stress were substantially higher when they were placed in unchallenging classroom settings [and that their] stress was considerably reduced when they were subjected to high levels of challenge and rigor" (p. 385). In summary, Rogers explains that educators must provide the high-ability and gifted and talented children with an opportunity to progress and feel successful in their learning. If they "sit year after year repeating what they have previously" learned, then all kinds of problems begin to occur (p. 386).

In order to provide this type of daily challenge, a change in delivery is required, whether it be flexible grouping within the class setting or restructuring the school schedule to provide a challenge-type class. Borland (2003) conducted a meta-analysis of many articles from expert theorists in the gifted realm. The first article written by Borland is entitled "The Death of Giftedness." In it, he argued that enrichment should not only be made available to children labeled gifted, but that it is applicable to all children (p. 114). Borland explained further that if "a student can work ahead of his or her age peers in say, mathematics, he or she can simply be allowed to do so; regardless of their identification" (p. 115). According to Borland, the enrichment-type classes should be available to any student who is ready for the challenge, regardless of their label.

One study which supported Borland's arguments investigated an enrichment social studies program which was implemented in heterogeneous classrooms. Little, Xuemei Feng, VanTassel-Baska, Rogers, and Avery (2007) completed this study and described the curriculum as "advanced content, higher level process emphases, and a conceptual orientation" (p. 272). They found that a curriculum which integrates higher level processes and specific conceptual thinking activities with strong content yields stronger content gains than a more direct, knowledge-based structure for teaching to standards. More importantly, Little et al. (2007) found that the challenging curriculum designed for the specific needs of the highly able children promoted learning for students not identified as gifted.

Rogers (2007) explained how research has shown "that consistent practice at progressively more difficult levels in skill, coupled with the talented learner's natural ability to link new knowledge to prior knowledge and skill accounts for what ultimately is perceived as expert performance" (p. 383). Rogers goes on to say that greater development occurs when both the school and the home make an effort "to provide the talented child with increasingly complex knowledge and skills" (p. 383). In other words, educators must take the mathematically talented learners and provide them with a more challenging curriculum in order to peak their performance. In fact, Rogers further explained how talented "learners who are grouped by performance level and provided with a fast-paced, compacted, beyond grade level curriculum in mathematics" gained over "four fifths of an additional year's academic achievement" (p. 389). Oakwood did not limit the enrichment pilot program to children in the gifted program. Through the investigation of the MAP and SAT10 scores, all sixth graders were scrutinized in order to find the students who would benefit most from this program. Being labeled "gifted" did not affect their placement in this program.

Another researcher who advocated differentiating the curriculum for high-ability learners in order to provide the challenges these students need regardless of their label is Sapon-Shevin (2003). It is her opinion that educators cannot treat these students "as though they were coherent, homogeneous groups with a unified set of educational needs" (p. 130). Sapon-Shevin's argument supported the need for this pilot program. She also explains that there is no research suggesting that unidentified students cannot also benefit from the opportunities being provided for students identified as gifted (Sapon-Shevin, 2003). If Oakwood's enrichment pilot program is effective for identified and unidentified students, then it is possible for it to be incorporated into all sixth-grade classes throughout the district. The pilot program consists of a small class with only 22 students, contains a rich curriculum, and provides more individualization than the regular math class. These factors have the potential to benefit all high-achieving students. To summarize Sapon-Shevin's (2003) thoughts, one size does not fit all. There is no doubt that students learn and achieve at different levels.

Although there are researchers who argue that opportunities should be made available to all students regardless of their label, there are those who have conducted extensive research on the comparison between the cognitive and motivational characteristics of students identified as gifted and nongifted. Fehrenbach (1991) and Gottfried and Gottfried (1996) found that gifted children are cognitively more competent and are more intrinsically motivated than their nongifted peers. Fehrenbach (1991) also concluded that gifted students tend to use more rereading, inferring, analyzing structure, predicting, and evaluating strategies. Gifted students also tend to be more strategic (Montague & Applegate, 1993). Shore and Carey (1984) found that gifted students are more likely to exercise conscious control over the solution process. In addition, these students use more strategies for organizing and transforming information (Zimmerman, 1990).

Hong and Aqui (2004) found that overall "adolescents academically gifted, creatively talented, and nongifted students in the mathematics area were different in many of the cognitive and motivational characteristics" (p. 191). They further explained in their study that adolescents who are academically gifted or creatively talented in math reported being more self-efficacious compared to their nongifted peers. Also, gifted students reported using cognitive strategies more often than the nongifted, and the creatively talented group reported significantly higher uses than the nongifted. Hong and Aqui (2004) also discovered that the academically gifted and the creatively talented students perceived themselves as highly abled in math and were confident in mathematics based on the survey distributed. If these students of varying abilities see themselves so differently, maybe they should not be grouped as equals. Perhaps they should be provided with different opportunities which mirror their abilities.

Loveless (2009b) summarizes this idea another way by asking a more specific question, "Are all eighth graders truly prepared to succeed in algebra class?" (p. 1). If some of them are not ready, perhaps they should be placed in a class which meets their academic needs. Loveless explains that well-meaning policy did not take into consideration the impact on the different levels of students when low-level tracks were abolished. According to *The 2008 Brown Center Report on American Education* (Loveless, 2009a), "Over a quarter of low-performing math students – those scoring in the bottom 10 percent on NAEP – were enrolled in advanced math courses in 2005" (p. 23). In this report, Loveless questioned how these "misplaced" students will be educated once policy makers decide to abandon tracking (p. 23). Loveless clarified that "tracking" refers to the "practice of grouping students into [specific] classes based on [their] achievement," not placing them into vocational tracks (p. 1). Loveless studied these changes and found surprising results.

Loveless (2009b) also found that tracked schools did better. Even more surprising is the finding that “detracking” adversely affected high-achieving math students. Loveless’s (2009b) study showed that middle schools “with more tracks have significantly more math pupils performing at the advanced and proficient levels” (p. 2). Further, detracked schools show the exact opposite. In other words, they have more math students who are failing, and more students who need improvement in math skills. Loveless (2009b) summarized, “More tracks, more high-performing kids and fewer failures. Fewer tracks, fewer high-performing kids and more failures” (p. 2). Loveless does not dispute the idea that tracking is a controversial topic. People fear that the divide between the low-level students and the high-level students will continue to widen. However, he explained in his article that this is not the case. The bottom line is that “American education needs to care more about taking students to the next level and less about how we get them there” (Loveless, 2009b, p. 3). Loveless reiterated by explaining that heterogeneous classrooms are valued over effective ones when society resists tracking. Not only do students vary in their overall abilities, but also in the rate at which they learn information.

Whether heterogeneous classrooms can provide adequately for both depth of knowledge and the pace of learning is still being debated by researchers. Start (1995) measured how quickly students learn and compared that with their IQ scores. Start found that a child with an IQ of 130 gains knowledge at a pace 8 times more rapidly than one with an IQ of 70. These findings support the fact that the pace of learning needs to be increased in order to be effective. When the pace is quickened there is less time for students to “lose focus, become distracted, act out, and/or perhaps misencode the concepts presented because of their lack of attention on the presentation" (Rogers, 2007, p. 390).

Homogeneous grouping can provide an environment which allows for effective pacing. However, that is not the only benefit to grouping. As Sternberg (1985) explained, gifted learners think from whole to part. He argued that gifted mathematicians tend to acquire knowledge as a whole and store it in their long-term memory the same way, whereas the normal learner acquires and stores information in small chunks. This is the reason most learners benefit from practice and review. They need help making the connections in order to see the whole concept. However, gifted learners can skip this step because of their ability to think automatically from whole to part. As Rogers (2007) explained,

> For a teacher to radically quicken the pace for gifted learners, eliminate most practice and review, and teach in a whole-to-part fashion by concepts, principles, issues, and generalizations rather than from the base facts, terms, and parts of a whole idea is almost an impossibility without some form of at least temporary regrouping or clustering of the high ability or high performing learners in the classroom and a commitment to spending a proportionate amount of classroom time differentiating instruction accordingly. (p. 391)

Not only is effective pacing important, but also the way in which the concepts are taught. Even though the pilot program offered by the Oakwood School District is not by definition a "tracked" program, it does offer the high-performing student an opportunity that would not exist without the program.

Another proponent of using homogeneous grouping in order to benefit high-ability learners is VanTassel-Baska (2003), who explained that there is a need for different types of grouping, including “flexible grouping, differentiated assignments as well as special-class grouping” (p. 182). She argued that heterogeneous classrooms provide little differentiation and “may not be as beneficial as special-class grouping” (VanTassel-Baska, 2003, p. 182). As Rogers (2007) explained, “The evidence is clear that powerful academic and affective effects are produced when gifted children are grouped with like-ability or like-performing peers and exposed to differentiated learning tasks and expectations” (p. 389).

Like Start, VanTassel-Baska (1992) also emphasized the importance of the pace of learning. She explained in her research that the “pace of the class and opportunity for in-depth work may be lost to gifted students as the teacher struggles to cover all of the material with everyone” (p. 182). In fact, one study surveyed 7,300 teachers throughout the country and found that these teachers offered very few differentiation opportunities for gifted students (Archambault, Westberg, Brown, Hallmark, Zhang, & Emmons, 1993). Advanced students require the chance to work with other students at their same skill levels and to continue moving forward at a consonant pace.

VanTassel-Baska (2003) also argued that curriculum differentiation “should go beyond a single text, present interesting and challenging ideas, treat knowledge as tentative and open-ended, and provide conceptual depth that allows students to make interdisciplinary connections” (p. 179). Reis (2003) discussed the discrepancy in mathematics textbooks. She explained that textbooks cannot seem to agree on the level of difficulty from one grade level to the next, nor do they meet the needs of high-ability learners. Finally, the textbooks tend to repeat concepts from year to year instead of providing a depth of understanding as the grade levels increase. Loef Franke, Kazemi, and Battey (2007) explained that students need to increase their understanding of concepts and skills in order to use mathematical ideas in a variety of situations. In order to attain the needed depth of understandings, students must be allowed to engage in higher order or critical-thinking opportunities.

Other researchers discuss how the most advantageous academic placement should be somewhat beyond the student's present level of performance. For example, Chall and Conrad (1991) also emphasized the significance of the similarity between a student's aptitude and the complexity of the assignment. Gessner (2008) used the analogy of a train when he defended his position on ability grouping, explaining that educators must provide different trains which travel at "different speeds and head for different destinations with a team of conductors and crew members who understand their passengers' needs and can meet them all" (p. 28). In this way, no child will ever be left behind, because "no child will be put on the wrong train" (Gessner, 2008, p. 28). Rogers (2007) affirmed this, "If bright children are to retain what they have learned in mathematics and science, it must be presented at their actual learning rate, not [considerably] slower than that rate" (p. 390). *A Nation Deceived* (Colangelo, Assouline, & Gross, 2004) described how acceleration can meet the requirements of advanced students. The authors explained that the concept of "acceleration" can be perceived in many different forms, but the basis– the positioning of advanced students with others of comparable ability– remains constant. Gessner (2008) maintained that highly abled students "are as much 'at risk' as any group targeted for help under NCLB" and that is why it is crucial to provide them with enrichment opportunities (p. 28). In fact, Gessner explained in his article that NCLB acknowledged that "schools will not be able to serve the highly abled students" well according to their definition of gifted learners" (p. 28). He then questions, Why not? The common assessment showed that the students participating in the pilot enrichment program had already mastered a majority of the material to be learned in the regular sixth-grade curriculum. That is why Oakwood is providing this opportunity for students to learn in a specialized group setting. Rogers (2007) summarized the importance of homogeneous grouping when she says,

> To provide for the different ways that gifted learners learn consistent challenge, daily talent development, independent work, whole-to-part, fast paced, depth and complexity, limited drill and review, educators must reconsider whether [and how] they can manage increasingly heterogeneous and diverse classrooms. In most cases some form of grouping will need to take place to appropriately differentiate on a direct and daily basis. (p. 391)

One reason the district selected this particular program was because it provided real-world problems for the students to solve at their level. VanTassel-Baska (2003) explained the importance of providing students with a challenging, yet, applicable curriculum. She argued that educators should investigate the following question when designing a curriculum: How do planned learning experiences provide "depth and complexity at a pace that honors the learner's rate of advancement through material?" (p. 178). She further explained that the curriculum should be standards-based and contemporary in terms of "real-world professionals" who use writing and problem solving on a daily basis. Furthermore, the curriculum should be planned with the needs of advanced students in mind by including “challenge, in-depth thinking and doing, and abstract conceptualization” (2003, p. 178). Vaughn, Feldhusen, and Asher (1991) supported the research of VanTassel-Baska. They explained that in order to be effective, the pull-out program should focus on precise extensions of the standard curriculum or on explicit skills and processes incorporated within the curriculum. According to Usiskin (1987) and Sheffield (1999), the extensions should also be utilizing the higher ordered thinking skills. They both agree that using inquiry and problem-based experiential learning in mathematics deepens the understandings among gifted mathematicians.

Brody and Stanley (2005) discussed how to best instruct gifted individuals. They explain that the goal when designing a program is to achieve an “optimal match” between “a student’s cognitive and other characteristics and his or her educational program” (p. 30). Brody and Stanley discussed the importance of utilizing curricular flexibility which requires willingness to adjust the level and the pace of the program. They warned in their conclusion that students who are precocious are at risk of being “turned off” to “anything academic and to developing social and emotional difficulties as well” if they never have to study to learn something (p. 32). Another researcher who emphasized the importance of high-level programs for precocious youth is Feldhusen (2005). He stated, “High-level achievements for highly able youth come from curricula and instruction that are at the upper level of the youths’ current capabilities” (p. 71). However, this type of curriculum is rarely offered.

Maker and Nielson (1995) suggested that the curriculum follow four principles: person, process, product, and learning environment. They described *person* as the need for the curriculum to be adjusted to meet the unique characteristics of the gifted learner. For example, rate of learning, large knowledge bases, and the ability to construct complex ideas should be addressed when designing a program. *Process* is the need for the curriculum to adapt to the high capacity in cognitive and thinking skills. *Product* is the need to design complex and creative products so the gifted students can utilize their expertise and engage in the individual tasks. Finally, *learning environment* refers to the overall conditions of the environment. For example, the students have the ability to work independently and cooperatively within a flexible environment. The sixth-grade enrichment pilot program takes into consideration all four of these principles.

Two other researchers, Callahan and Miller (2005), discussed the idea of *person* in more detail. The gifted learner as a *person* has different needs depending on what type of student he or she is, and the program should be differentiated to meet each learner's needs. In "A Child-Responsive Model of Giftedness," Callahan and Miller discussed two types of students: academic-focused creative-productive students and academic-accelerative students. The academic-focused creative-productive student is one who can "apply his or her gifts in open-ended contexts to create products and/or solve authentic and/or real-world problems" (p. 44). Giftedness, the authors wrote, is a behavior which emerges under the right circumstances. Academic-focused creative-productive students are "driven to identify new questions, new possibilities for explanation, and new solutions to problems" (p. 44). Callahan and Miller emphasized the importance of providing these types of students with the opportunity to solve real-world problems, think at sophisticated levels, and restructure their thought systems.

The academic-accelerative student, on the other hand, is one who has the desire to master the content and can do so rapidly. They are best served when they can work at their own pace and learn at a level at which they are able to excel. The curriculum offered to academic-accelerative students “should offer ever-increasing opportunity for them to study increased levels of depth and complexity” (Callahan & Miller, 2005, p. 42). These types of gifted learners receive satisfaction when they are offered a more advanced, more rapid presentation of advanced knowledge. However, they would also benefit from a program which allows for “both depth and complexity of learning that would demand sophisticated levels of analysis, the opportunity to create and develop individualized plans of study [alone or with similar peers]” (Callahan & Miller, 2005, p. 44). The enrichment mathematics pilot program was designed to provide these types of experiences to both of these types of unique learners.

Summary

The enrichment pilot program was designed to meet the needs of the mathematically precocious students. It takes into consideration all four areas, person, process, product, and learning environment, which Maker and Nielson (1995) describe. This program is merely an extension of the regular curriculum and attempts to align the needs of the students with the standards of the curriculum. Oakwood has chosen to use two different textbooks in order to meet these needs. The types of problems used in this curriculum require multiple steps and often require students to reflect upon how they derived their solution. This type of model encourages students to connect language to mathematics and also allows for multiple reasons for their answers. It is geared toward the academic-focused creative-productive student as well as the academic-accelerative student which Callahan and Miller (2005) described.

Since this program was designed to meet the needs of the different types of gifted learners, it should also meet their social and emotional needs. Students who are not being challenged exhibit a rise in psychological distress, stress, and boredom. This program was developed to allow students to work at their own pace at higher levels in order to alleviate these types of problems. However, identification and placement of students in a pull-out program needs to be done carefully and thoughtfully. As stated in the research, just because students appear to be academically ready for an enrichment program does not mean that it is the best situation for them.

The higher level of problem solving and the depth of knowledge needed to solve these problems correlate to the research which demands a more in-depth focus on the curriculum. America has fallen behind in mathematics in part because of an overly broad curriculum. This program was designed to increase the understanding of mathematic principles by providing students with in-depth, real-world, multi-step problems. However, the program must be assessed in order to evaluate its effectiveness.

VanTassel-Baska (2003) believed assessments should be used to determine the effectiveness of these types of programs since assessments are symbols of student achievement. However, she acknowledged that educators should also assess individual growth and development by using pre-assessment results. She explained that many times students are assessed on what they already know or are not held accountable for reaching new thresholds of learning. This study includes many different types of assessments which VanTassel-Baska recommended in her research.

This study is important because it will continue the investigations called for by other researchers. The next chapter will explain the methodology of this study specifically. The purpose of the study along with the research questions and hypotheses will be reviewed. More specific details will be addressed regarding the sample. Finally, they type of data collected and how it was collected and analyzed will also be described.

Chapter Three: Methodology

The purpose of this study was to investigate whether the enrichment pilot math program has increased student achievement or affected students' attitudes towards math. This study will focus on the value-added model for high achieving, rather than low achieving, students in one sixth grade mathematics enrichment pilot program. As a result, teachers and administrators will be able to plan more effectively for the social, emotional, and academic needs of the gifted/advanced student.

Research Setting

The students selected for this study attended Oakwood Middle School, located in Chesterfield, Missouri. The school had a staff of about 70 full-time professionals and support personnel and a total student body of approximately 900-1000 sixth-, seventh-, and eighth-grade students. The school district had over 18,000 students enrolled at the time of the study. The district's student population consisted of 11% Asian, 16% Black, 2% Hispanic, 0.1% Indian, and 70% White. Only 17% of the population was enrolled in the free and reduced meal program.

Oakwood Middle School provided a diverse curriculum to meet the needs of all students. The school offered a READ 180 program which is a remedial reading class provided for students who are below one to two grade levels and who are not receiving special education services. The middle school also offered challenge math and science classes for the seventh and eighth grades, an English Language Learner class, and a sixth-grade lower level math class. However, there was no enrichment mathematics class for sixth graders. In an attempt to meet the needs of the advanced learners, the Oakwood School District decided to implement a pilot enrichment mathematics program in one middle school during the 2008-2009 school year. Oakwood School District incorporated the enrichment program into the School Improvement Plan for school year 2008-09 in response to failure to improve math scores for all students on the MAP as predicted. It was important to determine the effects of this program in order to decide whether or not the program should be implemented at all five middle schools.

Purpose of the Study

The purpose of this study was to determine if the enrichment pilot program affected the learning and attitude of the advanced students. When analyzing data on these particular students it is difficult to measure gains because their standardized achievement scores are already very high. Therefore, the researcher was most concerned about the measurement of student achievement in this program and whether or not the students gained knowledge. Another purpose of the study was to investigate the relationship between the scores on the advanced assessment and the demographic data of the students then determine if a regression analysis could be used to predict which type of students would be most successful in this type of class in the future. This study also examined the attitudes of these students towards mathematics and how they changed during this school year.

Many studies have measured the academic achievement of students learning the Connected Mathematics Program (Bay, 1999; Bledsoe, 2002; Bray, 2005). However, this study was different in that it also measured the attitudes of these students towards a homogeneous enrichment mathematics class. Although the curriculum used the Connected Mathematics Program in part, it also incorporated enrichment material created by the Oakwood School District's mathematics department which paralleled the existing framework. This was another way that this study was unique. The Oakwood School District approved this study. (Appendix C).

Research Questions and Hypothesis

This study examined four overarching questions involving achievement in an enrichment pilot math program and attitude changes towards math as a result of the program.

RQ1: Will the students in the pilot math enrichment program show improvement on an advanced post-assessment?

$H1_0$: There will be no relationship between student scores on the advanced pre-assessment and student scores on the advanced post-assessment.

RQ2: Will there be a relationship between student scores on the advanced pre/post-assessments and the district post-tests?

$H2_0$: There will be no relationship between student scores on the advanced pre/post-assessment and the district's common assessment.

$H3_0$: There will be no relationship between student scores on the advanced pre/post-assessment and the MAP scores.

RQ3: Will there be a difference in student response when comparing results for students who scored in the top half on the total advanced pre/post-assessments and those who scored in the bottom half on the total advanced pre/post-assessments?

$H4_0$: There will be no difference in student response when comparing results for students who scored in the top half on the total test and those who scored in the bottom half on the total advanced pre/post-assessments.

RQ4: How does the enrichment pilot program affect students' attitudes towards math?

$H5_0$: There will be no significant change from pre to post responses on any individual survey item.

$H6_0$: There will be no relationship between the student responses on the complete survey and student scores on the district's common assessment.

$H7_0$: There will be no relationship between the student responses on the complete survey and student scores on the advanced post-assessment.

Sample Selection

The Oakwood School District selected the students for this program. In order to do this, the district's curriculum coordinator of mathematics analyzed student scores from the MAP and the SAT, looking specifically at four separate pieces of data. To be eligible for this program, students had to score at the 90th percentile or higher on the SAT Mathematics Problem Solving and Total Mathematics sections during their fourth- and fifth-grade years. They also had to be at the proficient or advanced level on their MAP in both the third and fourth grades. A total of 22 students qualified for the program. All qualified students were invited to participate, and all parents of these students accepted the invitation.

The study began with 22 sixth graders in the 2008-09 school year, but one of these students moved during the year and another dropped the enrichment math course. Therefore, the researcher had complete data on a total of 20 students. Slightly more of these students were male (55%) than female (45%). About a third were Asian (35%), and the remaining students were white (65%). Nearly half (45%) were participants in the district Gifted and Talented program, while the rest were not (55%). The school's student population at the time of the study consisted of 13% Asian, 18% Black, 1.7% Hispanic, 0% Indian, and 67% White. About 18% of the school's population was enrolled in the free and reduced meal program.

Data-Gathering Instruments

This pilot program was unique in that it used multiple assessments in order to provide the most tailored curriculum to sixth-grade high achieving mathematics students. As mentioned, several standardized test scores were used in order to select students for this program. Two additional assessments revealed how much these students learned in the past and how much they already knew about the curriculum before it was introduced.

The first of these was the district's common assessment which was given to all sixth-grade students in the Oakwood School District. As discussed in the definition, the term *common assessment* refers to the district-wide proprietary achievement test administered to all students at each grade level twice a year. The common assessments were created by teachers with the help of the mathematics curriculum coordinator from the district. They include both multiple choice questions as well as questions involving open-ended answers. All mathematics teachers use the common assessments to determine which concepts the students already know and which still need to be learned.

The district conducted statistical tests to verify the validity of the common assessment. According to the Oakwood Math Common Assessments Brief Report, the district's common assessment was a valid assessment tool (Tyson, 2009; Tyson, 2010). The director for program evaluation at the time of this study ran several correlations including the Pearson Coefficients of Correlations to measure the strength of the relationship between MAP math scores and math common assessments. All of the math common assessments in the fifth through eighth grades had reliability coefficients between 0.7 and 0.8. According to Salkind (2005), anything in the range of 0.6 to 0.8 indicates a "strong relationship" exists. Therefore, there was a strong relationship between each of the grade-specific MAP math tests and their respective math common assessments, which suggests that the math common assessments were valid. The students in the enrichment pilot program earned a total mean score of 19.9 out of 22 on the pre-test.

Therefore, a more advanced assessment was necessary, which is the reason the second assessment was created specifically for this program by the researcher and the coordinator of mathematics for the district (Appendix D). A more in-depth assessment of student knowledge was critical to this study because the majority of the students who were selected for this program scored very high on the district's common assessment. In fact, the class averaged a 91% on the district's common assessment. The same is true for the MAP scores. The students were already scoring at the 90th percentile or higher. These assessments, in isolation, show little room for growth. Therefore, it was imperative to use multiple types of assessments when evaluating who should be receiving a differentiated curriculum, the type of program to use, and the effectiveness of the program.

The sixth-grade mathematics curriculum consisted of nine chapters (Larson et al., 2007). Table 4 shows the type of information covered in each of the nine chapters.

Table 4

Topics of Each Chapter for the Sixth-Grade Mathematics Curriculum

Chapter	Title of Chapter
1.	Number Sense and Algebraic Thinking
2.	Measurement and Statistics
3.	Decimal Addition and Subtraction
4.	Decimal Multiplication and Division
5.	Number Patterns and Fractions
6.	Addition and Subtraction of Fractions
7.	Multiplication and Division of Fractions
8.	Ration, Proportion, and Percent
9.	Geometric Figures

Note. Titles of chapters were from *Math Course 1* by R. Larson, L. Boswell, T. Kanold, and L. Stiff, Copyright 2007 by McDougal Littell.

The advanced assessment was comprised of 14 different items. They ranged from one to three points per items. Solving most items required multiple steps. Most items also required some type of reflection from the student. The amount of steps involved in answering the questioning determined its value. For example, a question with one answer where the student needed to show how they achieved their answer was worth two points; one for the correct answer and one for the work shown. However, an answer that required the students to explain their reasoning in words or describe the method they used in order to find their answer was worth three points; one for the correct answer, one for showing their work, and one for providing a rational explanation. Many of the items required the student to apply and synthesize their knowledge of several topics in order to find their answer. The types of problems were like those found in the *Connected Mathematics* (Lappan et al., 2006) textbook. Table 5 shows the correlation between the items in the advanced assessment and the chapters in the *Math 1* (Larson et al., 2007) text associated with those items.

Table 5

Comparison of Items to Chapters

Item	Chapter
1.	9
2.	1, 3, 4
3.	5, 8
4.	3, 4, 9
5.	3, 4, 9
6.	5, 7
7.	5, 7
8.	1, 5, 9
9.	6, 7
10.	1, 3
11.	1, 5, 7
12.	1, 5, 7
13.	2
14.	2

Note. Titles of chapters were from *Math Course 1* by R. Larson, L. Boswell, T. Kanold, and L. Stiff, Copyright 2007 by McDougal Littell.

The director of program evaluation for the district and the researcher designed a fall and spring survey for this study group (Appendix E). The fall and spring survey consisted of 20 statements and used a 5-point Likert-type scale. In responding to each statement, the students chose among five responses. The possible responses were never, seldom, sometimes, often, and always. The fall survey was distributed at the beginning of the year to determine the attitudes of the students before implementation of the program. The spring survey was distributed at the end of the school year to determine whether their attitudes had changed.

Data-Collection Procedures

Before the study began, the researcher met with the mathematics coordinator for the district and the director of program evaluation for the district. The mathematics coordinator and the researcher created the advanced pre/post-assessment. All items on the advanced assessment were aligned with the enrichment curriculum. The director of program evaluation generated the fall and spring survey based on a core of questions used in former surveys by the district and several other local school districts over the past 10 years.

The researcher distributed the fall survey and the advanced pre-assessment to the enrichment students during the first semester of the 2008 school year. Students were given as much time as they needed in order to complete both the survey and the advanced pre-assessment. The researcher explained that neither the advanced assessment nor the survey affected their grade and that the survey was anonymous. All students finished both the advanced pre-assessment and the survey within the given class period.

The researcher distributed the spring survey and the advanced post-assessment to the enrichment students in the same way as the fall survey and advanced pre-assessment. Both were collected on the same day by the researcher in May of 2009. Again, students were given as much time as they needed in order to complete both the spring survey and the advanced post-assessment. The researcher explained that neither the advanced post-assessment nor the spring survey affected their grade and that the spring survey was anonymous. All students finished both the assessment and the survey within the given class period.

A value-added analysis of the enrichment group was based on the work of Sanders and Rivers (1996). The researcher used the following data in a multiple regression equation to predict the post-test measures. As stated in the definition section, three conditions needed to be met for this procedure to make sense: The tests used must a) be highly correlated with curricular objectives, b) ensure sufficient stretch to measure different student abilities, and c) include multi-discipline input on individual students.

Demographic data were used in the application of a regression analysis. The data included numeric codes for gender, ethnicity, and participation in the official gifted program. These categorical items can show a relationship to the dependent variable, but they are not used as predictors (Myers, Well, & Lorch, 2010). Other data included the reading, science, social studies, and math scaled scores from the SAT10 (Pearson Education, 2010b) test that students took in the fifth grade. The SAT10 is a multiple-choice norm-referenced achievement test used from kindergarten through 12th grade. The SAT10 provides scaled scores, national and local percentile ranks and stanines, grade equivalents, and normal curve equivalents. Although there is a computerized version of the SAT10, the Oakwood School District does not administer it.

Student ability index scores from students' most recent OLSAT (Pearson Education, 2010a) and reading scores from the DOMINIE reading assessment (Williams, 2009) were also used in the regression analyses. The OLSAT assessed abilities that are related to school success and evaluated skills such as finding similarities and differences, recall, following directions, classification, sequence of events, and analogies. In this way, the OLSAT tested students' ability to reason and think logically. The DOMINIE reading assessment tested a variety of oral and written skills related to reading. The assessment consisted of short-answer, fill-in-the-blank, multiple-choice, and read aloud.

The regression analyses also used fifth-grade MAP math and communication arts scaled scores, current and cumulative grade point averages, and scale scores from the students' most recent SRI (Scholastic, 2010); and students' total raw scores on the district common math assessment, the math attitudes survey, and the pre-test results from the advanced math assessment. The SRI is a computerized "reading comprehension test which assess students' reading levels, tracks students' reading growth over time, and helps guide instruction according to students' needs" (Scholastic, 2010). All teachers in the district have access to this data. Since this data was available for the sample, a multiple regression analysis was run with this data in order to predict the post-test measures. The researcher also included student demographic measures because the researcher wanted to know whether the program was working equally well for all types of students. All data that was available was entered into the multiple regression analysis in order to discover if there was a relationship among the post-advanced assessment and any of the available data.

Data-Analysis Procedures

The fall survey results were analyzed first. A reliability test was run on the survey using Cronbach's alpha to determine if the survey should be left as it was or if certain statements should be deleted. Cronbach's alpha is one of the more widely used reliability measures (Streiner, 2003). One reason it is popular is because it does not require test-retest administrations. Instead, reliability is determined from an equation formulated by split-half computations, all of which are taken from the same sample. As a result of the reliability test, all items were left in the spring survey.

The researcher then took the scores from the advanced pre-assessment and common assessment and correlated them to the surveys using the Pearson product moment correlation coefficient test. This provided information about how the math attitudes of the students related to their achievement.

The spring survey results were analyzed after the data was collected. Again, the researcher examined the reliability of the survey using Cronbach's alpha calculation. The researcher then used the total scores in a paired-sample *t* test to compare the information from the spring survey to the fall survey to determine if there were any significant changes in attitudes.

Data described in the previous section (numeric codes for gender, ethnicity, and participation in the official gifted program; reading, science, social studies, and math scores from the SAT10 test that the students took in the fifth grade; results from students' most recent Otis-Lennon School Ability Test and DOMINIE reading assessment; the fifth-grade MAP math and communication arts scores; current and cumulative grade point averages; scores from the students' most recent Scholastic Reading Inventory assessment; and students' scores on the district common math assessment, the math attitudes survey, and the pre-test results from the advanced math assessment) were used in addition to the achievement tests in order to determine if a prediction could be made of the students' final scores on the advanced math test. This could be used as one more type of data which would aid in the decision of student placement for future enrichment classes. As discussed in the literature review, an advanced class is not always the best placement for every high achieving student and not every child can be identified with one or two assessments. Therefore, a wide-variety of data must be scrutinized before placing a student in an advanced program. The regression analysis is helpful because it considers demographic data, reading ability, as well as other types of achievement. As a result, more of the whole child is recognized.

Each item on the advanced assessment was correlated to the curriculum. The district's common assessment was also correlated to the curriculum. The curriculum was aligned with the Show-Me Standards and the Grade-Level Expectations, which were also correlated to the MAP test. Therefore, all assessments used have met the first requirement in Sanders'and Rivers' (1996) analysis procedure.

The second requirement for the procedure to be effective was that it must ensure enough stretch to measure different student abilities (Sanders & Rivers, 1996). The district's common assessment did not meet this requirement alone. Therefore, the advanced assessment was created. The advanced assessment had the potential to show growth for each student.

The last step of Sanders'and Rivers' (1996) procedure required using multi-discipline input on individual students. Therefore, a variety of demographic data for each student was used in the value-added analysis. This individualized data input allowed every student to serve as his or her own control in value-added assessment.

The advanced pre/post-assessment was also tested for its reliability using Cronbach's alpha. Then, a comparison, using a paired-sample *t* test, was made between the advanced pre-assessment scores and the advanced post-assessment scores in order to determine if the students improved from the beginning of the year to the end. The advanced pre/post-assessment was also compared to the district post-tests in order to assess the validity of the advanced pre/post-assessment using the Pearson product moment coefficient correlation.

Finally, an analysis of variance test was used to test for difference in responses on the advanced pre/post-assessment. Understanding and using this information is imperative if this type of assessment is to be used in the future.

Summary

The purpose of this study was to investigate the growth of achievement and change in attitude of students in an enrichment pilot math program. Since this program was new, information regarding achievement and attitude was necessary to the future of the program. The researcher compared results of a survey collected at the beginning of the year and at the end of the year to determine a change in attitude. The survey was also correlated to various achievement tests. The researcher also compared results of an advanced pre/post-assessment in order to determine academic growth. The advanced assessment was also used in a regression analysis along with data from a variety of achievement tests and demographic data in order to predict success on post-test measures. This study will help educators understand all the needs of the high-achieving students, including those needs discussed in the literature review. As a result, teachers and administrators will be able to plan more effectively for the social, emotional, and academic needs of the gifted/advanced student.

Chapter Four: Results

Fall Survey Results

The survey results for the total group are shown in the frequency tables (Appendix F). Most of the respondents were generally enthusiastic about math. For example, they all said that math was “often” or “always” important (100%), three-fourths to two-thirds indicated that they “often” or “always” like math (73%) and considered it their favorite subject at school (64%). As a group, these students also believed that they had good math competency. Almost all thought they were usually good at working with numbers (91%), reported good math grades (91%), and said that they “never” or “seldom” felt nervous about math (91%). Nearly as many (86%) believed that they “often” or “always” knew how to find the correct answers to math problems.

However, they were more mixed on other issues, such as whether they needed to meet high standards in their math classes. Less than half (41%) reported that their math classes are “often” or “always” challenging, most (59%) thought these classes were sometimes too easy, and an even bigger majority said that the math classes were “seldom” or “never” too hard (82%). However, only a minority (41%) said that math classes have usually been easy for them. A large majority indicated that they pay attention in math class (96%) and all reported that they “often” or “always” tried hard to do their best in math class (100%). Similarly, only 18% considered the pace in their math classes to be about right, but the rest were fairly evenly divided between finding the pace too slow (46%) and too quick (36%).

Reliability

The less error there is in a measure, the more flexible it is considered to be. One type of reliability for surveys is the internal consistency, or the extent to which all the questions in a survey measure the same "thing." Cronbach's Alpha is an indicator of internal consistency or reliability. If there were perfect internal consistency, Cronbach's Alpha would be equal to 1.0. But all measures have some error; there is no perfect internal consistency. For measuring and comparing groups over time, most researchers seem to agree that a survey should have an Alpha value of at least 0.6 to provide sufficiently reliable results (Salkind, 2005; Nunnally, 1967).

Even though the recommended sample size is 50 when running Cronbach's Alpha, it was run on the fall survey of 22 students, with all questions included, and the result was an Alpha of 0.88. This shows that the survey has better than adequate reliability if left as is. The Alpha was even better if four survey items (questions 15, 16, 17, and 20) were removed. The fact that these questions are limiting the Alpha indicated that students answered those survey items a little differently than they answered the others. On this more reliable survey with those four items removed, the Alpha went up to 0.92, getting close to perfect. But this was not a substantial gain from 0.88 and when these questions were left in, the complete survey was a better predictor of students' math test scores, as described in the following section. Therefore, all statements were kept in the spring survey.

Correlating the Survey and Test Results

In order to understand how much the math attitudes measured by the survey are related to the students' math achievement measured by the test, the researcher correlated the survey answers with students' test scores. The correlations will be high and positive if the students who score high on the attitude scale also tend to score high on the tests and vice versa. If there is no correlation, or a very low one, obviously, it suggests there is not much connection.

However, correlations are not perfect measures of association. According to the director of program evaluation for the district, they can be affected by the "restricted range." In this study all of the participants were high achievers, and also tended to be high on math attitudes too, so the data was restricted to only the top of the distribution. This type of restricted range makes for lower correlations (Bluman, 2008).

With that limitation in mind, the Pearson correlations were run between the total score on two versions of the survey (the survey with all 20 items and the more reliable survey with only 16 items) and the scores from the district's common assessment and the advanced assessments. The total scores on the survey were just the sum of the ratings on each item, with the negative items reversed. In other words, if a student responded to all of the questions like whether they like math by marking "Always" (a "5" on the answer scale) and to all of the questions like whether they feel nervous about math problems by marking a "Never" (a "5" on the reversed answer scale) that student would earn a total score of 100 on the complete 20 item survey. On the more reliable 16 item survey, the student would have a total score of 80.

Null Hypotheses:

There will be no relationship between the student responses on the complete survey and student scores on the district's common assessment.

There will be no relationship between the student responses on the complete survey and student scores on the advanced assessments.

There will be no relationship between the student responses on the more reliable survey and student scores on the district's common assessment.

There will be no relationship between the student responses on the more reliable survey and student scores on the advanced assessments.

Neither the complete survey ($r=0.424$, $p<0.049$) nor the more reliable version ($r=0.406$, $p<0.061$) correlated significantly with the advanced assessment scores. The correlation between the shorter 16 item and more reliable total scores and the district's common assessment was approaching significant, ($r=0.406$, $p<0.061$). However, the correlation between the 20 item total survey scores and the district's common assessment scores was statistically significant ($r=0.424$, $p<0.049$). However, this is not a strong correlation. The Coefficient of Determination indicates that about 18% of the variance in students' scores on the district's common assessment can be explained by the math attitudes measured by the complete survey. However, given that the result is statistically significant and considering the restricted range limitation, it is a good indication that there is a moderate relationship between math attitudes and math achievement in this group of students.

Further, combining the ratings from the survey items produced even stronger connections between measured attitudes and measured performance. Each individual survey item was correlated separately to the district common assessment scores. As a result, the answers to three questions alone yielded a stronger relationship to the district's common assessment scores than the entire survey did ($r=0.612$, $p<0.002$). This information was found when a subscale was created by adding together the students' answers to the survey questions. The entire survey scores used in the analyses were simply the sum of the scores from each item. For the subset scales, the scores used were the sum of the ratings indicated in the subscale. Students' answers to questions 12, 14, and 18, account for 7% of the variance in their scores on the district's common assessment. Survey item 12 stated, "I get good grades in math." Survey item 14 stated, "I pay attention in math." Survey item 18 stated, "I see connections with math and the real world."

The same type of correlation as discussed in the previous paragraph was run between the survey and the advanced assessment scores in order to determine if any of the individual items on the survey correlated to the advanced assessment. As a result, three questions were found to be fairly strong correlates of the advanced assessment scores. These were questions 13, 16, and 19. Survey item 13 stated, "I know how to find correct answers to math problems." Survey item 16 stated, "I have felt challenged in my math class." Survey item 19 stated, "My math classes have been easy for me." These three items combined correlated at 0.603 ($p<0.003$) with the advanced assessment scores. So, students' feelings about their own math skills and the lack of challenge or difficulty in their math classes can explain 7% of the variance in their advanced assessment performance.

Spring Survey Results

The survey results for the total group are shown in the frequency tables (Appendix G). The spring survey results were rather similar to the fall survey results. Like the fall survey, the spring survey had good reliability. The internal consistency or reliability of the students' responses to the survey was about the same on the post-survey as it had been on the pre-survey. Cronbach's Alpha was 0.88 on the fall survey and 0.84 on the spring survey. So, both surveys obtained good reliability.

As a group, the students consistently indicated that they hold some positive beliefs about math, such as that it was important and relevant to their lives and that they were proficient at math. They were more mixed on other issues covered on the survey, such as how much they enjoyed math and how well their math classes were paced. There were no significant changes from fall to spring in how students responded to all of the survey questions but one, concerning how often they earned good grades in math. It is important to understand that the students were answering the survey questions in the fall based on their prior experience in their elementary math classes. Yet in the spring they were answering the survey questions about their math class based on their experience in the enrichment math pilot program. Although both surveys stated the term "math class" in several of the items, the interpretation of that term depends on whether or not the student was taking the survey in the fall or the spring. The details on this analysis will follow in the section discussing changes from fall to spring.

Students' Ratings

As a group, when they answered the spring survey, the students gave somewhat mixed signals as to how frequently they enjoyed math. Most (60%) indicated that they "often" or "always" like math, and that math was usually their favorite subject at school. Three-fourths (75%) reported "never" or "seldom" thinking that they had too much math at school. However, less than half indicated that they "often" or "always" had fun with math (45%) or enjoyed solving number problems (40%), and 70% said they liked reading more than math at least sometimes.

These respondents were more definite and consistent in expressing their belief that math was important and relevant to their lives. Nearly all (95%) agreed that math was “often” or “always” important. Almost as many (85%) similarly indicated that they usually used math outside of school, and they regularly made connections between the real world and what they learned in the enrichment program (70%).

While most of these students did not usually find math to be easily, they did consider themselves to be proficient at math. Only a minority (40%) indicated that math class was “often” or “always” easy for them, and a small majority (55%) reported that they “never” or “seldom” find it “too easy.” But, a large share of the sample said that they were “often” or “always” good at working with numbers (85%) and “seldom” or “never” felt nervous about math (85%). Big majorities also indicated that they usually earned good grades in math (80%) and knew how to find the correct answers to number problems (85%). Nearly three-fourths (70%) reported that they “seldom” or “never” find math to be too hard.

Finally, the students were convinced that they were participating in their math class, but they were more divided on the challenge level and pacing in their math class. Most reported that they “often” or “always” pay attention in their math classes (85%), and all said they usually tried hard to do their best in math (100%). However, less than half indicated that they “often” or “always” felt challenged in math classes (45%), and nearly as many indicated that they “seldom” or “never” do (40%). This group was also fairly evenly divided when they were asked about how their math classes “move along.”

About a third indicated that the pacing was about right (33%), about a third thought the class moved too quickly (35%) and about a third rated math class too slow (30%).

Changes from Fall to Spring

Table 6 shows the average rating on each survey item from the 20 students who completed both the fall and spring questionnaires. There was a slight change in average ratings over the course of the school year. There was no statistically significant change in the students' ratings on any item except question 12 which asked about getting good grades in math. The students' average rating in both the fall and the spring suggests that they felt they usually did earn good grades in math, but in the fall they reported that this happened nearly "always," while in the spring they said that this occurred just a little more frequently than "often."

Null Hypothesis: There will be no significant change from pre to post responses on any individual survey item.

Based on paired-sample *t* tests, the only statistically significant change on any survey item occurred on question 12 ($t = 2.269$, d.f. = 19 $p < .035$). As a group the students indicated that they usually get good grades in math in both the fall and the spring. But in the fall, on average, they tended to say that they "always" get good math grades, while in the spring, the average score was close to "often" on the answer scale.

Table 6

Average Score for Student Math Survey: Fall 2008 and Spring 2009

Question #	Item	Fall 2008	Spring 2009
1.	I like math.	4.0	3.7
2.	I like reading more than math.	3.2	3.4
3.	I have fun when we do math.	3.5	3.4
4.	Math is my favorite subject.	3.8	3.4
5.	I enjoy trying to solve number problems.	3.7	3.3
6.	Math is important.	4.9	4.7
7.	I use math even when I am not at school.	4.1	4.3
8.	I think we have too much math at school.	1.9	2.1
9.	I am good at working with numbers.	4.4	4.1
10.	Math makes me nervous.	1.5	1.8
11.	Math is too hard.	1.9	2.3
12.	I get good grades in math.	4.7	4.2
13.	I know how to find correct answers to math problems.	4.0	4.0
14.	I pay attention in math.	4.4	4.3
15.	I try hard in math class.	4.9	4.8
16.	I have felt challenged in my math class.	3.3	3.3
17.	I think math is too easy.	2.8	2.5
18.	I see connections with math and the real world.	3.4	3.9
19.	My math classes have been easy for me.	3.3	3.3
20.	My math classes have moved along slowly/quickly.	3.0	3.1

Note: Average ratings on five-point answer scale ranging from “Never” (1) to “Always” (5) on questions 1 through 19 and “Very Slowly” (1) to “Very Quickly” (5) on question 20. N=20

Achievement Test Results

Three measures of math skills were used in this study, the state MAP test, the district common assessment and a special, more difficult exam developed for high-performing math students (advanced pre/post-assessment). The psychometric properties of the state and district tests were already well established, but since it was brand new, the psychometric properties of the advanced pre/post-assessment were unknown and needed to be investigated.

Based on the results from this study, the advanced pre/post-assessment had moderately good reliability, considering the small sample size. Cronbach's Alpha internal consistency and test-retest correlations for this assessment were around 0.6, which is an acceptable level, especially for a new instrument (Salkind, 2005; Nunnally, 1967). Based on the analyses, the reliability could be increased if some items (especially question 10) were deleted from the assessment or revised. The validity of the new assessment could not be determined, because there was no good criterion measure with which to compare. The correlations, as calculated using Pearson Product Moment Correlation Coefficient, between the advanced pre/post-assessment scores and the other math measures used in this study were usually low. This could be due to the fact that these students all scored at the advanced level on the MAP and at the 96th percentile on the district common assessment, but their scores varied more widely on the advanced pre/post-assessment. It was anticipated that these students may not show much change on the MAP and district common assessment because they were so high performing and therefore inclined to ceiling effects on these assessments. The more advanced pre/post-assessment was developed precisely for this reason, and on this more difficult measure, this group of students demonstrated greater improvement.

Null Hypothesis: There will be no relationship between the student scores on the advanced pre-assessment and the student scores on the advanced post-assessment.

On this advanced assessment, the mean raw score for this group of students increased from 9.55 in the fall to 19.125 in the spring. Based on a paired-sample *t* test at the 95% confidence level, this improvement in the students' test scores was statistically significant ($t = -10.72$, d.f. = 19, $p < .0005$).

Reliability

A test is considered reliable if it produces a relatively low amount of measurement error. Measurement error is random, so if a measure carries a high degree of error, respondents' answers will vary considerably each time they take the measure. On the other hand, if there is a low level of error, respondents' answers will tend to be consistent across test administrations over time. This is the test/re-test correlation which is one technique for assessing reliability (Nunnally, 1967).

In this study, subjects took the advanced pre/post-assessment twice, so a comparison can be made between their performances on these two test administrations. The correlation between the pre-test and post-test assessments was moderately high and statistically significant ($r = 0.578$, $p < 0.008$, $n = 20$). This indicates that the students did respond consistently to the assessment. Those who scored relatively well on the pre-test also tended to score that way on the post-test, and those who scored relatively low on the first test administration also tended to be at the bottom of the distribution on the second test administration. So, this assessment had reasonably good reliability, based on this test/re-test measure.

Another type of reliability indicator is known as internal consistency. The issue here is whether students are responding randomly to individual test items, or whether they tend to respond to each item in a fairly consistent way. In other words, do students who perform poorly or well on some of the questions also tend to perform the same way on other questions? If their performance is consistent across test items, it indicates that their scores are not much influenced by random factors such as measurement error (Nunnally, 1967).

Internal consistency can be assessed with a statistic known as Cronbach's Alpha, or a special version of Alpha known as Kuder-Richardson 20 (KR20). Cronbach's Alpha is most often used in assessing the reliability of surveys (where there is usually no "right" answer), while KR20 is more often used with tests (which do have a "correct" response). The KR20 coefficients for this new assessment were moderate. The coefficient for the pre-test was 0.567 and on the post-test it was 0.652. According to Nunnally (1967), a new measuring instrument should have an internal consistency of 0.6 or higher to be considered reliable. So, the new assessment met the accepted reliability benchmark for internal consistency.

However, if the advanced pre/post assessment is going to be used in the future, the reliability of the advanced pre/post assessment could be improved by deleting or revising question 10. When responses to item 10 on the advanced pre-assessment were removed, the KR20 coefficient for the advanced pre-assessment increased from 0.567 to 0.657. Similarly, deleting item 10 from the advanced post-assessment improved KR20 from 0.652 to 0.700. Removing any of the other items tended to lower rather than improve the KR20 coefficient. Therefore, students responded more randomly to item 10 than they responded to the other items on the advanced assessment.

Validity

An assessment is considered valid if it can be shown to measure what it claims to measure. Usually, validity of a new measure is determined by administering that instrument along with a known and established measure of the same construct. If scores on the new measure correlate well with scores on the established measure, the new measure is valid in the sense that it produces results that are similar to those produced by the established or "criterion" measure.

The students in this study took the advanced pre/post-assessment along with the district and state math tests. However, only the new measure was designed to assess higher-order math skills exclusively, so the advanced pre/post-assessment was not intended to measure the same "thing" as the other tests used in this study. Therefore, there was no good criterion measure in this data which could be used to determine the validity of the advanced pre/post-assessment.

As might be expected, the correlations between the advanced pre/post-assessment and the other measures used in this study were generally low to moderate. After all, all of the students in this study scored at the top of the MAP and the district math assessment, but their scores varied more widely on the more difficult, advanced pre/post-assessment.

Null Hypothesis: There will be no relationship between student scores on the advanced pre-assessment and student scores on the MAP.

At the 95% confidence level, there were no statistically significant correlations between the students' advanced pre/post-assessment scores and their MAP math scores, as measured by the Pearson Product Moment Correlation Coefficient. The correlation between the pretest and the MAP was 0.312 ($p < 0.181$) while the correlation between the post-test and the MAP was 0.382 ($p < 0.097$). The correlation between the advanced pre/post-assessment and district pretests was -0.022 ($p < 0.926$), which indicates a negative relationship.

Null Hypothesis: There will be no relationship between student scores on the advanced assessment and the district common assessments.

There was a statistically significant correlation between the advanced assessment and district common assessment ($r = 0.550$, $p < 0.012$), so to some extent, those two measures may have been assessing the same "thing." However, the overall pattern of low correlations here demonstrates the uniqueness of the advanced assessment and the lack of a good criterion measure for determining validity.

Discrimination

The researcher thought that another way to show that the advanced assessment was reliable was to examine how well each test item discriminated between those who scored well on the test overall and those who scored less well. In other words, did a given test question distinguish between students who had mastered the material (because they scored well on the total test) and students who may not have mastered the material (because they scored relatively low on the test)? Since the advanced assessment was a new assessment, all reasonable ways to test reliability and validity were applied to this study.

Table 7 compares the average individual test question results for the students who scored in the top half of the total test and the students who scored in the bottom half. An Analysis of Variance test was used to test for difference in responses.

The Null Hypothesis was: There will be no difference in student response when comparing results for students who scored in the top half on the total test and those who scored in the bottom half on the total test.

On almost all of the test questions, the students in the top half scored better than those in the bottom half. The two exceptions to this general rule were questions 2 and 10 on the pre-test, on which the students who scored below the median total score performed a little better, on average, than those who scored above the median. While the high-scorers did better than the low-scorers on these two items on the post-test, neither of these questions consistently discriminated between the top and bottom half of students.

Table 7

Mean Item Scores: Students Scoring Below and Above the Median on the Total Advanced Assessment

		Pre-test			Post-test		
Item No.	**Points Poss.**	**Below Median**	**Above Median**	**Sig.**	**Below Median**	**Above Median**	**Sig.**
1	2	.70	.73	N	1.10	1.50	N
2	2	1.90	1.82	N	1.60	1.80	N
3	2	.40	.73	N	1.10	1.40	N
4	2	.40	.73	N	1.30	1.50	N
5	1	.40	.55	N	.80	.90	N
6	2	.40	1.36	Y	1.20	1.90	Y
7	2	.20	1.27	Y	1.30	1.90	Y
8	2	.10	1.00	Y	1.10	1.70	Y
9	2	.40	1.18	Y	1.10	1.80	Y
10	3	1.00	.55	N	1.30	1.50	N
11	2	.00	.64	Y	1.35	1.80	Y
12	2	.40	1.00	N	1.80	1.90	N
13	3	.30	.64	N	1.10	1.30	N
14	1	.00	.18	N	.00	.70	Y

Note: Median on the pre-test was 10.0 and 19.0 on the post test. Based on a one-way analysis of variance, the median split differences were statistically significant on pretest questions 6 ($F[1,19] = 8.443$, $p<.009$), 7 ($F[1,19] = 9.721$, $p<.006$), 8($F[1,19] = 7.396$, $p<.014$), 9 ($F[1,19] = 5.054$, $p<.037$) and 11 ($F[1,19] = 4.72$, $p<.043$) and post-test questions 6 ($F[1,18] = 17.64$, $p<.001$), 7 ($F[1,18] = 6.48$, $p<.020$), 8 ($F[1,18] = 10.80$, $p<.004$), 9 ($F[1,18] = 5.188$, $p<.035$), 11 ($F[1,18] = 5.832$, $p<.027$) and 14 ($F[1,18] = 21.00$, $p<.0005$).

The average scores of the top half and bottom half were not only in the right direction, but were also different to a statistically significant degree on five of the questions on the pre-test and post-test. Question 14 was also found to be a statistically significant discriminator on the post-test.

Overall, the individual test items on this advanced pre/post-assessment distinguished between the higher and lower performing student groups. If this test is going to be used in the future, it might be advisable to consider revising questions 2 and 10, since they did not discriminate well on the pretest. However, questions 6 through 9 and 11 should be kept, since they consistently showed a statistically significant difference between the students who scored at the top and the bottom of this advanced assessment.

Predicting Students' Scores on the Advanced Math Assessment

The advanced math test was the only measure that showed any significant change over time. Therefore, it needed to be further investigated. A wide range of variables was entered into a stepwise multiple regression analysis, including numerical codes for gender, ethnicity, and participation in the official gifted program; reading, science, social studies, and math scores from the SAT10 test that students took in fifth grades; results from students' most recent Otis-Lennon School Ability Test and DOMINIE reading assessment; the fifth grade MAP math and communication arts scores; current and cumulative grade point averages; scores from the students most recent Scholastic Reading Inventory assessment; as well as their scores on the district common math assessment; the math attitudes survey, and their pre-test results from the advanced math assessment.

The regression analysis, displayed in Figure 4, revealed that out of all of these variables, the best prediction of students' final scores on the advanced math test could be made with just five measures: post-test raw scores on the district common assessment, pre-test scores on the advanced math assessment, the student's percentile rank on the Scholastic Reading Inventory, their scale scores from the fifth-grade MAP math assessment and whether or not they were in the gifted program. These five variables together were strongly correlated with the post-test advanced math assessment results (multiple R = 0.887), and this relationship was definitely statistically significant (F [5, 14] = 10. 305, $p < 0.0005$). Based on the results of the regression analysis, the best prediction of students' final scores on the advanced math assessment would be made with the following equation:

$$Y = 57.766 + 1.118P_1 + .398\ P_2 - .15S - .065M - 2.468G$$

Figure 4 Regression analysis equation
Note: P_1= post-test common assessment raw score. P_2 = pre-test advanced assessment raw score. S = Scholastic Reading Inventory percentile rank. M = fifth grade MAP math scale score. G = value added based on gifted enrollment: 1 = gifted; 2 = not gifted.

Value-added

There was not much difference between the average predicted advanced math assessment score and average actual math assessment score for this group, though the actual scores were slightly higher. The mean predicted raw score was 19.09 and the mean actual raw score was 19.13. There was no statistically significant difference between these two averages as indicated by a paired sample *t* test.

However, a slight majority of the students who participated in this project did score better than they were predicted to do on the final advanced math assessment. The predicted and actual score for each participating subject was shown in Table 8. Out of this group of 20, nine scored a little worse than predicted, but 11 scored better than predicted. Therefore, most of the participating students scored better on the post-advanced math assessment than would have been expected from a combination of their gifted status and their performance on previous tests and assessments.

Summary

On most of the measures used to gauge student performance and attitudes in this study, there was little change over the course of the year. On the total math attitudes survey developed for this study, the mean score for this group of 20 students went from 77.4 in the fall to 74.5 in the spring, a statistically insignificant change. Question 12, which asked about getting good grades in math, was the only item that had any significant change in response from the students. The students' average rating in both the fall and the spring suggests that they felt they usually did earn good grades in math, but in the fall they reported that this happened nearly "always," while in the spring they said that this occurred just a little more frequently than "often."

On the district math common assessment, the mean score was 19.9 on the pre-test and 19.1 on the post-test. This change also was not statistically significant. On the MAP math test that these students took at the end of fifth grade, they had an average scale score of 720.6. At the end of sixth grade, their average MAP math scale score was 722.2. So, there was no significant change on this measure either based on a paired sample *t* test. However, it was anticipated that there would not be much change on these assessments. Therefore, the advanced assessment was used. On this advanced assessment, the mean raw score for this group of students grew from 9.55 in the fall to 19.125 in the spring which was statistically significant ($t = -10.72$, d.f. = 19, $p < .0005$). Finally, most of the questions on the advanced pre/post assessment, with the exception of questions 2 and 10, did a consistently adequate job at discriminating between higher and lower performing students. The best discriminators were questions 6, 7, 8, 9, and 11.

The regression analysis revealed that the best prediction of students' final scores on the advanced math test could be made with just five measures: post-test raw scores on the district common assessment, pre-test scores on the advanced math assessment, the student's percentile rank on the Scholastic Reading Inventory, their scale scores from the fifth-grade MAP math assessment and whether or not they were in the gifted program.

The next chapter restates the research problem, reviews the methodology, and summarizes problem and research questions surrounding the study. It will also provide a synopsis of the results, and possible ways to utilize the information gathered in this study, as well as recommendations for future research.

Chapter Five: Summary and Discussion

High-stakes assessments have essentially allowed educators to ignore the needs of the top performers. Oakwood School District incorporated an enrichment pilot mathematics program into the School Improvement Plan for the school year 2008-09 in response to improve math scores for all students on the MAP. Therefore, this study focused on the academic achievement and attitudes of sixth-grade students who were placed in the enrichment math pilot program. One purpose of this study was to determine if the program affected the learning of the advanced students. Analyzing data on these particular students is difficult because their standardized achievement scores are already very high. Therefore, the researcher used an advanced assessment created specifically for the students in the program. The results of that assessment will be discussed in this chapter.

Another purpose of the study was to investigate the relationship between the scores on the advanced assessment and the demographic data of the students, then determine if a regression analysis could be used to predict which type of students would be most successful in this type of class in the future. The regression analysis will also be discussed in this chapter.

Finally, this study examined the attitudes of these students towards mathematics and how they changed during this school year. In order to measure the attitudes of the students, a survey was distributed at the beginning and at the end of the year. The results of the survey will also be discussed in this chapter.

Review of the Methodology

As explained in chapter 3, the purpose of this study was to determine whether an enrichment mathematics pilot program affected the achievement and/or attitude of the sixth-grade students enrolled in the class. The researcher examined data from an advanced assessment created specifically for the enrichment class. The advanced assessment was distributed to the students in the fall of 2008 and in the spring of 2009. The researcher also analyzed results from a survey which was distributed in the fall of 2008 and in the spring of 2009. Finally, the researcher used quantitative data retrieved from the database of the district, including numeric codes for gender, ethnicity, and participation in the official gifted program; reading, science, social studies, and math scores from the SAT10 test that the students took in the fifth grade; results from students' most recent Otis-Lennon School Ability Test and DOMINIE reading assessment; the fifth-grade MAP math and communication arts scores; current and cumulative grade point averages; and scores from the students most recent Scholastic Reading Inventory assessment.

The regression analysis provided good information because it considered demographic data, reading ability, as well as other types of achievement. The researcher used all of the demographic data that was available at the time of the study. Even though it seemed like some of the data could not possibly be related to mathematics, none was exempt. As discussed in chapter 2, advanced classes are not always the best placement for every high achieving student and not every child can be identified with one or two assessments. This is the reason why a wide-variety of data was scrutinized for the regression analysis.

Discussion of Results

On most of the measures used to gauge student performance and attitudes in the study, there was little change over the course of the year. The changes from fall to spring on the district math common assessment were not statistically significant. The students' scaled scores on the end-of-fifth-grade MAP math test compared to those at the end of sixth grade also showed no significant change. However, it was anticipated that there would not be much change on these assessments. Therefore, the advanced assessment was used.

One of the four overarching questions in this study involved achievement in an enrichment pilot math program.

RQ1: Will the students in the pilot math enrichment program show improvement on an advanced post-assessment?

> $H1_0$: There will be no relationship between student scores on the advanced pre-assessment and student scores on the advanced post-assessment.

The advanced assessment was the only assessment which showed significant student growth. On the advanced assessment, the mean raw score for this group of students grew from 9.55 in the fall to 19.125 in the spring, which was statistically significant (t = -10.72, *d.f.* = 19, p < .0005).

In order to test the validity of the advanced assessment, comparisons were made between the advanced assessments and the post assessments used by the district including the MAP and the district common assessment.

RQ2: Will there be a relationship between student scores on the advanced pre/post-assessments and the district post-tests?

$H2_0$: There will be no relationship between student scores on the advanced pre/post-assessment and the district's common assessment.

$H3_0$: There will be no relationship between student scores on the advanced pre/post-assessment and the MAP scores.

There were no statistically significant correlations between the students' advanced pre/post-assessment scores and their MAP math scores, as measured by the Pearson Product Moment Correlation Coefficient. However, in regards to the district common assessment, there was a statistically significant correlation between the advanced assessment ($r = 0.550$, $p <0.012$), so to some extent, those two measures may have been assessing the same construct. Yet, the overall pattern of low correlations here demonstrates the uniqueness of the advanced assessment and the lack of a good criterion measure for determining validity.

Another comparison was also made between the scores of the top half of the students and the bottom half of the students on the advanced assessment. Therefore, a third overarching question in this study involved whether there was a difference in student response when students who were in the top half of the ranking on total advanced assessment were compared to those ranked in the bottom half.

RQ3: Will there be a difference in student response when comparing results for students who scored in the top half on the total advanced pre/post-assessments and those who scored in the bottom half on the total advanced pre/post-assessments?

$H4_0$: There will be no difference in student response when comparing results for students who scored in the top half on the total test and those who scored in the bottom half on the total advanced pre/post-assessments.

Overall, the individual test items on this advanced pre/post-assessment distinguished between the higher and lower performing student groups. On almost all of the test questions, the students in the top half scored better than those in the bottom half. The two exceptions to this general rule were questions 2 and 10. Although the top half did better than the bottom half on these two questions, neither question consistently discriminated between the top and bottom half of students. One reason could be because the students did not understand what the questions were asking. However, both questions were the only questions on the assessment involving the multiplication, division, addition, and subtraction of decimals. Therefore, another reason the questions did not discriminate well between the two groups could have been because neither group completely understood how to solve problems involving decimals.

The average scores of the top half and bottom half were not only in the right direction, but were also different to a statistically significant degree on five of the questions on the pre-test and post-test. Question 14 was also found to be a statistically significant discriminator on the post-test. This question was one of two which related to the measurement and statistics chapter. It was also the last question on the test and the students who knew all of the information well, may have been able to answer all 14 questions without becoming mentally exhausted. Students who were struggling throughout the test may have simply given up by the time they reached the last question. The best discriminators were questions 6, 7, 8, 9, and 11. All of these questions had concepts in common: addition, subtraction, multiplication, and division of fractions. It could be that the top half of the students understood the concepts of fractions better than the bottom half. Yet neither group was able to apply the concept of fractions to decimals since questions 2 and 10 dealt with decimals.

The final question in this study involved the change in attitudes of the students in the enrichment pilot mathematics program.

RQ4: How does the enrichment pilot program affect students' attitudes towards math?

$H5_0$: There will be no significant change from pre to post responses on any individual survey item.

$H6_0$: There will be no relationship between the student responses on the complete survey and student scores on the district's common assessment.

$H7_0$: There will be no relationship between the student responses on the complete survey and student scores on the advanced post-assessment.

There was only one significant change from the results of the fall survey to the spring survey. The statement concerned how often the students earned good grades in math. As a group, the students indicated in both the fall and spring that they usually earn good grades in math, but in the fall, on average, they tended to say that they "always" earn good grades, while in the spring, the average score was close to "often" on the answer scale. Perhaps the students were in the habit of earning "A's" on all of their work in the elementary school because they were not required to complete challenging work or use multiple mathematical skills to solve multi-step problems. Many times learning information is easy for advanced students and they do not learn how to apply concepts in order to solve higher ordered thinking problems. This could be one of the first times these types of students were exposed to new information where they had to solve problems using critical thinking skills and they found themselves not always making "A's."

Other analyses were run with the data from this study. One of these was a regression analysis which revealed that the best prediction of students' final scores on the advanced math test could be made with just five measures: post-test raw scores on the district common assessment, pre-test scores on the advanced math assessment, each student's percentile rank on the Scholastic Reading Inventory, their scale scores from the fifth-grade MAP math assessment, and whether or not they were in the gifted program. A slight majority of the students who participated in this project did score better than their prediction.

Additional analyses yielded other interesting results. These were found when the survey was correlated with the assessments used in the study. For example, correlation of the survey and the district's common assessments revealed a significant indication of a moderate relationship between math attitudes and math achievement in the pilot enrichment group of students. Specifically, questions 12, 14, and 18 from the survey correlated to the district's common assessment. Survey item 12 stated, "I get good grades in math." Survey item 14 stated, "I pay attention when we have math at school." And survey item 18 stated, "I see connections between what I learn in math class and the real world." Therefore, students' thoughts about whether they get good grades, how well they pay attention in class, and understanding connections in the real world, correlate to the common assessment. According to the research discussed in chapter 2, advanced students need to understand why they are studying what they are studying in order to maintain motivation academically. Therefore, this correlation between attitude and achievement makes sense.

Questions 13, 16, and 19 correlated to the advanced assessment. Survey item 13 stated, “I know how to find the correct answers to math problems.” Survey item 16 stated, “I have felt challenged in my math class.” And survey item 19 stated, “My math classes have been easy for me.” Therefore, students’ feelings about how challenging their math classes were and how well they could find the correct answers explained some of the variance in their advanced assessment performance. This is logical given the research regarding students’ motivation toward academics in challenging versus unchallenging environments. If students feel challenged and are able to show their successes then they will do better academically.

Recommendations for Future Studies

The first research question in the study asked whether or not students in an enrichment pilot mathematics class at one middle school would improve on an advanced assessment. Unfortunately, there were no other schools implementing the program at the time of the study. As a result, the research was limited to the 22 students in the enrichment class and there was no opportunity to study a control group. Since completion of the study, all five middle schools in the district have implemented an enrichment math program for the sixth grade. Therefore, the researcher suggests that more investigations be completed on the program now that the sample size has grown.

As discussed in chapter 4, another way to examine assessments is to investigate how well each test item discriminates between those who scored well on the test overall and those who scored less well. In other words, does a given test question distinguish between students who have mastered the material (because they scored well on the total test) and students who may not have mastered the material (because they scored relatively low on the test)? According to the results from this study, the advanced assessment should be revised if it will be used in the future. Specifically, this study found that questions 2 and 10 should be reworded, revised, or deleted since they did not discriminate well between the top half and the bottom half of the class. As discussed previously, one reason for the discrepancy could be because the students did not understand what the questions were asking. However, both questions were the only questions on the assessment involving the multiplication, division, addition, and subtraction of decimals. Therefore, another reason the questions did not discriminate well between the two groups could have been because neither group completely understood how to solve problems involving decimals. Perhaps additional questions regarding decimals on the advanced assessment could help determine if this was the issue.

However, questions 6 through 9 and question 11 should be kept, since they consistently showed a statistically significant difference between the students who scored at the top and the bottom of this advanced assessment. All of these questions had concepts in common: addition, subtraction, multiplication, and division of fractions. It could be that the top half of the students understood the concepts of fractions better than the bottom half. Yet neither group was able to apply the concept of fractions to decimals. Again, more questions differentiating between fractions and decimals would help the researcher clarify the issue at hand.

It is vital to choose students carefully for an enrichment program, especially when they have never been exposed to an advanced class. Students at the elementary level are provided with enrichment opportunities, but they are not typically separated into different classes based on ability. Homogeneous grouping may not be the right choice for every advanced student. The research from the literature found conflicting results when investigating the attitudes of high-ability students in homogeneous classes. Some students preferred heterogeneous classes because they were easier and allowed them to earn a high class ranking with little work (Adams-Byers, Squiller Whitsell, & Moon, 2004). Other researchers (Csikszentmihalyi, Rathude, & Whalen, 1993; Rogers, 2007; Sternberg, 1986) found that stress, boredom, underachievement, lowered academic self-esteem, and social and behavioral maladjustments increased when high-ability students were not in a challenging environment. This is the reason why the multiple regression analysis should be implemented. However, it is recommended that similar analyses to this study should be run on the data in order to perfect the regressions analysis equation. This will help in the selection process of students for this type of program because it uses all types of data to examine the whole child instead of only using achievement scores. The discrepancy between attitude and achievement of advanced learners was part of the purpose for the study. According to the research, students who are placed in the appropriate setting will have a higher achievement rate. Therefore, the multiple regressions analysis would be another piece of data which would help to determine the proper placement for the advanced students.

Initially, the study focused on whether or not the attitudes of the enrichment students changed from fall to spring. Further investigation of the data revealed that the only significant change in attitude was in regard to how often the students felt they earned good grades in math. The students' average rating in both the fall and the spring suggested that they felt they usually did earn good grades in math, but in the fall they reported that this happened nearly "always," while in the spring they said that this occurred just a little more frequently than “often.” Did this change occur because the curriculum was harder? Did the students realize that there was information that they did not know? If this study is to be repeated, it might be beneficial to ask the students those types of questions. Once the results of future studies have been analyzed and a change of attitude has been determined, an interview with the students regarding the changes would be more meaningful and informative. Therefore, the researcher would recommend the attitude survey be analyzed in a timely manner so that an interview could be conducted regarding the changes prior to the end of the course.

By assessing students’ attitudes towards mathematics at the beginning of the year, teachers can be proactive and identify those students most at-risk and those who need enrichment. Research discussed in chapter 2 showed that when students are taught to make connections between math and the real world, they understand the concepts better and, as a result, make more progress. Therefore, all teachers could use items 13, 16, and 19 from the survey in order to better understand students’ attitudes towards math and to predict how they might perform academically.

Implications for District of Study

Students in this study did show improvement on the advanced assessment. In fact, the advanced assessment was the only assessment in which the students showed significant growth. Since the students were already scoring at the 90th percentile or higher on the MAP and the district’s common assessment, no significant growth was measured from the analysis of those scores. The second research question for this study investigated whether or not students improved on the district common assessment and the MAP assessment. If the only assessments used in the study were the MAP and the district's common assessment, it would appear as if the students did not improve. However, the results from the advanced assessment showed that the students did in fact improve from fall to spring. Therefore, this study reinforces that other assessments are necessary to show growth for advanced students. As a result, the researcher would recommend the use of advanced assessments when evaluating the growth of high-ability students.

This study reinforced the current research which explained that state and national assessments alone are not good indicators of demonstrating improvement for the advanced students (Gessner, 2008). Yet, educators are being held accountable to show improvement for all students. Therefore, more advanced assessments like the one used in this study should be implemented in schools for accountability purposes in order to show improvement for all students. These types of assessments are good not only for educators, but also for the students taking them. Too often students see that they score at the advanced or proficient level on state and national tests and then assume they have nothing to learn, which leads to lack of motivation (Sternberg, 1986).

According to the research, all students should be provided with a rigorous curriculum. In order to improve their self-efficacy and motivation, students need an opportunity to show academic growth. The literature consistently explains how advanced students need the opportunity to explore mathematical concepts at a higher and deeper level and at a faster pace in order to improve their understanding. Therefore, an advanced assessment should be implemented in order to show growth and benefit the students.

According to Borland (2003), an enrichment-type class should be available to any student who is ready for the challenge. One of the limitations of this study was in the selection of students. At the time, the best indicators of students' readiness were based on scores on previous national and state assessments. This study provides an additional method to determine if students are ready to be placed in the enrichment class. As discussed in the literature review, an advanced class is not always the best placement for every high achieving student and not every child can be identified with one or two assessments. The regression analysis is helpful because it applies demographic data, reading ability, as well as other types of achievement in order to scrutinize all types of students before placing a student in an advanced program. As a result, more of the whole child is recognized.

The regression analysis revealed that the best prediction of students' final scores on the advanced math test could be made with just five measures: post-test raw scores on the district common assessment, pre-test scores on the advanced math assessment, each student's percentile rank on the Scholastic Reading Inventory, their scale scores from the fifth-grade MAP math assessment, and whether or not they were in the gifted program. These five variables together were strongly correlated with the post-test advanced math assessment results ($R = 0.887$), and this relationship was definitely statistically significant (F [5, 14] = 10.305, $p < 0.0005$). Therefore, any student could be offered the pre-advanced math assessment and be given the opportunity to be screened for this program. Pre-assessing all students would widen the scope of students being identified for the program. Since more data is used to discern whether or not a student is ready for the enrichment class, there is a possibility that more students would be identified.

In other words, all students who scored at the advanced level in mathematics could be given the revised version of the pre-advanced assessment created for this study.

Those results, when applied to the regression analysis, provide educators with a predicted post-advanced assessment score. Therefore, the instructors of the enrichment class would have a better idea of how those students would perform in the program and could make a better decision regarding who would be eligible for the class.

It is recommended that the use of surveys be implemented throughout the district. The three questions which correlated to the district's common assessment could be used by all sixth-grade mathematics teachers in the district. The three questions from the survey which correlated to the advanced assessment scores could be used by the teachers of the enrichment classes. Students' feelings about their own math skills and the lack of challenge or difficulty in their math classes explained some of the variance in their common assessment and advanced assessment performance. So, instead of distributing the entire survey to all of the students in a class, a teacher in the district could simply ask students to rank those three statements at the beginning of the year in order to predict how well they would perform on the district common assessment. Perhaps all teachers of the sixth-grade enrichment math program should ask those three questions of their students at the beginning of the year. The interpretation of those three statements would help the teacher determine who might be in need of additional support. Again, research explains that students who do not feel challenged are more likely to underachieve. If teachers identify students who are at risk for underachievement at the beginning of the year, they will be able to provide a challenging environment immediately and hopefully change the attitudes of those students for the better.

Summary

Overall, several recommendations are obvious given these results. First, the advanced assessment should be revised to make it more reliable. Second, it should be distributed to all of the potential enrichment mathematics students at each middle school in the district and be used in the future as an additional form of data to discriminate among all students to find those most ready for the enrichment class. Third, a similar analysis to this study should be run on the data in order to perfect the regression analysis equation. Finally, some form of a survey should be collected at the beginning of the year in order to be sure that the emotional and social needs of the students are understood so that the proper academic challenge can be administered throughout the year.

Every educational institution has one major goal at the forefront: to ensure that all students are capable learners who understand and can respond productively to the constantly changing world. In order to accomplish this goal, the curricular expectations for every student must change. Each student should be provided with a rigorous curriculum so they are able to compete nationally and internationally. All students need opportunities to learn and grow. Teachers, administrators, and parents need to be able to show academic and emotional growth over time. The future of America's society depends upon how well our students are able to meet the demands of the world. How will today's students become lifelong learners and self-sustaining citizens if they are allowed to accept a mediocre education? The results and recommendations from this study will help to show educators the importance of creating a balance among academic, emotional, and social needs of high-ability students.

Appendix A: Outline of the General Mathematics Program Curriculum

Chapter 1: Number Sense and Algebraic Thinking

Estimate and Compute Whole Numbers

Powers of Whole Numbers

Order of Operations

Strategies for Problem Solving

Chapter 2: Decimals

Place Value

Addition, Subtraction, Multiplication and Division

Distributive Property

Chapter 3: Fractions

Greatest Common Factor

Least Common Multiple

Divisibility

Prime Factorization

Chapter 4: Measurements and Statistics

Read, Create, and Interpret Different Representations of Data

Chapter 5: Data Representation

Data Interpretation

Bar Graphs

Line Plots

Stem and Leaf Graphs

Coordinate Graphs

Chapter 6: Ratios, Proportions, and Percents

Relationships Between Quantities and Values

Chapter 7: Geometric Figures

Geometric Terminology

Compare and Classify Geometric Figures

Symmetry, Similarity, and Congruence

Chapter 8: Perimeter and Area

Measurement and Formulas

2D Figures

Volume of Cubes

Properties of 1-. 2-, and 3-Dimensional Figures

Appendix B: Outline of the Sixth Grade Enriched Math Pilot Curriculum

Chapter 1: Number Sense and Algebraic Thinking

Whole Number Operations

Whole Number Estimation

Powers and Exponents

Order of Operations

Variables and Expressions

Equation and Mental Math

A Problem Solving Plan

Chapter 2: Measurement and Statistics

Measuring Lengths

Scale Drawings

Frequency Tables and Line Plots

Coordinates and Line Graphs

Circle Graphs

Chapter 3: Decimal Addition and Subtraction

Decimals and Place Value

Measuring Metric Length

Ordering Decimals

Rounding Decimals

Decimal Estimation

Adding and Subtracting Decimals

Chapter 4: Decimal Multiplication and Division

Multiplying Decimals and Whole Numbers

The Distributive Property

Multiplying Decimals

Dividing by Whole Numbers

Appendix C: Approval Letter from the District

October 1, 2008

Ms. Tamara Tow
808 Kiefer Trails Drive
Ballwin, Missouri 63021

Dear Ms. Tow:

This letter is the official notification that your proposed research project, "Comparing Differences in Math Achievement and Attitudes toward Math in a Sixth Grade Mathematics Enrichment Pilot Program", has been approved for implementation in the Oakwood School District. You may proceed to administer pre/post surveys and assessments to students participating in the program, and to compare that data with other student information that is available to you as a district teacher.

You may report group results to others, but of course, you are required to maintain strict confidentiality on the performance or expressed attitudes of any individual student. You are also required to review your collected data and data analyses with my office, and to provide a copy of your final report to the district.

Thank you for your interest in determining "what works" for Oakwood students, and the best of luck with your research endeavors.

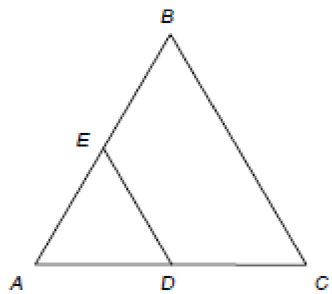
Sincerely,

Dan Coates
Director of Program Evaluation

C: Robert Malito, Superintendent
Desi Kirchhoff, Assistant Superintendent
Mike Baugus, Principal
Greg Bergner, Assistant Principal
Tim Hudson, Mathematics Coordinator
Denise Pupillo, Gifted Education Coordinator

Appendix D: Advanced Assessment

1. In the equilateral triangle below, the length of $\overline{AB}$ is 9 units. The midpoints of two of the sides have been marked and then connected by a line segment, $\overline{DE}$. What is the perimeter of trapezoid *BCDE*?



Perimeter = _______________ units

2. Julie has a bread recipe that calls for 1.75 pounds of flour. She has no flour at home. How many 5-pound bags of flour should she buy to make the recipe three times? Show your work.

_______________ bags

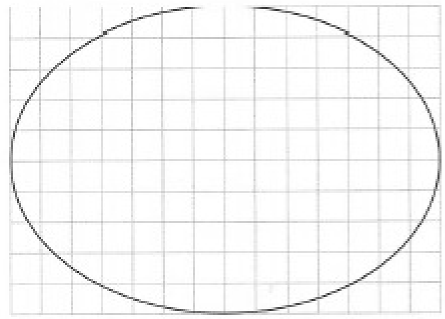
3. Tomas and Sharlina work on weekends and holidays doing odd jobs around the neighborhood. They are paid by the day, not the hour. They each earn the same whole number of dollars per day. Last month Tomas earned \$184 and Sharlina earned \$207. How many days did each person work? What is their daily pay?

Tomas worked ____________ days

Sharlina worked ___________ days

Daily pay: \$__________

Below is a drawing of an ellipse grid paper.



4. Estimate the area of this ellipse and describe the method you used to estimate it.

Area = _______________ square units

5. Is your estimate for area more or less than the exact area of the ellipse? Explain your reasoning.

6. What is $\frac{2}{9}$ of 3? Show your work.

Answer: ______________

7. What is $\frac{3}{4}$ of 3? Show your work.

Answer: ______________

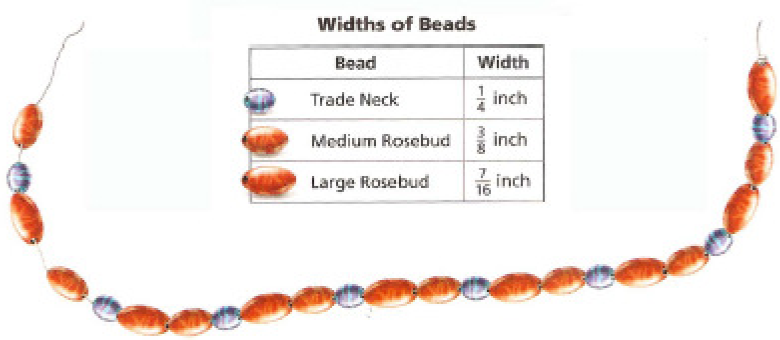
8. A school band has 64 members. The band marches in the form of a rectangle. How many different rectangles can the band director make by arranging the members of the band? Show your work.

9. Min Ji uses balsa wood to build airplane models. After completing a model, she has a strip of balsa wood measuring $\frac{7}{8}$ yard left over. Shawn wants to buy half of the strip from Min Ji. How long is the strip of wood Shawn wants to buy? Show your work.

____________ yards

10. Tanisha and Belinda found estimates for the product of 5.2487 x 100.3678 in two different ways:
Tanisha said: "I round 5.4287 to 5 and 100.3678 to 100.4. Then I multiply 5 x 100.4.
Belinda said: "I prefer to round 100.3678 to 100 and 5.2487 to 5.2. Then I multiply 100 x 5.2.
Whose estimation is closer to the exact answer? Explain your reasoning.

Violeta and Mandy are making beaded necklaces. They have several beads in various colors and widths. As they design patterns to use, they want to figure out how long the final necklace will be. Violeta and Mandy have the following bead widths to work with.



Widths of Beads

Bead	Width
Trade Neck	$\frac{1}{4}$ inch
Medium Rosebud	$\frac{3}{8}$ inch
Large Rosebud	$\frac{7}{16}$ inch

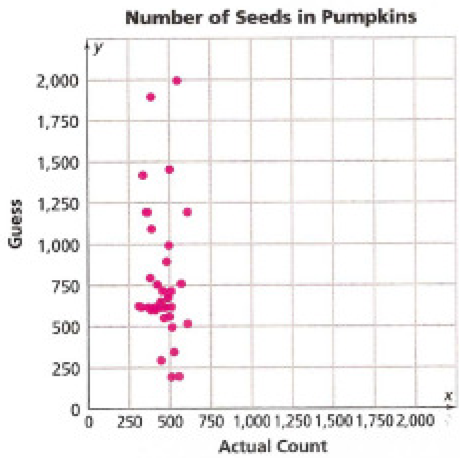
11. If Mandy uses 30 Trade Neck beads, 6 medium Rosebud beads, and 1 large Rosebud bead, how long will her necklace be? Show your work.

_______________ inches

12. The beans shown below represent $\frac{3}{5}$ of the total beans on the kitchen counter. How many total beans are there on the counter? Show your work.

_____________ beans on the counter

A group of students challenged each other to see who could come the closes to guessing the number of seeds in his or her pumpkin. The data they collected are shown in the table and graph.



Number of Seeds in Pumpkins

Guess	Actual
630	309
621	446
801	381
720	505
1,900	387
1,423	336
621	325
1,200	365
622	410
1,000	492
1,200	607
1,458	498
350	523
621	467
759	423
900	479
500	512
521	606
564	494
655	441
722	455
202	553
621	367
300	442
200	507
556	462
604	384
2,000	545
1,200	354
766	568
624	506
680	486
605	408
1,100	387

13. In general, did the students make good guesses? Use what you know about median and range to explain your reasoning.

14. Explain how would you change the scale to show the data points better.

Appendix E: Survey

Student Math Survey
Fall 2008

Think about the math classes you have had, and answer the questions below based on your experiences in those classes. Please read each statement and then mark the answer that best reflects your opinion. It is important to mark only **one** answer for each statement.

1. I like math.

   Never Seldom Sometimes Often Always

2. I like reading more than I like working with numbers.

   Never Seldom Sometimes Often Always

3. I have fun when we work on math at school.

   Never Seldom Sometimes Often Always

4. Math is my favorite subject at school.

   Never Seldom Sometimes Often Always

5. I enjoy trying to solve number problems.

   Never Seldom Sometimes Often Always

6. I think math is important.

   Never Seldom Sometimes Often Always

7. I use math even when I am not at school.

   Never Seldom Sometimes Often Always

8 I think we have too much math at school.

   Never Seldom Sometimes Often Always

9. I am good at working with numbers.

   Never Seldom Sometimes Often Always

10. It makes me nervous even to think about having to do a math problem.

Never	Seldom	Sometimes	Often	Always

11. I think math is too hard.

Never	Seldom	Sometimes	Often	Always

12. I get good grades in math.

Never	Seldom	Sometimes	Often	Always

13. I know how to find the correct answers to math problems.

Never	Seldom	Sometimes	Often	Always

14. I pay attention when we have math at school.

Never	Seldom	Sometimes	Often	Always

15. I try hard to do my best in math class.

Never	Seldom	Sometimes	Often	Always

16. I have felt challenged in my math classes.

Never	Seldom	Sometimes	Often	Always

17. I think math is too easy.

Never	Seldom	Sometimes	Often	Always

18. I see connections between what I learn in math class and the real world.

Never	Seldom	Sometimes	Often	Always

19. My math classes have been easy for me.

Never	Seldom	Sometimes	Often	Always

20. My math classes have moved along…

Very Slowly	Slowly	About right	Quickly	Very Quickly

Appendix F: Fall Survey Frequency Table

Student Math Survey
Fall 2008
(N=22)

How do you feel about math? Please read each statement below, and then mark an answer to show whether you **never** feel that way about math, feel that way **sometimes** or feel that way about math **most of the time.** Please mark only **one** answer for each statement.

1. I like math.

Never	Seldom	Sometimes	Often	Always	Blank
0%	9.1%	18.2%	40.9%	31.8%	0%

2. I like reading more than I like working with numbers.

Never	Seldom	Sometimes	Often	Always	Blank
13.6%	9.1%	40.9%	13.6%	22.7%	0%

3. I have fun when we work on math at school.

Never	Seldom	Sometimes	Often	Always	Blank
0%	18.2%	31.8%	36.4%	13.6%	0%

4. Math is my favorite subject at school.

Never	Seldom	Sometimes	Often	Always	Blank
4.5%	13.6%	18.2%	31.8%	31.8%	0%

5. I enjoy trying to solve number problems.

Never	Seldom	Sometimes	Often	Always	Blank
4.5%	13.6%	22.7%	36.4%	22.7%	0%

6. I think math is important.

Never	Seldom	Sometimes	Often	Always	Blank
0%	0%	0%	18.2%	81.8%	0%

7. I use math even when I am not at school.

Never	Seldom	Sometimes	Often	Always	Blank
0%	0%	22.7%	50.0%	27.3%	0%

8. I think we have too much math at school.

Never	Seldom	Sometimes	Often	Always	Blank
40.9%	31.8%	22.7%	0%	4.5%	0%

9. I am good at working with numbers.

Never	Seldom	Sometimes	Often	Always	Blank
0%	0%	9.1%	50.0%	40.9%	0%

10. It makes me nervous even to think about having to do a math problem.

Never	Seldom	Sometimes	Often	Always	Blank
54.5%	36.4%	9.1%	0%	0%	0%

11. I think math is too hard.

Never	Seldom	Sometimes	Often	Always	Blank
31.8%	50.0%	13.6%	4.5%	0%	0%

12. I get good grades in math.

Never	Seldom	Sometimes	Often	Always	Blank
0%	0%	9.1%	18.2%	72.7%	0%

13. I know how to find the correct answers to math problems.

Never	Seldom	Sometimes	Often	Always	Blank
0%	4.5%	9.1%	72.7%	13.6%	0%

14. I pay attention when we have math at school.

Never	Seldom	Sometimes	Often	Always	Blank
0%	4.5%	0%	50.0%	45.5%	0%

15. I try hard to do my best in math class.

Never	Seldom	Sometimes	Often	Always	Blank
0%	0%	0%	13.6%	86.4%	0%

16. I have felt challenged in my math classes.

Never	Seldom	Sometimes	Often	Always	Blank
9.1%	13.6%	36.4%	27.3%	13.6%	0%

17. I think math is too easy.

Never	Seldom	Sometimes	Often	Always	Blank
4.5%	22.7%	59.1%	13.6%	0%	0%

18. I see connections between what I learn in math class and the real world.

Never	Seldom	Sometimes	Often	Always	Blank
13.6%	9.1%	13.6%	45.5%	18.2%	0%

19. My math classes have been easy for me.

Never	Seldom	Sometimes	Often	Always	Blank
0%	22.7%	36.4%	27.3%	13.6%	0%

20. My math classes have moved along...

Very slowly	Slowly	About right	Quickly	Very quickly	Blank
9.1%	36.4%	18.2%	22.7%	13.6%	0%

Appendix G: Spring Survey Frequency Table

Student Math Survey
Spring 2009
(N = 20)

1. I like math.

Never	Seldom	Sometimes	Often	Always	Blank
0%	5.0%	35.0%	45.0%	15.0%	0%

2. I like reading more than I like working with numbers.

Never	Seldom	Sometimes	Often	Always	Blank
5.0%	25.0%	25.0%	15.0%	30.0%	0%

3. I have fun when we work on math at school.

Never	Seldom	Sometimes	Often	Always	Blank
0%	15.0%	40.0%	40.0%	5.0%	0%

4. Math is my favorite subject at school.

Never	Seldom	Sometimes	Often	Always	Blank
10.0%	10.0%	20.0%	50.0%	10.0%	0%

5. I enjoy trying to solve number problems.

Never	Seldom	Sometimes	Often	Always	Blank
10.0%	10.0%	40.0%	20.0%	20.0%	0%

6. I think math is important.

Never	Seldom	Sometimes	Often	Always	Blank
0%	0%	5.0%	25.0%	70.0%	0%

7. I use math even when I am not at school.

Never	Seldom	Sometimes	Often	Always	Blank
0%	5.0%	10.0%	40.0%	45.0%	0%

8. I think we have too much math at school.

Never	Seldom	Sometimes	Often	Always	Blank
25.0%	50.0%	20.0%	5.0%	0%	0%

9. I am good at working with numbers.

Never	Seldom	Sometimes	Often	Always	Blank
0%	0%	15.0%	60.0%	25.0%	0%

10. It makes me nervous even to think about having to do a math problem.

Never	Seldom	Sometimes	Often	Always	Blank
35.0%	50.0%	15.0%	0%	0%	0%

11. I think math is too hard.

Never	Seldom	Sometimes	Often	Always	Blank
15.0%	55.0%	20.0%	10.0%	0%	0%

12. I get good grades in math.

Never	Seldom	Sometimes	Often	Always	Blank
0%	0%	20.0%	40.0%	40%	0%

13. I know how to find the correct answers to math problems.

Never	Seldom	Sometimes	Often	Always	Blank
0%	0%	15.0%	70.0%	15.0%	0%

14. I pay attention when we have math at school.

Never	Seldom	Sometimes	Often	Always	Blank
0%	0%	15.0%	40.0%	45.0%	0%

15. I try hard to do my best in math class.

Never	Seldom	Sometimes	Often	Always	Blank
0%	0%	0%	25.0%	75.0%	0%

16. I have felt challenged in my math classes.

Never	Seldom	Sometimes	Often	Always	Blank
5.0%	35.0%	15.0%	15.0%	30.0%	0%

17. I think math is too easy.

Never	Seldom	Sometimes	Often	Always	Blank
15.0%	40.0%	35.0%	5.0%	5.0%	0%

18. I see connections between what I learn in math class and the real world.

Never	Seldom	Sometimes	Often	Always	Blank
0%	5.0%	25.0%	45.0%	25.0%	0%

19. My math classes have been easy for me.

Never	Seldom	Sometimes	Often	Always	Blank
0%	25.0%	35.0%	25.0%	15.0%	0%

20. My math classes have moved along…

Very Slowly	Slowly	About right	Quickly	Very Quickly	Blank
0%	30.0%	35.0%	35.0%	0%	0%

Vitae

Tamara Susan McCollum Tow is a teacher of gifted in the Parkway School District in St. Louis, Missouri. She graduated with a Bachelor's Degree in English in 1994 from Northeast Missouri State University in Kirksville, Missouri. She then proceeded to earn a Master's Degree in Elementary Education from the same university in 1995. She furthered her career by earning a Gifted Specialist certificate in 2006. Tamara has been teaching since 1995. Her experience includes sixth-grade language arts and science, READ 180, and gifted education. Tamara has also served as the Director of Outdoor Education and the Lead Mentor for her school. Tamara has also been involved with the school's Staff Development Committee.

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