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A survey of students' attitudes on the implementation of an integrated high school mathematics program

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A SURVEY OF STUDENTS' ATTITUDES ON THE IMPLEMENTATION OF AN INTEGRATED HIGH SCHOOL MATHEMATICS PROGRAM

by
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ABSTRACT

Lori Ann Austin, A Survey of Students' Attitudes on the Implementation of an Integrated High School Mathematics Program, 2002, Dr. Eric Milou, Mathematics Education

The purpose of this study was to determine if there is a significant difference in the attitudes of general education students toward their math education before and after the implementation of an integrated mathematics program.

The study population was comprised of students enrolled in ninth grade general education classes at Williamstown High School in Williamstown, NJ. The sample consisted of ninety-six students.

A survey was administered to students to examine their attitudes toward general math class. After a four-week implementation of the Interactive Mathematics Program, the survey was administered a second time. T-tests and an ANOVA were performed to determine significant differences in attitudes. The research questions determined if there was a significant difference in the attitudes of students toward their math education before and after the implementation of an integrated math program, if there was a difference between students in inclusion classes and non-inclusion classes, and if there was a significant difference in the researcher's classes compared to other teachers.

The results indicated no significant difference in the students' attitudes and no significant difference between instructors. Students in the inclusion classes found their math class to be more fun after the implementation of the integrated math program.

MINI-ABSTRACT

Lori Ann Austin, A Survey of Students' Attitudes on the Implementation of an Integrated High School Mathematics Program, 2002, Dr. Eric Milou, Mathematics Education

The purpose of this study was to determine if there is a significant difference in the attitudes of general education students toward their math education before and after the implementation of a problem-based integrated mathematic program. The results indicated that there were no significant differences in the attitudes of students.

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Introduction to the Study

Introduction

In 2000, the National Council of Teachers of Mathematics (NCTM) published a revision to their 1989 *Curriculum and Evaluation Standards*. In this revision, *Principles and Standards for School Mathematics*, NCTM suggested a vision for mathematics' teaching and learning. Their vision suggests that all students should attain a standard of mathematical competence that allows them to compete in a workplace where "the level of mathematical thinking and problem solving has increased dramatically." (NCTM, 1998, p. 4).

The focus of the NCTM vision is that all students, not just those that are college bound, have access to a learning environment that prepares them for the future. College bound students have traditionally followed an educational track that covers Algebra, Geometry, Trigonometry, Calculus, and possibly Statistics and Probability. Simultaneously, general level students traditionally focus on basic skills where they touch upon the beginnings of Algebra and Geometry (Apler et al., 1997a; Findell, 1996). According to the *Principals and Standards for School Mathematics,* all students need to move beyond basic number crunching to an understanding of various mathematical concepts.

Over the past ten years, many curriculum programs have surfaced with the intention of fulfilling the vision of the *Curriculum and Evaluation Standards*. These programs include, at the secondary level: Applications/Reforms in Secondary Education (ARISE); CORE-Plus Mathematics Project; Math Connections; Systemic Initiative for Montana Mathematics and Science (SIMMS); and The University of Chicago Schools Mathematics Project. The National Science Foundation funds each of these programs. The programs focus on an integrated problem-solving approach to teaching mathematics that is more "student centered" and less "teacher centered" than traditional curricula (Findell, 1996).

The Interactive Mathematics Program (IMP), also funded by the NSF, is one such curriculum program. IMP is an integrated, problem solving based curriculum that encompasses all disciplines of mathematics. It centers on central themes used to engage all students and keep them actively involved in learning. Determining if such a program could be successful with traditionally low achieving students is the focus of this study.

Related Research

Despite the efforts of many reform movements in math education, many students are being taught using the same methods that were employed to educate their parents and grandparents, who were educated in the industrial age (NCTM, 1989; NRC, 1989; NJDOE, 1996). In 1989, when the National Research Council (NRC) published *Everybody Counts*, a report of the future of mathematics, they contended that “for lack of mathematical power, many of today’s students are not prepared for tomorrow’s jobs. In fact, many are not even prepared for today’s jobs.” (NRC, 1989, p.1). Students need to be prepared for the technological society of the future and not the industrial economy of the past (NCTM, 1989).

Everybody Counts, NCTM's *An Agenda for Action*, NCTM's *Standards*, the National Council of Supervisor's of Mathematics (NCSM) publication entitled *Standards in Essential Mathematics for the 21st Century*, and reports published by Mathematical Association of America and the Mathematical Sciences Education Board all provided the impetus for current reform efforts. As such a program, the Interactive Mathematics Program was developed approximately ten years ago by Lynne Apler, Dan Fendel, Sherry Fraser, and Diane Resek (Apler et al, 1996). IMP is a four-year, problem-based, integrated math curriculum intended to replace the traditional Algebra I through Calculus sequence. The IMP program integrates most subjects within mathematics and places them into a meaningful context to fulfill both the needs of students entering college and those preparing to go directly into the workforce. This program was developed to meet the needs of most students, excluding a small percentage with special needs (Apler, et al., 1997a).

The IMP curriculum units each focus on a central problem. Some examples of these problems include setting up a bakery, city planning, or a game of probability. Students explore the central problem throughout a five to eight week unit, investigating the problems individually, in-group activities, and as take home assignments reviewed with family members. The students are actively involved in the learning process and construct their ideas in a context that has both a "real world" and an applied meaning.

Apler et al. have implied that the idea of a student's work possessing real meaning to them is significant in math education (1997a). They further demonstrate that if students feel a task has a genuine value, they are willing to become involved in the educational process required to learn it (Apler et al., 1997a). If learners feel the problem has relevance and is intriguing they will persevere to see the end results (i.e. to solve the problem). The IMP program provides such problems, and creates a process of learning both mathematical concepts and problem solving skills.

The major theoretical paradigm behind IMP is that all students are capable of thinking about and understanding complex mathematical concepts (Apler et al., 1996, p. 19). Low achieving and some learning disabled students are generally placed in remedial math courses where they continue doing the same rote computations they failed to master in earlier grades. The underlining traditional argument is that students cannot move on to more complex mathematical concepts until they have mastered basic skills. Unfortunately for the traditional approach, Hallas and Shoen argue that data show that general level students are no better at the end of the year than they were at the beginning, so remediation progresses continuously without increasing learning outcomes. As the remedial cycle continues, students' attitudes become increasingly negative as they continue practicing the same drills they have yet to "master." Students continue a negative cycle in their math education where little perceived progress is achieved (Hallas and Shoen, 1993, p. 113).

Adoption of a problem-based curriculum, such as IMP, could resolve this problem. Studies of the IMP program across the country have shown students making significant gains. They have outperformed their non-IMP peers on standardized tests such as the PSAT, SAT and SAT-9 (Webb & Dowling, 1996; Merlino & Wolff, 2001). IMP students have done better on tests measuring problem solving and statistics (Webb & Dowling, 1997). IMP students have gone on to take more math classes and are shown to be more confident in their math learning (White, Gamoran, & Smithson, 1995).

Students could move away from rote pencil and paper computations progressing into more relevant and intriguing mathematical processing. Data from the National Association of Educational Progress provides evidence that students can maintain their current arithmetic skills even if arithmetic is not the focus of their lessons. Students' arithmetic skills may even improve as they move toward topics that involve higher level thinking by improving their conceptual understanding of mathematics (Hallas and Shoen, 1993, p. 113).

Statement of the Problem

The purpose of this study is to determine if there is a significant difference in the attitudes of general education students toward their math education before and after the implementation of a problem-based curriculum unit. This study will demonstrate if the participation in a problem-based curriculum can influence the attitudes of students. It will also examine if the placement in an inclusion class affect the students attitudes, and the effect of instruction by the researcher compared to other instructors.

Research Questions

(1) Is there a significant difference in the attitudes of students toward their math education before and after the implementation of an IMP unit?

(2) Is there a significant difference in the attitudes of students placed in inclusion classes as compared to students placed in non-inclusion classes before and after the implementation of an IMP unit?

(3) Is there a significant difference in the attitudes of students taught the IMP program from the researcher compared to those taught the IMP program from one of the other participating instructors?

Need for the Study

In 1996, the New Jersey State Board of Education adopted the New Jersey Mathematics Curriculum Framework based on the Core Content Standards also developed by the New Jersey State Board of Education. The goal of the framework is:

> To enable all of New Jersey's children to move into the twenty-first century with the mathematical skills, understandings, and the attitudes that they will need to be successful in their daily lives (NJDOE, 1996).

Statewide assessment measurements administered in grades four, eight, and eleven have evolved to reflect these current standards. The High School Proficiency Assessment (HSPA) has now replaced the eleventh Grade High School Proficiency Test (HSPT). This replacement was made so the test could effectively reflect the New Jersey Mathematics Standards (NJDOE, 1996). The HSPA will be administered for the first time in New Jersey during the Spring of 2002.

The first five New Jersey's Mathematics Standards, referred to as the process standards, reflect the NCTM's Standards of problem solving, connections, reasoning and communicating, and technology. Standards six through fifteen, referred to as the content standards, are specifically related to different disciplines of mathematics that all students are expected to learn including algebra, geometry, trigonometry, statistics and probability, discrete math, and the building blocks of calculus.

The study location, Williamstown High School, is part of Monroe Township School District located in Williamstown, New Jersey. Currently at Williamstown High School, students enrolled in the general level Applied Math courses are not yet receiving an education based on these standards. The high school consists of 1,393 students where approximately 16% of the students are enrolled in general level math classes. The administration of the high school is committed to an analytical examination of the programs effect on the local school population, with the goal of improving the curriculum.

The general courses currently taught at Williamstown High School are Applied Math I, Applied Math II, and Business Math. Applied Math I covers the first half of a consumer math book and Applied Math II covers the second half. The students use calculators to compute simple equations (i.e., purchases, pay, travel etc.). Except for the use of a daily HSPA related problem the students are not systemically exposed to mathematical concepts beyond numerical operations.

Students are placed in Applied Math because of poor performance in a previous math course. Approximately half of these general students are also placed in a second math course as a result of low scores on the GEPA or Terra Nova standardized test. These students are placed in a HSPA Math course where they concentrate on skills needed to pass the proficiency assessment. The remaining students in the Applied courses are not lacking the skills needed to progress into a "higher level" math course but lacked the effort to succeed in a previous course. Some students with learning disabilities are also placed in the Applied courses. These Applied courses are co-taught with a special education teacher within the inclusion program. The same content is covered with the special education teacher making necessary adjustments for the special needs students.

The applied curriculum concentrates on numerical operations and "low level" word problems that are related to real life and does not currently reflect the New Jersey Mathematics Standards. The change to a curriculum such as IMP could focus the curriculum on real life problems while integrating all disciplines of mathematics. IMP teaches students to reason, problem solve, communicate their thoughts through writing and speaking, and to make connections to other disciplines and life.

The IMP program was piloted for one unit to determine if the general level students' attitudes changed toward their math education. The program was piloted in the regular Applied I courses and the Inclusion Applied I courses. The study was the first step in researching the need for replacing the general level curriculum with a standard-based curriculum. The IMP program reflects the New Jersey Core Curriculum Standards and the NCTM Standards in mathematics. By reflecting these standards, the IMP curriculum serves as solid preparation for the High School Proficiency Assessment and for their futures outside of high school. Students will be exposed to all disciplines of mathematics and mathematical reasoning as well as problem solving, giving all students the necessary skills to move on to college or the workforce.

Limitations of the Study

This study was limited as the survey was conducted only on students in Williamstown High School that were chosen as a purposive sample rather than a random sample (i.e., the results should not be generalized). Additionally, some of the classes studied were taught by the researcher, thus a possible Hawthorne Effect could influence the validity of the outcomes. The study was conducted over a four-week period, not giving the students enough time to adjust and form accurate opinions. Still, the outcomes of the study can serve as a basis for deciding on implementing a full-scale one-year pilot of the program. Additionally, the results represent the attitudes of the classes studied and surveyed.

Definitions

Interactive Mathematics Program (IMP) – IMP is a four-year curriculum of problem-based, integrated mathematics designed to replace the traditional Algebra I, Geometry, Algebra II/Trigonometry, and Pre-Calculus sequence.

Hawthorne Effect - A term coined in reference to a series of productive studies at the Hawthorne plant of the Western Electric Company in Chicago, Il. The researchers discovered that their presence affected the behavior of the workers being studied. The term currently is used to describe the impact of research on a human subject. (Babbie, 1989, pg. 63)

Inclusion- A program where a limited number of special needs students are placed in regular education classes. These classes have a special needs teacher and the regular education teacher instructing the class.

Chapter Two

Review of the Literature

Introduction

A review of the literature provides an understanding into why a problem-based, integrated curriculum is an effective method of instruction in contemporary math classrooms. The first section examines the current need for reform in mainstream math curricula. The next section looks at the curricula that have responded to that need in the past ten years. The following section reflects on how students' attitudes play an important role in their achievement and in making these curricula successful. The final section looks extensively at one of the new math programs, the Interactive Mathematics Program (IMP), and examines how it was developed summarizing the research that has been conducted relating to IMP programs.

Current Need for Reform

The current need for reform in math education stems from an understanding of past mathematical reform and practices. Over the past fifty years, we have seen changes in mathematics curricula, as in other curricula, reflecting the changes taking place in society (Ornstein & Hunkins, 1998). As our society has recently evolved from an industry-based to a technology-based economy, mathematics programs have tried to keep pace with the changes in order to properly prepare students to compete in today's workplace (NCTM, 2001; NJDOE, 1996).

In the first half of the twentieth century, when only a small percentage of students actually completed high school, math education consisted primarily of basic computations set around consumer and general math classes. The "new math" reform movement took place in 1950's and 1960's as a result of a national need for better-trained mathematicians and scientists required to speed up our space exploration movements (Findell, 1996). This "new math" shifted focus from computation to that of theory. Soon, since many parents, teachers, and educators felt students were not learning the basic facts of arithmetic, a "back-to-basic" movement emerged during the 1970's. By the late 1970's, educators were convinced that the basics were not enough and the 1980's saw many need-for-reform publications outlining mathematical reforms that set a standard for today's math education (Findell, 1996).

The National Council of Supervisors of Mathematics (NCSM) published one of the first reform papers in 1977. In this position paper, (NCSM) outlined ten basic mathematical skills, including: problem solving, estimation, measurement, prediction, and gathering and organizing data (Findell, 1996). The National Council of Teachers of Mathematics (NCTM) followed up with *Agenda for Action*, which called for an increased emphasis on problem solving, more students learning more mathematics, and more integration of calculators and computers in the classrooms (NCTM, 1980). In 1989, the National Research Council published *Everybody Counts. Everybody Counts* recommended a common core of mathematics for all students and a change from a teacher-centered dissemination of knowledge to a student centered discovery approach.

NCTM created its vision for the future of mathematics education in its 1989 *Curriculum and Evaluation Standards*. That document provided an overview of what should be in place in educational math programs across the country. The first four standards are the process standards that reflect how students should be learning mathematics through reasoning, problem solving, connecting, and communication. Following the process standards are a set of content standards that include algebra, geometry, trigonometry, statistics, probability, discrete mathematics, and calculus. NCTM proposes that college bound and non-college bound students be taught to these standards through a core-curriculum for all students. NCTM subsequently produced addenda publications each year to provide educators with suggestions and ideas on the implementation of these standards.

The state of New Jersey used the NCTM Standards as a basis for its *Mathematics Standards* adopted by the New Jersey State Board of Education in May of 1996. To help teachers implement these Standards, a coalition of educators developed the *New Jersey Mathematics Curriculum Framework* in December of 1996. The standards represent very high expectations for all students attending school in New Jersey. The premise of the New Jersey standards is that "all students need to achieve these standards if they are to be productive in the 21st century; all students can achieve these standards if we create environments in which learning is both possible and expected."(NJDOE, 1996, p 2). The state of New Jersey is determined to overcome the principle that students simply lack mathematical ability, and to provide educators, parents, and community members with an instrument to aid them in achieving this goal (NJDOE, 1996).

NCTM began the process evaluating and updating their *Curriculum and Evaluation Standards* as they started assimilating into math curricula across the country. Their new vision, as outlined in *Principles and Standards for School Mathematics*, is "highly ambitious."(NCTM, 2000). They call for an inclusive math program for all students that integrates a wide variety of math topics through the use of technology, collaborative groups, oral, and written communication; where students are expected to become independent thinkers and resourceful problem solvers (NCTM, 2000). The end desired outcome is that students will "value mathematics and engage actively in learning it." (NCTM, 2000, p. 3).

Research on Current Standards Based Curriculum Projects

As a result of the reports published throughout the 1980's many curriculum projects dedicated to change in mathematics teaching were developed. These programs are problem based and developed for all students to focus instruction on the learner not the teacher (Findell, 1996). The majority of the current projects have been funded through the National Science Foundation (NSF). Some of these projects have received "Exemplary" or "Promising" status from the Department of Education and preliminary research on these projects has been overwhelmingly positive (DOE, 1999).

At the high school level, these programs include the Interactive Mathematics Program (IMP); Applications/Reforms in Secondary Education (ARISE); CORE-Plus Mathematics Project; MATH Connections; Systemic Initiative for Montana Mathematics and Science (SIMMS); The University of Chicago Schools Mathematics Project; and the Connected Mathematics Project (CMP) in the middle school. Each of these new curricula presents mathematics in problem settings and are student-centered rather than teacher-centered (Findell, 1996).

As the NSF funds each of these programs, they contain many common features, including the integration of number sense, algebra, geometry, statistics, probability, and discrete math. All present topics within thematic units designed to engage the students and encourage them to think critically about mathematics. Students work independently and within collaborative groups. They learn to work with graphing calculators and integrate computer technology into their learning (Findell, 1996; Merlino & Wolff, 2001).

The research conducted on these new standards-based math programs has been promising at the least. A field test of the CORE-Plus program at 33 schools done by Schoen & Ziebarth (1998) shows CORE-Plus students having a significantly better understanding of conceptual, application, and problem solving tasks than traditionally taught students in the same schools. An evaluation summary of the MATH Connections program reports students in the program are achieving the objectives of math learning as set by the Connecticut Board of Education at a higher degree than non-MATH Connections students. This summary also reported that MATH Connections students are more confident in their math learning and perceive mathematics to be more useful in life (www.mathconnectins.com\evalsum01.htlm). A study by Hoover, Zawojewski, & Ridgeway (1997) on CMP, a middle school program, showed the development of basic skills remaining similar between CMP and non-CMP students but a higher growth content areas such as algebra, geometry, probability and statistics.

In contrast to traditionally taught mathematics programs, where students sit passively and listen to the teacher, "these curricula presuppose students are inherently 'active learners' who interpret and construct meaning from their engagement with interesting mathematical questions and concrete materials."(Merlino & Wolff, 2001, p.35). Teachers' roles in these new programs are designed to guide students through an organized discovery where students can think about the process instead of recalling a traditionally memorized algorithm (Merlino, 2001; Fendell, 1996).

Research on Students Attitudes Toward Math Education

Learning mathematics is a cognitive process, however, as the following research demonstrates, students' attitudes play a significant role in learning mathematics (Reyes, 1984; Macleod, 1994). In particular, mathematics anxiety has been found to be related to mathematics achievement. Studies have shown that high achievement in mathematics is related to low anxiety levels for students in all grade levels (Aiken, 1976; Crosswhite, 1972; Hendel, 1977).

Corbitt (1984) and Schoenfeld (1989) conducted studies examining students' beliefs and attitudes toward mathematics. Though Schoenfeld studied high school geometry students and Corbitt studied eighth grade middle school students, both studies had similar findings. In Schoenfeld's study, geometry students found that they enjoyed their successes, liked problem solving, and felt it was beneficial to their learning. Corbitt's middle school students liked mathematics if they were good at it and most enjoyed solving the mathematical games and puzzles. One difference between the two studies was that the geometry students found that the memorization of equations and formulas was essential in mathematics, whereas the eighth grade students in Corbitt's study disliked memorizing rules and formulas and rated it with minimal importance.

Hembree (1990) conducted a meta-analysis about the nature, effects, and relief of math anxiety. His study included journal articles, ERIC documents, doctoral dissertations, and reports conducted at the elementary, high school, and college levels.

His findings demonstrated that higher math anxieties were slightly related to lower IQ levels. Correlation between math anxiety and aptitude/achievement were inverse across all grade levels. Higher math anxiety was consistently related to lower math performance. Positive attitudes consistently related to lower mathematics anxiety, with strong inverse relations observed for an enjoyment of mathematics and self-confidence in the subject matter. Consequently, high-anxious students took fewer high school math courses and showed less of an intention to take more classes in college (Hembree, 1990).

Madsen and Lanier conducted a study in 1992 to determine the effect of conceptually oriented instruction on students' computational competencies and their attitudes towards mathematics (as cited in Malouf, 1999). This study was done in part to improve the general math curriculum by the inclusion of teaching mathematics for conceptual understanding. In one set of classes, the students learned concepts through problem-solving, activity based skills, and cooperative learning. In the control group, students were taught arithmetic through traditional teaching methods. Observations of the students indicated that their attitudes towards mathematics had changed as they became more confident in their abilities and more willing to try new approaches (Malouf, 1999).

Consistent with most research done on attitudes toward mathematics there exists a correlation between attitudes, and student performance. The data raises a question about how to change students' attitudes toward math. The research suggests that educators can change students' attitudes toward math by implementing a relevant, problem-based curriculum, such as IMP, which relies on interesting yet challenging problems that students can solve at their own pace. In 1996, IMP students were found to be "more confident about their abilities in the mathematics, more likely to see mathematics as meeting the needs of society rather than being a set of arbitrary rules, placed higher value on communication in mathematics learning, and were more likely to see mathematics in everyday life." (Clarke, Wallbridge & Fraser, 1996).

IMP Research

In 1989, Apler et al. designed an innovative new curriculum created to fulfil the *Standards* set forth by NCTM. This program, Interactive Mathematics Program (IMP), was originally funded by the California Post Secondary Education Commission and later received major funding from the National Science Foundation. The IMP program with other previously discussed math curricula (CORE-Plus, ARISE, SIMMS and Connected Math) is part of a core of new programs designed to lead our students into the twenty-first century (Apler et al., 1997a).

The IMP program integrates four years of high school mathematics into an integrated problem-based curriculum that encourages cooperative learning, reasoning, communications, and connections among the disciplines in mathematics and outside of mathematics. This program was specifically developed to target all students, including those who will enter the workforce after graduation and those in danger of not graduating at all. The research on IMP suggests students take more math classes, and complete the courses with a higher level of achievement (Apler et al., 1997a).

One extensive study completed on IMP was done through the University of Wisconsin-Madison. Through the Wisconsin Center for Educational Research, Norman Webb and Martiza Dowling conducted a five-year study containing three components.

One component of the study compared the high school careers of IMP and non-IMP students. This component looked at courses taken, results on standardized test scores, and overall grade point average. For this part of the study, IMP and non-IMP students with similar pre-high school standardized test scores were compared. The IMP group achieved a statistically significant higher overall GPA and took more semesters of math classes than non-IMP students. Although their scores on the SAT showed no significant difference, it was noted that 87% of the IMP group took the SAT, while only 58% of the non-IMP group took the SAT. This suggested that the IMP group maintained comparable test scores for a majority of students (Webb & Dowling, 1996).

Another aspect of the Wisconsin study was initiated to examine students' content knowledge in statistics, problem solving, and quantitative reasoning. Each was studied at a different school in different areas of the country where IMP was implemented. In the discipline of statistics, IMP students scored statistically significantly higher in their ability to develop and interpret statistical information. In the area of problem solving, second year IMP students were compared to students in geometry and honors Geometry. Based on the eighth grade achievement test results the IMP students and the Geometry students were comparable in their math achievement, whereas the Honors students entered high school at a significantly higher level of achievement. Still, the grade ten IMP students demonstrated a significantly higher degree of proficiency in problem solving than either the Geometry students or the Honors Geometry students. The problem-solving test examined student's ability to solve problems, develop and test conjectures, and write clear explanations of solutions (Webb & Dowling, 1997).

There is also evidence that this increase in performance occurred with low achieving students. In a study of high schools in New York and California predominated by low-income and low-achieving populations, a higher growth in achievement was observed among ninth grade IMP students than for ninth grade college prep Algebra I students. The IMP students began the school year at a lower achievement level than the college prep students and finished at a higher level (White, Gamoran & Smithson, 1995).

The IMP program began in Philadelphia in the 1993-94 school year. The program was implemented in six of the thirty-five public high schools with approximately 2% of the of the ninth grade population enrolled. Over a five-year period, IMP data was collected from a variety of sources using various techniques. The findings were published in a report from The Greater Philadelphia Secondary Mathematics Project. The results of this study suggested increases in students' achievement in math, English, social studies, and science. IMP students also achieved higher scores on the PSAT and the SAT compared to students enrolled in the traditional curriculum (Merlino & Wolff, 2001). The study also examined whether IMP students as a group perform better or worse on an Ivy-league math exit exam than traditionally taught students. The study demonstrated the IMP students scoring significantly more problems correct than the non-IMP students (Merlino & Wolff, 2001).

The Philadelphia study also included a Student Attitudinal Study in 1994. A short questionnaire was administered to the ninth grade students at the end of the first year of implementation. The results showed that "students overwhelmingly preferred IMP to algebra classes and indicated they would continue with the course." (Merlino & Wolff, 2001, p. 16) In an international study examining student attitudes conducted through

Australian Catholic University in 1996, 182 first year IMP students were compared to 217 Algebra I students. Results demonstrated that IMP students appeared to be more confident than their peers, found mathematics to be more relevant to their daily lives, and valued communication in mathematics learning more highly than their peers (Clarke, Wallbridge & Fraser, 1996).

A study conducted recently by Malouf in California showed no significant differences in IMP student's achievement and attitudes in mathematics than traditionally taught students. Malouf studied remedial students after six weeks of enrollment in an IMP program. His results showed no significant difference in the achievement and attitudes of most of the students after the six weeks and negative results on achievement and attitudes of the remedial students enrolled in the IMP (Malouf, 1999).

Conclusion

The need for change in the mathematics curriculum to reflect current national and state standards is apparent. The state of New Jersey has set high standards for all students to achieve. The high standards should include students who are considered low achieving as well as students who have been classified with learning disabilities but are in regular education classes through "mainstreaming" or placement in an inclusion program. Research indicates that the placement of students with disabilities in inclusion programs has led to academic gains for those students (Salend, 1999). This research has also indicated that the placement of students without disabilities in inclusion programs has had no negative effect on their academic outcome but in fact may actually increase their level of performance (Salend, 1999).

Research has indicated that when a problem solving based curriculum is implemented "students at a variety of different achievement levels attain higher results on average than in a traditional mathematics classroom." (Erikson, 1999). The research is evident that there is a correlation between students' attitudes in mathematics and their achievement in associated math classes. A problem based integrated curriculum such as IMP, not only reflects the national and New Jersey State standards in math education, but involves all level of students in an engaging relevant curriculum designed to prepare them for any future they decide upon. The focus of this study was to determine if such a program does have an influence on students' attitudes in remedial and inclusive math classes.

Chapter Three

Procedures & Methods

Introduction

A comprehensive research-based quasi-experimental design and subsequent statistical analysis can provide understanding into whether a problem-based, integrated curriculum is an effective method of instruction in contemporary math classrooms at Williamstown high school, NJ. The first section of this chapter explains how and when data was collected, and details on the population of Williamstown high school, and in particular details on the 9th grade cohort. The second section explains why the sample was selected, details the sample design, and demonstrates its relevance to the population under investigation. The next section explains the quasi-experimental design and the development of the instrument. The final section illustrates the statistics that will be utilized to answer the research questions and determine the statistical significance of the relationships under investigation.

Data Collection

During the four weeks of February 2002, three teachers under the direction of the researcher implemented an experimental teaching method, known as the Integrated Mathematics Program (IMP) in substitution for the traditional program of Applied (level one) Mathematics that would normally have been taught during the same period. The three teachers (two teachers and the researcher) implemented this curriculum in a total of five classes. The five classes represented the total Applied I population of math students at Williamstown high school.

All three teachers implemented the same IMP curriculum (i.e., the same unit of the applied IMP curriculum), the *Patterns* unit. In this unit students explore patterns and number relationships to gain an understanding of functions, operations with integers, angle measures, and problem solving skills. The teachers met regularly with the researcher to ensure uniformity in the lesson plans, assignments, lectures, classroom teaching methods, and in the student performance assessments (tests) to minimize the effect of other variables on student perception. A pretest attitudinal survey and a posttest attitudinal survey were administered to assess the effectiveness of the IMP program and to answer the research questions. The attitudes on the pretest were compared to the attitudes on the posttest to answer each of the three research questions.

The study was conducted at Williamstown high school, located in Monroe Township, Gloucester County; a county in southern New Jersey. There were 1,393 total students in Williamstown high school at the time of this study. 420 were in the 9^{th} grade, while an estimated 1,267 total students were enrolled in mathematics classes at the high school. Williamstown high school is comprised of grades 9-12, with a gender breakdown of 49.7% male and 50.3% female. The racial/ethnic breakdown is 79.0% Caucasian, 15.6% African-American, with 5.3% from another minority group.

Sample & Population

In February 2002, a purposive sample of all 9^{th} graders enrolled in Applied Mathematics I classes was selected to be part of this study. This sample consisted on 109 total students from a 9^{th} grade mathematics student population of 420 students. The sample was selected based on the desire of the school administration to look for alternative mathematics curricula to replace the existing applied mathematics curriculum currently in practice at the school. The sample was designed to gather attitudinal information from all 9th grade students enrolled in the Applied Math I curriculum, and to use this information to both assess the effectiveness of the IMP mathematics curriculum as a potential replacement, and to offer information to decision-makers on the use of IMP in the potential replacement of other math curricula in the school.

The original sample size, which consisted of 109 students, was representative of the total 9th grade population and the school population. The gender breakdown was near consistent (53% male/47% female), while the racial/ethnic demographic breakdown (25% African-American, 67% Caucasian, and 7% other minority group) was disproportionate with heavy concentrations by non-white cohorts. Three of the classes were also inclusion classes that mainstreamed 24 special education students, allowing for an analysis on the effect of IMP on special education students as well.

Quasi-Experimental Design

A group of three teachers, including the researcher, met in December 2001 to review a predetermined unit (by the researcher) of the IMP curriculum (Apler et al., 1997). A permission letter (Appendix B) was sent home with each student in January 2002 to notify parents about the change in curriculum and about the surveys that would be administered. The unit was piloted in February 2002, both a pretest survey and posttest survey were administered to assess the change in attitude and/or perceptions of students toward mathematics based on participation in an IMP based curriculum. The surveys were coded with a unique identifier to allow the researcher to determine both the instructor of the respondent and whether the respondent was placed in an inclusion class or not.

Before the implementation of the IMP curriculum, a pretest survey measuring attitudes on mathematics and the teaching of mathematics was administered to the students. At the conclusion of the unit, a posttest was conducted through the administration of the same instrument on student attitudes to measure changes in attitudes toward mathematics and the teaching of mathematics. The survey (Appendix A) was developed by integrating two existing, and previously validated survey instruments, the Merlino instrument used in Philadelphia (Merlino & Wolff, 2001), and the Malouf instrument used to measure high school students' mathematics performance and attitude (Malouf, 1999). The final instrument represents a revised version of the Merlino and Wolff instrument (revised and used with permission) that was enhanced by the addition of revised questions of the Malouf instrument. The final survey instrument is attached as Appendix A.

The survey instrument developed is a multiple question survey instrument designed as an ordinal level Likert scale survey that measures students' attitudes and perceptions on mathematics, the teaching of mathematics, and on comparisons between mathematics and other subjects.

Statistical Analyses

Upon completion of the pilot and administration of the survey, a set of statistical analyses were conducted to determine attitudinal means and the statistical significance of each measurement used to answer the research questions. T-tests were used to answer the first two research questions. The independent samples t-test statistic was chosen as it measures the significance of mean difference between two groups, a pre-experiment set of outcomes and the post-experiment outcomes. The analysis of variance (ANOVA) statistical test was chosen to answer the third research question. The ANOVA statistic was chosen as it is a statistical technique employed to analyze multi-group experiments, through the use of the F-test, allowing for an overall comparison of whether there is a significant difference between the means of groups (Pagano, 1986). Additionally, the F-test is more appropriate than the traditional t-test due to sample size, and the decreased chance of Type-I error, normally associated with the t-test.

An independent samples t-test was used to answer the first research question: "Is there a significant difference in the attitudes of students toward their math education before and after the implementation of an IMP unit?" An independent samples pretest to posttest comparison t-test was used to answer the second research question: "Is there a significant difference in the attitudes of students placed in inclusion classes as compared to students placed in non-inclusion classes before and after the implementation of an IMP unit?" Finally, the ANOVA statistic with a post hoc Tukey level of analysis was utilized to answer the third research question: "Is there a significant difference in the attitudes of students taught the IMP program from the researcher compared to those taught the IMP program from one of the other participating instructors?" The ANOVA is the more appropriate statistic for the final research question as it allows the researcher to measure the effect of the three instructors on students' attitudes and the level of interaction between them (i.e., teaching method and teacher, or researcher effect). These statistics were chosen to determine both attitudinal mean difference and the level of significance.

Chapter Four

Data Analysis

Introduction

The study was initiated and surveys were completed, the survey data was entered into the statistical software package SPSS 10.1.0, and the data was analyzed. A purposive sample of all 9th graders enrolled in Applied Mathematics I classes was selected to be part of this study. The original sample size consisted of 109 total students from a 9th grade mathematics student population of 420 students; the total number of respondents to the survey was 96 (representing 88% of the potential population of students enrolled in selected classes). The responses were analyzed using frequency distributions, t-tests, and an ANOVA test with a post hoc Tukey statistic as a means of answering the three research questions.

Respondent Demographics

In the administration of the pretest survey ninety-six of a potential one hundred and nine 9th grade students were surveyed. The ninety-six students were enrolled in five unique sections of Applied Mathematics I classes taught by three teachers (one of the teachers being the researcher), described in Table 4.1. Three of the five sections of

Table 4.1

Teacher Class Size

Category	Frequency	Percent
Researcher	39	40.6
Teacher 2	16	16.7
Teacher 3	41	42.7

Applied Mathematics were inclusion classes, Table 4.2 illustrates the breakdown of students by inclusionary class status.

Table 4.2

Inclusion Frequency

Category	Frequency	Percent
Inclusion	59	61.5
Non-Inclusion	37	38.5

The students' surveys were coded to help ensure that demographic characteristics could be classified to demonstrate that the sample was representative of the school population. Table 4.3 illustrates the sex/gender distribution of respondents. As Williamstown high school is comprised of grades 9-12, with a gender breakdown of 49.7% male and 50.3% female. The respondents of the survey appear to be more representative among male students than the high school total population in general.

Table 4.3

Sex/Gender Frequency

Category	Frequency	Percent
Male	50	52.0
Female	40	41.7
Unknown	6	6.3

The racial/ethnic breakdown of the high school is 79.0% Caucasian, 15.6% African-American, with 5.3% from another minority group. The racial ethnic breakdown of respondents is presented in Table 4.4. This breakdown suggests that the sample is over represented among minority group members. The respondent demographics suggest that the high school Applied Mathematics I classes may be over represented by both male and non-white students.

Table 4.4

Race/Ethnic Frequency

Category	Frequency	Percent
African-American	17	17.7
Latino/Latina	2	2.1
Asian-American	1	1.0
Caucasian/European Ances.	49	51.0
Other/Unknown	27	28.1

After the first survey was taken, the IMP curriculum was initiated and one unit of the curriculum was taught, the posttest survey was administered. Table 4.5 illustrates that of the ninety-six original respondents, a posttest "n" of 81 was achieved. Fifteen student responses were unable to be secured due to a combination of factors including: student relocation, attrition, suspension, and/or absences. There were several responses in the second administration of the survey that were not present in the pretest, these responses were intentionally omitted to ensure the overall validity of the results.

Results

Responses to questions of both the pretest survey and posttest survey were used to answer the first research question. A t-test was run on the responses to each of the survey questions.

> "Is there a significant difference in the attitudes of students toward their math education before and after the implementation of an IMP unit?"

The results, illustrated in Table 4.6, demonstrate that there was no statistically significant difference in student attitudes toward their math education before and after the implementation of the IMP curriculum. However, there were many positive changes in several of the mean differences. As the survey design (Appendix A) was coded strongly agree equal to 1, and strongly disagree equal to 5; decreases in means on positive questions such as “Mathematics is enjoyable to me.” would be desirous, while an increase in the mean on questions such as “Mathematics is boring.” would also suggest an improvement in student attitudes.

The mean differences in posttest responses to questions numbered 1, 3, 4, 5, 6, 7, and 10 would suggest that the students found the curriculum more favorable. For each of these questions students responses shifted slightly to desirous result. Answers to questions 13, 14, and 15 would suggest that the students did not find the new level of workload responsibility favorable. However, since the significance level for all t-values were greater than .05 it is determined that there is no significant difference in the students’ attitudes before and after the implementation of the IMP curriculum.

Table 4.5

T-test Results for Difference in Student Attitudes Before and After IMP Implementation

	Mean		Standard Deviation			
Question #	Pre-IMP	Post-IMP	Pre-IMP	Post-IMP	df	t-value
1	3.37	3.25	1.13	1.09	174	.710
2	2.00	2.12	.94	.99	175	-.848
3	2.70	2.81	1.15	1.19	175	-.603
4	3.57	3.42	1.11	1.03	175	.942
5	3.22	3.10	1.19	1.02	174	.762
6	3.58	3.44	1.01	1.07	175	.885
7	3.36	3.24	1.02	1.04	174	.779
8	3.21	3.24	1.10	1.06	174	-.221
9	3.28	3.25	1.16	1.15	175	.125
10	2.46	2.44	.90	1.00	173	.165
11	2.55	2.56	1.21	.98	172	.959
12	2.63	2.58	.84	.87	173	.446
13	2.00	2.29	.95	1.23	173	-1.787
14	3.12	3.30	.87	1.07	172	-1.211
15	2.61	2.87	.88	1.12	173	-1.712

**P<.05

Responses to questions of both the pretest survey and posttest survey were again used to answer the second research question.

> "Is there a significant difference in the attitudes of students placed in inclusion classes as compared to students placed in non-inclusion classes before and after the implementation of an IMP unit?"

Table 4.6

T-test Results for Difference in Student Attitudes Between Inclusion and Non-Inclusion Classes

	Mean		Standard Deviation			
Question #	Inclusion	Non-Inclusion	Inclusion	Non-Inclusion	df	t-value
1	-.1636	.0385	1.08	1.24	79	-.746
2	-1.455	-.0769	1.37	1.05	79	-.224
3	.0364	.5000	1.24	.86	79	-1.711
4	-.0370	.5679	1.16	.94	78	-2.340**
5	.1091	.3846	1.11	1.20	79	-1.011
6	.0545	.2308	1.17	.90	79	-.674
7	-.1481	.2692	1.13	1.25	78	-1.486
8	.1091	-.2308	1.49	.95	79	1.058
9	-.0943	.1923	1.14	1.20	77	-1.027
10	-.1698	.0769	1.31	1.16	77	-.814
11	.0556	.0800	1.10	.86	77	-.098
12	-.2222	-.1200	1.51	1.05	77	-.305
13	-.1852	.0400	1.18	.88	77	-.847
14	-.3519	.0400	1.21	1.20	77	-1.1336
15	2.32	2.11	1.10	1.07	79	.813

**P<.05

A t-test was run on the mathematical difference in individual responses to each of the survey questions (pretest versus posttest) and compared between the inclusion and non-inclusion samples, demonstrated in Table 4.6.

The results, illustrated in Table 4.6, demonstrate that there was one statistically significant difference in the attitudes of students placed in inclusion classes as compared to students placed in non-inclusion classes before and after the implementation of an IMP unit. In response to the statement: "Taking math is fun," inclusion students saw a statistically significant improvement in their attitude toward the new mathematics curriculum. In simple terms, the data suggests that inclusion students found the IMP mathematics curriculum more enjoyable than the traditional Applied Mathematics curriculum regularly used in the district.

Additionally, inclusion students also demonstrated an enhancement in attitude as demonstrated by mean difference improvement on questions 1, 2, 3, 4, 7, 9, 10, 12, 13, and 14; suggesting that inclusion students' attitudes generally improved and that they found the new teaching methods and the adjusted student workload more desirable than the traditional Applied curriculum. However, since the significance level for the remainder of the t-values were greater than .05 it is determined that there is no significant difference in the students' attitudes before and after the implementation of the IMP curriculum on any other indicator.

Finally, responses to questions of both the pretest survey and posttest survey were again used to answer the final research question.

> "Is there a significant difference in the attitudes of students taught the IMP program from the researcher compared to those taught the IMP program from one of the other participating instructors?"

Table 4.7

Analysis of Variance for Teacher

Question	Between Subjects Factors (Teachers) F_4
1	.756
2	1.270
3	3.166
4	1.757
5	.270
6	1.557
7	.554
8	1.358
9	2.248
10	.179
11	.640
12	1.247
13	1.686
14	.973
15	.254

$p. < .05$ for F score
**$p. < .05$ for any associated Post Hoc Tukey Score

An ANOVA with a post hoc Tukey test was run on the difference in responses to each of the survey questions with student responses compared between the three teachers, demonstrated in Table 4.7.

The results of the ANOVA test and the associated post hoc Tukey test demonstrate that there is no significant difference in the responses between any of the three teachers. Since the significance level for all F-values were greater than .05 it is determined that there is no significant difference in the attitudes of students taught the IMP program from the researcher compared to those taught the IMP program from one of the other participating instructors.

Chapter Five

Discussion, Conclusions, & Recommendations

Discussion

As the National Council of Teachers of Mathematics and the State of New Jersey have revised their teaching standards to keep pace with the "New Economy" of the postmodern society, schools need to reform and revise as well. The purpose of this study was to look at a curriculum that aligns with new national and state standards and determine if the attitudes of students change after the implementation of such a program.

Student's attitudes play an integral role in their mathematical achievement. In particular, mathematics anxiety has been found to be related to mathematics achievement. Studies have shown that high achievement in mathematics is related to low anxiety levels for students in all grade levels (Aiken, 1976; Crosswhite, 1972; Hendel, 1977). Positive attitudes consistently related to lower mathematics anxiety, with strong inverse relations observed for an enjoyment of mathematics and self-confidence in the subject matter. Consequently, high-anxious students took fewer high school math courses and showed less of an intention to take more classes in college (Hembree, 1990). Attitudes of students generally become more confident when they see purpose in what they are learning. Students are also more willing to embrace problem solving techniques and new learning methods (as outlined by national standards), if they have a positive attitude toward learning.

After the implementation of problem-solving, integrated, student-centered curriculum, which was adjusted from a general consumer-based, teacher-centered curriculum, students' attitudes were measured. There were no significant differences in total students' attitudes after the implementation of the IMP program, yet some substantive differences can be noted. The mean differences to questions 1,3,4,5,6,7 showed that students found the IMP program to be more enjoyable, less boring, and less tense. This supports research form other studies that found students taking IMP classes found those classes more interesting than their peers in non-IMP classes (Merlino & Wolff, 2001).

When the inclusion students' data were examined and compared to the entire population, similar substantive differences were apparent but with a significant difference in their response to the question "Taking math was fun." The students in the inclusion classes saw their math class as more fun with the IMP program as compared to the consumer based program. As a central purpose of this research was to determine if a program, such as IMP, could be successful with traditionally low achieving students, these findings are monumentally important as the increased satisfaction among inclusion students could lead to better student learning outcomes, and higher achievement among disaffected students if the program was initiated across the curriculum.

The results of the ANOVA conducted on the data to analyze the effect the instructor, particularly the researcher, indicated that neither the researcher nor the other two instructors had any significant effect on students' attitudes toward change in the curriculum. This finding illustrates that all improvements in attitudes, both statistically significant or not, were the result of curriculum change, rather than any attempt by the instructors to make the material more palatable or desirable for any other reason than improved student learning.

Conclusion

Though the study did not have any significant differences except for in the inclusion sections, the substantive differences are noteworthy, especially when student written evaluations are taken into consideration. As previously stated, there were overall differences in Questions 1,3,4,5,6,7; and it can be concluded that the students did find the work more enjoyable, less boring and less tense. There were also substantive differences in questions 13, 14 and 15 where students did not necessarily enjoy the actual work involved such as the group work, homework, and the writing component. The results are now qualitatively apparent in many of the individual student's writings throughout the program.

Some quotes which similarly appear in many student's papers suggest that "this problem was fun to work on, but not fun to write up," "I enjoyed working on the 1-2-3-4 puzzle myself, not getting help from group members," and "it was fun to figure out the answer to the egg problem....I don't like trying to explain what I did." These quotes suggest that the change toward the positive (even though not statistically significant) was important as many of the students may not initially view the change as positive given the increased expectations and problem solving work associated with this type of curriculum. In fact, a small degree of initial dissatisfaction with the program when examined more closely may be seen as a positive outcome of the change.

Another interesting mean difference was on question 2 when students were asked if what they learned in math class was useful in life. After the implementation of the IMP program there was a slight shift from agree (2.00) toward neutral (2.12). One student in reference to a completed problem wrote "though this problem was fun to work on I did not find it educationally worthwhile or useful, all it did was force me to think for the first time in this class." Many students had statements similar to this on their problem write-ups. The fact that they did not find these problems as useful was not surprising since they spent four months prior to the IMP program learning consumer math only. The fact that they felt the IMP program made them have to think emphasizes the notion that the consumer math did not involve as much mathematical thinking or "problem solving."

As the National Council of Teachers of Mathematics vision suggests that all students should attain a standard of mathematical competence that allows them to compete in a workplace where "the level of mathematical thinking and problem solving has increased dramatically." (NCTM, 1998, p. 4), a program that clearly increased thinking and problem solving among students represents a positive and proactive change. Although the change was not statistically significant, the fact that there were positive changes, however small, suggests that a more in-depth pilot is necessitated.

The only significant difference in the study was in the inclusion sections. Students in inclusion classrooms felt their math class became "more fun" after the implementation of the IMP program. Approximately 50% of the students in the inclusion classes are special education students who are mainstreamed into a math class for the first time. Most of their math experience prior to the IMP program had been basic skills with rote practice year after year. Hellas and Shoen (1993) noted when students continue practicing the same drill they have yet to master, their attitudes become increasingly negative. In the four months prior to the implementation of the IMP program, these students continued with the same rote practice in consumer math that they had experienced in previous years. It was no surprise that the first time the students were relieved from the traditional teaching methods, they suddenly perceive their math class as more "fun."

As low achieving and learning disabled students are generally placed in remedial math courses where they continue doing the same rote computations that they failed to master in earlier grades, the improvement of attitude in the new curriculum implementation is significant. The underlining traditional argument is that students cannot move on to more complex mathematical concepts until they have mastered basic skills. Hallas and Shoen have demonstrated that data show that general level students are no better at the end of the year than they were at the beginning, so remediation progresses continuously without increasing learning outcomes (1993, p. 113). Since the IMP implementation demonstrates an improvement in low achieving students' attitudes toward mathematics, they may be able to improve their skills in relation to their increased level of interest in the subject matter.

The fact that there was no significant difference in the results of any of the three teachers in comparison to each other is a positive one. Every effort was made so that all instruction was consistent. Identical daily outlines were made for all teachers to follow with weekly meetings and daily individual meetings to ensure everyone was making the same progress and uniform adjustments could be made accordingly throughout the study.

Implications for Local Educational Institution

This is the first step in changing the general math program at Williamstown high school. The fact that no significant changes in attitudes were seen in the population should not deter the school from considering an integrated problem-based curriculum to replace their general level consumer math program. The statistically significant improvement of inclusion students' attitudes alone suggests that the change in the curriculum is warranted. In addition, since general students attitudes did not become more negative considering the advanced level of problem solving and thinking skills involved in the new program, the outcomes should be looked at as a positive and a "hold from harmless" method of improving learning for inclusion students. The results of this study should be used to continue the efforts started to revamp the program with one that is consistent with the national and state standards.

Additionally, as the individual student write-ups demonstrate that all negative attitudes toward the program emerged from a student perspective that disliked the increased need for "thinking" and "problem solving," a change in the pre-IMP curriculum is needed. The lack of statistically significant improvements more likely arose from the method of the experiment (i.e., sudden unexpected change), which would suggest the need for at least a yearlong study to measure genuine student learning outcome and perception change.

Recommendations

The recommendation set forth by this study would be for Williamstown high school to commence a full one-year pilot of the IMP program, or a curriculum similar to it. This one-year study should look at student attitudes and student achievement. The program should be taught by at least two different teachers, so discussions among the instructors could generate program improvements and evaluations. The program should be expanded and examined in-depth for a full year so students can start the year fresh with a new method of learning, and so that the high level of new student learning expectations would not be sudden and would not influence any evaluation of student perception and/or learning outcomes.

Future Research Recommendations

A significant and important recommendation for future research would be for the time period of the study to be much longer in duration. Students need to have more time to adjust to the new teaching methods before making judgments on it. The study should be conducted at the beginning of the year, before students have become accustomed to a single curriculum before a new one so drastically different is introduced. A new study may want to look at student achievement as well as attitudes and the relations between the two variables. Additionally, both perception and student learning outcomes should be examined and compared between inclusion and non-inclusion students (as opposed to the classroom technique employed in this research), so that a real difference in results can be measured and evaluated.

The Interactive Mathematics Program is just one of a group of programs that have received national support from the Department of Education. A recommendation is for studies to be completed on other programs. Such programs include CORE-Plus Mathematics Project, Math Connections, Systemic Initiative for Montana Mathematics and Science (SIMMS), and Applications/Reforms in Math Education (ARISE). Conducting short-term studies on the effects of these new programs is a first step in gaining teacher, student, and parental support necessary to integrating a new program.

The final set of recommendations for this research is that it be shared with the local district (i.e., both the school principal and the local superintendent). It should also be shared with other math teachers throughout the state to encourage a dialogue on the content standards and the means of engaging these standards in ways that increase student learning outcomes, satisfy public accountability expectations, and improve teaching effectiveness.

APPENDIX A: Williamstown HS IMP Survey

WILLIAMSTOWN NINTH GRADE STUDENT ATTITUDES OF THE INTERACTIVE MATHEMATICS PROGRAM
February 2002

Directions: Williamstown High School is interested in listening to its students. Therefore, your thoughtful and honest answers to these questions are very important. You are part of a sample of students carefully selected to share feedback about your thoughts on mathematics classes thus far. To make sure that you can be honest, and that your answers are confidential, your name is not requested.

Please darken the box that most honestly reflects your opinion.

What is your reaction to each of the following statements?	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. Mathematics is enjoyable to me.	☐	☐	☐	☐	☐
2. I can use what I learn in math class in my life.	☐	☐	☐	☐	☐
3. Mathematics is boring.	☐	☐	☐	☐	☐
4. Taking math is fun.	☐	☐	☐	☐	☐
5. When I am in math class, I feel at ease and relaxed.	☐	☐	☐	☐	☐
6. Compared to my other classes, math class is exciting.	☐	☐	☐	☐	☐
7. I look forward to coming to math class.	☐	☐	☐	☐	☐
8. Compared to how much I know in other classes, I know a lot about math.	☐	☐	☐	☐	☐
9. When the teacher is showing the class a problem, I worry that others might understand it better than me.	☐	☐	☐	☐	☐
10. I think the method in which I am being graded in math is fair.	☐	☐	☐	☐	☐
11. Right now, I am happy with my results in math class.	☐	☐	☐	☐	☐

What is your reaction to each of the following questions?	Very Positive	Positive	Neutral	Negative	Very Negative
12. How do you feel about the method by which you are being tested in math?	☐	☐	☐	☐	☐
13. How do you feel about working in groups?	☐	☐	☐	☐	☐
14. How do you feel about the writing component in Math class?	☐	☐	☐	☐	☐
15. How do you feel about the type of homework assignments given to you in your math class?	☐	☐	☐	☐	☐

Number:____

APPENDIX B

Parental Permission Letter

January 2, 2002

Dear Parent/Guardian,

I am one of the three math teachers at Williamstown High School who teaches the Applied Math I course that your child is currently enrolled. I am also a graduate student at Rowan University working on my Master's thesis concerning students' attitudes toward a standards-based curriculum. The high school is in the process of changing the curriculum for the Applied math program to one that aligns with the Core Curriculum Content Standards recently adopted by the State of New Jersey.

To assist in this process the Applied I teachers will be piloting a new math program for the month of February. The program is called the Interactive Mathematics Program. This program was started ten years ago and has had great results when implemented in various schools across the country. The program integrates algebra, geometry, and statistics and will help prepare them for the more rigorous HSPA exam they will take as juniors.

To get a better understanding of the students' responses to this program, we would like to have your child participate in filling out a survey before and after the program is implemented. The survey will be a short questionnaire evaluating students' attitudes toward their mathematics instruction. The results will be used as part of my Master's thesis. All data will be reported in terms of group results and no individuals will be mentioned.

Your decision to allow your child to complete the survey will have no effect on your child's standing in the class. At the conclusion of the study a summary of the results will be made available to all interested parents. Is you have any questions please contact me at 262-8200 ext. 2962. Thank you.

Sincerely,

Lori Ann Austin

Please complete and return only if you do not wish your child to complete a survey.

____ I do not grant permission for my child ______________ to complete a survey.
Name

_________________________________ ______/______/______
(Parent/Guardian Signature) *(Date)*

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