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A survey comparing attitudes towards mathematics of students in the Interactive Mathematics Program

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A SURVEY COMPARING ATTITUDES TOWARDS MATHEMATICS OF STUDENTS IN THE INTERACTIVE MATHEMATICS PROGRAM

by
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ABSTRACT

Anne Marie DeWitt, A Survey Comparing Attitudes Towards Mathematics of Students in the Interactive Mathematics Program, 2000, E. Milou, Mathematics Education

The purpose of this study was to determine whether significant differences existed between the attitudes of students enrolled in the Interactive Mathematics Program (IMP) and students enrolled in traditional courses towards mathematics.

The population used for this study was comprised of approximately one hundred students from three IMP classes and students from three college preparatory geometry classes at Pennsauken High School in Pennsauken, New Jersey. A survey was designed to obtain information about students' attitudes toward mathematics. Survey questions were designed to measure their enjoyment of mathematics and their perceived value of mathematics. One-sample and two-sample t-tests were performed to determine if significant differences existed.

The conclusion from this study indicated that there were significant differences between the attitudes of the students. There was a significant difference in the responses regarding the students' enjoyment of learning mathematics. As to how students value mathematics, there was no significant difference between the students.

MINI-ABSTRACT

Anne Marie DeWitt, A Survey Comparing Attitudes Towards Mathematics of Students in the Interactive Mathematics Program, 2000, E. Milou, Mathematics Education

The purpose of this study was to compare attitudes of students enrolled in the Interactive Mathematics Program and those in traditional courses. The conclusion indicated there were significant differences in the responses regarding the students' enjoyment of learning mathematics and no significant differences as to how they value mathematics.

ACKNOWLEDGEMENTS

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Introduction

At the secondary level in mathematics education, a strong emphasis had always been placed on algebra and geometry. In the last ten years, there had been curricula projects written that replaced the traditional sequence of Algebra 1 – Geometry – Algebra II/Trigonometry. Determining which curriculum was the best method to prepare all students for higher learning and for the work force has become the challenge for educators.

Related Research

There had been very little change in mathematics education in the last century. However, there had been time periods where math reforms were the focus of the nation. For example, in 1957, when the Soviet Union launched the first Sputnik, the United States government responded by increasing funds and its support for new math reforms in our schools for curriculum and teacher training (Kilpatrick & Stanic, 1995). Again in the 1970's, another new math reform was underway called Back to Basics. This movement however received opposition from the National Council of Supervisors of Mathematics (NCSM) and the National Council of Teachers of Mathematics (NCTM). In 1980, the NCTM published its *Agenda for Action* which rejected the Back to Basics movement. The NCTM called for a balanced approach that would include problem solving, understanding and applications to realistic situations (Kilpatrick & Stanic, 1995).

Another publication in 1983, *A Nation At Risk*, also called for school reform in all areas. It was this publication that was usually given credit for the current school reform movement (Kilpatrick & Stanic, 1995).

But in 1989, the NCTM published its *Curriculum and Evaluation Standards for School Mathematics*, which was referred to as the *Standards*. It was this document that set the stage for the current reform in curriculum, instruction and assessment for mathematics (Kilpatrick & Stanic, 1995). This document represented the guidelines for good teaching of good mathematics. The NCTM wanted "to ensure quality, to indicate goals, and to promote change" (NCTM, 1998, p. 11). Throughout the last ten years, the NCTM published various articles and documents to help teachers of mathematics implement these changes. A periodic review allowed improvement to continue, so last year, the NCTM began working on *Principles and Standards for School Mathematics 2000*.

Educators were not the only advocates of changing the curriculum. Business and industry supported a change in the curriculum. Leaders of business and industry wanted employees that were knowledgeable in solving real-world problems (Ohanian, 1997). Employers reported that they were re-training employees because they lacked mathematical problem-solving and communication skills (Introduction and Implementation Strategies for the Interactive Mathematics Program, 1998).

Lastly, if one looked at the students in our high schools, one would see that students were taking only the minimum required mathematics courses. Even teachers said that they were dissatisfied with the mathematical experiences that even our best students were having (Introduction and Implementation Strategies for the Interactive Mathematics Program, 1998).

With all the technological changes that occurred in the last thirty years, why was it that so little had changed in education? If the students of today were to be ready to inherit this advanced technological world, then they needed to be better prepared. "They need a higher level of mathematical, scientific, and technical literacy than they have ever needed in the past" (Introduction and Implementation Strategies for the Interactive Mathematics Program, 1998, p. 1).

In response to these concerns, secondary schools throughout the country were beginning to make changes in mathematics – both in curriculum and instruction. Many new secondary curriculum-development projects replaced the traditional sequence of math courses and were being implemented in high schools throughout the country. In 1991, the National Science Foundation (NSF) made significant contributions to the math reform movement. NSF supported and promoted programs that try to ensure high-quality education for students in mathematics, science and technology (Cuoco, Goldenberg, and Mark, 1995). The NSF helped to support projects that called for a standards-based curriculum. Some of these projects were the Interactive Mathematics Program (IMP), Core Plus, Math Connections, and Applications/Reform in Secondary Education (ARISE) (Brombacher, 1997).

One goal of these projects was to expand content to include probability, statistics, and discrete mathematics. Furthermore, assessment was to include open-ended questions and explanations. The projects used realistic situations as a basis for instruction and technology was used for understanding and exploration (Brombacher, 1997). Other new curriculum projects included the Atlanta Mathematics Project, the Systemic Initiative for Montana Mathematics and Science, and the University of Chicago School Mathematics Project.

This study focused on the Interactive Mathematics Program (IMP) and the effects that IMP had on students' attitudes. IMP consisted of a four-year program that replaced the traditional mathematics courses taught at the secondary level. The directors of IMP are Dan Fendel, Diane Resek, Sherry Fraser and Lynne Alper. Fendel and Resek are professors of mathematics at San Francisco State University. Fraser and Alper are mathematics educators associated with Sonoma State University and had experience in the classroom as secondary mathematics teachers.

According to the directors of IMP, the program stressed that mathematics was for all students and the program was designed to create heterogeneous classes of college preparatory students. The program emphasized the *Standards* set forth by NCTM in 1989. According to Lori Green (1997), "the major reforms that are included are:

- a shift from a skill-centered to a problem-centered curriculum
- a broadening of the scope of the secondary curriculum to include such areas as statistics, probability, and discrete mathematics

- changes in pedagogical strategies, including emphasis on communication and writing skills
- expansion of the pool of students that receives a 'core' mathematical education" (p. 1).

The authors of IMP stressed the ideas set forth in the *Standards* that mathematical content and processes were important if they built productively on students' prior knowledge and experience, engaged their interest, and made sense (NCTM, 1998; Alper, Fendel, Fraser, and Resek, 1995). This program allowed students to explore mathematics in a group setting; then students made conjectures from their explorations; and finally, students reflected on their results (Alper et al., 1995).

IMP was implemented at Pennsauken High School in Pennsauken, New Jersey. Pennsauken is an urban, middle class community in Camden County. It is the home to people of a broad range of ethnic backgrounds. The schools are a true reflection of the community and of society in today's world. The Pennsauken School District provided education for approximately 6000 students in grades pre-kindergarten through 12. Enrollment was on the rise. The district consisted of one high school, one middle school, eight elementary schools, one pre-school and one alternative school. Pennsauken High School had approximately1500 students in grades nine through twelve. There were approximately 47% students who were white, 29% who were black, 15% who are Hispanic and 9% students who were Asian or American Indian.

IMP was first introduced to the teachers of Pennsauken High School in the spring of 1998 and three teachers began training that summer. The first year that IMP level 1 was offered to students was the school year 1998-1999. Four classes of students were randomly chosen to participate. They were assigned to two teachers. One teacher had three classes of IMP 1 and another teacher had one class. The students were in grades nine through twelve and had a wide range of previous math courses.

The goal of this study was to determine if IMP had a significant impact on the attitudes of the students regarding mathematics. Research that had been conducted about students' attitudes towards mathematics was extensive. Since mathematics had a reputation for being unpopular, teachers were concerned about students' feelings and attitudes (Tapia, 1996). One's attitude toward mathematics influenced its perceived usefulness and one's confidence, as well as one's persistence in the subject (Stage in Klein, 1985).

Statement of the Problem

The purpose of this study was to determine how the attitudes towards mathematics of the students enrolled in the first four classes of IMP I at Pennsauken High School in Pennsauken, New Jersey were affected by the new mathematics curriculum and how their attitudes compare to the attitudes of students enrolled in the traditional sequence of Algebra I/Geometry.

Research Questions

(1) Is there a significant difference in the students' attitudes regarding the value of mathematics between students enrolled in the traditional sequence of Algebra I/Geometry and the students enrolled in IMP I/ IMP II.

(2) Is there a significant difference in the students' attitudes regarding enjoyment of mathematics between students enrolled in the traditional sequence of Algebra I/Geometry and the students enrolled in IMP I/ IMP II.

(3) Do more students who are enrolled in IMP I/IMP II plan to study mathematics for more years in high school than those students who are enrolled in the traditional sequence?

(4) Is there a significant difference in the students' attitudes towards mathematics due to their enrollment in IMP?

Need for the Study

Students, teachers of mathematics, and business and industry leaders supported a change in the mathematics curriculum at the secondary level. Students needed to have an answer to the question, "Why learn math?" Our current curriculum did not answer this question satisfactorily. A math curriculum should suggest that the answer to this question be "We're getting a head start on the math we will use one day – when we go to work" (Ohanian, 1997, p. 27). According to the directors of IMP, "Many mathematics educators agree that in order to develop 'mathematics power' in our students, the primary focus of mathematics education must shift from the learning of procedures to the solving of complex problems" (Alper, Fendel, Fraser, Resek, 1997a, p. 148). And as previously noted by Ohanian (1997) and in Introduction and Implementation Strategies for the Interactive Mathematics Program (1998), employers reported that employees lack mathematical problem-solving skills. Therefore, there was a need to attempt new curricula and new instructional approaches on the secondary level. It was also important to study how the students react to these changes.

In the past decade at Pennsauken High School, mathematics teachers had been teaching Algebra I to all students. The titles of these classes had been College

Preparatory Algebra, General Algebra and Integrated Mathematics I. The students in these classes were taught the basic algebra concepts in a traditional setting at various speeds. However, the attitudes of the students towards mathematics had not improved and the average standardized test scores had not improved.

IMP was a totally different approach to teach algebra. This study helped to determine if the students' attitudes towards mathematics improved because of this course.

Limitations of the Study

This study was conducted at Pennsauken High School, a school system comprised of approximately 1500 students in grades nine through twelve. This study surveyed approximately 100 randomly chosen students who were in grades ten, eleven and twelve. The students were randomly chosen to enroll in IMP during the school year 1998-1999. The survey was answered during one of the students' mathematics classes. "The real test of success will be what happens to IMP graduates after they leave high school. It is too soon to have answers to this question, but a major long-term study is under way, conducted by Norman Webb of the Wisconsin Center for Education Research." (Alper et al., 1995, p. 637)

Definition of Term

> "The Interactive Mathematics Program (IMP) is a growing collaboration of mathematicians, teacher-educators, and teachers who have been working together since 1989 on both curriculum development and professional development for teachers. With the support of the National Science Foundation, IMP has created a four-year program of problem-based mathematics that replaces the traditional Algebra I, Geometry, Algebra II/Trigonometry, Precalculus sequence and that is designed to exemplify the curriculum reform called for in the Curriculum and Evaluation Standards of

the National Council of Teachers of Mathematics (NCTM)."
(http://www.mathimp.org/)

Chapter Two
Related Research

Introduction

This chapter was devoted to the discussion of related literature and related research. A brief synopsis of the history of the mathematics curricula during the twentieth century was given.

History of Mathematics Curricula

The mathematics curriculum that was followed in most secondary schools is approximately 500 years old (Ohanian, 1997). According to an article by Kilpatrick and Stanic (1995), in the early part of this century, school officials believed that less time be spent on mathematics. It was in 1920 at the next national convention of the National Education Association (NEA) that 127 mathematics teachers from 20 states organized the National Council of Teachers of Mathematics (NCTM) (Kilpatrick & Stanic, 1995).

Student enrollment in mathematics courses at the secondary level declined throughout the 1930's, 1940's and 1950's. This was in part due to "general education reforms associated with social efficiency, behaviorist theories of learning and progressive education" (Kilpatrick & Stanic, 1995, p. 4). New math reforms began to occur in the late 1950's and 1960's and put school mathematics on the national agenda. However, at this point, there was a shortage of mathematically trained personnel. In 1957, when the Soviet Union launched the first Sputnik, the United States government began to dramatically increase its support for "curriculum development projects and teacher education projects to improve school mathematics" (Kilpatrick & Stanic, 1995, p. 4).

In the 1970's, the Back to Basics movement began. The NCTM with its *Agenda for Action* and the National Council of Supervisors of Mathematics (NCSM) issued documents that rejected this movement. According to Kilpatrick and Stanic (1995), "They [NCTM] called for an approach that would be more balanced. One that included problem solving, understanding and applications to realistic situations (p. 5)."

Other publications also called for school reform. *A Nation At Risk* in 1983 was a publication by the National Commission on Excellence in Education which is credited for the current school reform movement. NCTM helped pave the way for school reform in mathematics in curriculum, instruction and assessment (Kilpatrick & Stanic, 1995). In 1989, the NCTM published its *Curriculum and Evaluation Standards for School Mathematics*, and in 1991, *Professional Standards for Teaching Mathematics*, and the *Assessment Standards for School Mathematics* in 1995. Each document was widely circulated and received many endorsements along with some criticism.

The NCTM has published numerous documents in the last twenty years to help mathematics educators make reforms. The NCTM was working on the document, *Principles and Standards for School Mathematics 2000*. Also, in New Jersey, *The New*

Jersey Mathematics Curriculum Framework (1996) was designed to help teachers implement the *Standards* by NCTM. These two documents helped to set the tone for curriculum development in New Jersey's schools.

Need for Reform

Why was there a need to change the secondary mathematics curriculum? Whenever school districts needed to change the curriculum in the past, they ordered new textbooks (Ohanian, 1997). This did not change the idea that "mathematics lessons are based on a set of immovable facts and formulas, one separate from another. Students memorize and practice a set of strategies and then forget them, because learning in isolation is the least productive way" (Ohanian, 1997, p. 25). According to the article, "Designing a High School Mathematics Curriculum for All Students", by Lynne Alper, Dan Fendel, Sherry Fraser and Diane Resek (1997a), "Many mathematics educators agree that in order to develop 'mathematics power' in our students, the primary focus of mathematics education must shift from the learning of procedures to the solving of complex problems" (p. 148).

Also, business and industry leaders supported a change in the curriculum. Teachers were no longer just giving facts to their students; they needed to find a balance between how much they explain and how much time and space was needed for students to explore on their own. "Business leaders describe that skills must be learned in the context of solving real-world problems; students must construct knowledge for themselves and work together cooperatively as well as individually" (Ohanian, 1997, p. 26). There was a large consensus among leaders in professional organizations, business, industry and education that students needed to become better prepared for the world of tomorrow. They needed a higher level of mathematical, scientific, and technical literacy than they had ever needed before. The demands in the real world required problem-solving, communication, and reasoning skills. These skills were not being provided in the typical high school program (Introduction and Implementation Strategies for the Interactive Mathematics Program, 1998).

Ohanian (1997) also suggested that there was a need to have the question "Why learn math?" answered. Most students answered that they need math to go to the next grade. The math curriculum should suggest that the answer be "We're getting a head start on the math we will use one day – when we go to work" (p. 27).

Other reasons for the need for a curriculum change were "the growth of technology, the increased number of applications, the impact of computers and the expansion of mathematics itself" (Introduction and Implementation Strategies for the Interactive Mathematics Program, 1998, p.1). These areas in the last twenty years were combined to extend both "the scope and the application of the mathematical sciences" (Introduction and Implementation Strategies for the Interactive Mathematics Program, 1998, p. 1).

Society could not afford to have only a few mathematically literate people. "The high school curriculum has changed very little in the last century, despite the fact that society and its technological tools have changed" (Introduction and Implementation Strategies for the Interactive Mathematics Program, 1998, p. 2). Students took only the minimum required mathematics courses and teachers were dissatisfied with the mathematical experiences that students were having, even the best students. Professors complained that students were unable to think and reason mathematically. Leaders of business and industry said that they needed to re-train employees because that they lacked mathematical problem-solving and communication skills (Introduction and Implementation Strategies for the Interactive Mathematics Program, 1998).

Current Changes in Mathematics Curricula

However, secondary schools scattered throughout the country were beginning to make big changes in mathematics – both in the content of the curriculum and the way it is delivered. Many projects had been started in the country to help teachers change the curriculum and their instructional methods.

The National Science Foundation (NSF) had made significant contributions to reforms that attempt incorporate the *Standards*. In 1992, four curriculum projects were awarded funding by NSF. These projects were the Interactive Mathematics Program (IMP), Core-Plus Mathematics Project, Math Connections and Applications/Reform in Secondary Education (ARISE) (Brombacher, 1997).

> "The Interactive Mathematics Program (IMP) is a growing collaboration of mathematicians, teacher-educators, and teachers who have been working together since 1989 on both curriculum development and professional development for teachers. IMP is a four-year program of problem-based mathematics that replaces the traditional Algebra I, Geometry, Algebra II/Trigonometry, Pre-calculus sequence and that is designed to exemplify the curriculum reform called for in the Curriculum and Evaluation Standards of the National Council of Teachers of Mathematics (NCTM)." (http://www.mathimp.org/)

Core-Plus was a "curriculum that builds upon the theme of mathematics as sense making" (Coxford, Fey, Hirsch, Schoen, Burrill, Hart, Watkins, Messenger & Ritsema, 1997, p. 1). Through investigations which were based on real-life contexts, students worked on developing a sense which enabled them to work out new situations and problems. The curriculum had strands of algebra, functions, geometry, trigonometry, statistics, probability, and discrete mathematics (Coxford et al., 1997). Math Connections was also a secondary mathematics curriculum. Its purpose was to excite and challenge students as it bridged math and real-life. The curriculum integrated algebra, geometry, probability, trigonometry, and discrete mathematics. The motto was "Think math. Do math. Talk math. Write math." Students were asked to explore, look for patterns and reason as individuals, in groups and as a class (Math Connections, 1997). In ARISE, students worked on a unit centered around an application theme which had mathematical topics as strands throughout. They were actively involved in the problem-solving process. Students developed mathematical models as they analyze real-world situations. The modeling approach resulted in a natural integration of mathematical topics (Consortium for Mathematics and Its Applications, 1996).

Another program initially funded by NSF was the Atlanta Mathematics Project (AMP). AMP attempted to help teachers change their style of teaching to one that would stimulate the construction of new knowledge through discussions and problem solving (http://www.gsu.edu/~wwwamp/index.html).

Two other new programs were the Systemic Initiative for Montana Mathematics and Science and the University of Chicago School Mathematics Project. The Systemic Initiative for Montana Mathematics and Science promoted integration within science and mathematics education by redesigning curricula, assessment materials, and teacher-preparation and in-services programs. The University of Chicago School Mathematics Project encompassed curriculum reform at the elementary and secondary levels, teacher development, and implementation of ideas and methods used in other countries (Cuoco et al., 1995).

Research on the Interactive Mathematics Program

This study focused on the Interactive Mathematics Program. IMP was started with Dwight D. Eisenhower funds through the California Post-secondary Education Commission. At first, IMP was supported by the National Science Foundation grant ESI-9255262 (Alper et al., 1995).

"The National Science Foundation (NSF) supports programs that promote and try to ensure high-quality education for all students in the areas of mathematics, science and technology" (Cuoco et al., 1995, p. 236). In the last few years, technology has been the reason for reform in education. "To paraphrase Luther Williams, Assistant Director for the Education and Human Resources Directorate at NSF, 'We not only need to do things better, we need to do better things' " (Cuoco et al., 1995, p. 236).

According to the *Principles and Standards for School Mathematics: Discussion Draft* by the NCTM (1998), mathematics curriculum should include content and processes that make up a comprehensive set of instructional goals and activities.

> "As in the original *Standards,* the term 'curriculum' as used here incorporates several dimensions, including the mathematics that students need to know, how students are to achieve mathematical goals, what teachers need to do to help students develop their knowledge, and the context in which teaching and learning occur" (NCTM, 1998, p. 27).

The mathematics curriculum for a secondary school needed to contain a balance of conceptual knowledge and procedural competence in all important areas. For example, when students were learning new concepts and skills, problem solving could be used (Hiebert, 1998). Since it was believed that conceptual understanding could precede skill development in a technological environment, excessive practice at procedures before understanding could lead to difficulty in making sense of the procedures later (Heid, 1988 Palmiter, 1991, and Hiebert, 1998).

According to the NCTM (1998), "Mathematical content and processes are important if they build productively on students' prior knowledge and experience, engage their interest, and make sense" (p. 28). This was the goal of the IMP curriculum. IMP integrated algebra, geometry, trigonometry, probability, statistics, logic, number theory, and much more (Ohanian, 1997). These mathematical ideas were set in a variety of contexts, including the settlement of the American West, games of chance, Edgar Allen Poe's horror story "The Pit and the Pendulum, a baseball pennant race, election polling, and a Ferris wheel circus act (Ohanian, 1997).

The directors of IMP are Dan Fendel, Diane Resek, Sherry Fraser and Lynne Alper. Fendel and Resek are professors of mathematics at San Francisco State University. Fraser and Alper are math educators. This program emphasized the solving of complex problems rather than learning procedures. IMP stressed the importance that mathematics was for all students. The program was designed to create heterogeneous classes of college preparatory students. This program allowed students to explore mathematics in a group setting; then students made conjectures from their explorations; and finally, students reflected on their results.

"The following four principles guided the curriculum development for IMP:

> 1. Students must feel at home in the curriculum.
> 2. Students must feel personally validated as they learn.
> 3. Students must be actively involved in their learning.
> 4. Students need a reason for doing problems"
>
> (Alper et al., 1997a, p. 150).

The IMP curriculum tried to reach a wider range of students, learning styles and cultures (Alper et al., 1997a). One goal of the IMP curriculum was to help members of minority groups feel comfortable in the mathematics classroom. IMP tried to seek situations that will be interesting to most students and tried to ensure that there were situations in the curriculum that were particularly interesting for each student (Alper et al., 1997a). All work done in an IMP classroom was done in cooperative groups. This was to help the students feel more comfortable as well as to deepen their understanding by having to explain their ideas (Alper et al., 1997a). The aim of IMP was to empower students mathematically. Students were expected to work harder. To attain mathematical power, they were to think! This was hard work and to get students to do this, the curriculum tried to provide sufficient motivation (Alper et al.,1997a). Many students found it difficult to understand a task when it is stated very abstractly. IMP tried to use any context that could make the situation concrete enough for students to begin thinking about the problem (Alper et al., 1997a).

IMP students were doing well on standardized testing. In studies that compared IMP students to other students on the Scholastic Achievement Test (SAT), there had been no significant difference in scores or the IMP students had scored significantly higher. "Norman Webb from the Wisconsin Center for Educational Research began a five-year evaluation of the project in 1992. Part of his study was a transcript analysis of the 1,121 students who graduated in 1993 from three original pilot schools. Here are the two major findings from that study:

> (1) a higher percentage of students (90 vs. 74 percent) in the IMP program took at least three years of college-preparatory mathematics than did students enrolled in the traditional sequence

(2) IMP students consistently achieved higher grade point averages than did students in the traditional program, both in mathematics and overall" (Alper et al., 1997a, p. 172).

IMP prepared students for college and for college entrance tests also. Current IMP evaluation data showed that IMP students did as well and sometimes better on standardized tests than students in traditional mathematics course sequences. This was especially significant, as IMP students devoted 20-30 percent of class time to learning important topics not covered in the traditional curriculum (Alper et al., 1997a).
In 1996, Webb conducted three separate studies of mathematical achievement using nontraditional measures. In all of these studies, IMP students outperformed students in a traditional sequence (Alper et al., 1997a). Other studies also performed compared the impact of IMP on students in low-income and low-achieving student populations. The results indicated that higher growth in achievement occurs with students enrolled in IMP than in traditional courses (White, Gamoran & Smithson, 1995).

Research on Attitudes

Since mathematics had a reputation for being unpopular, teachers were concerned about students' feelings regarding mathematics. Therefore, extensive research had been conducted in the area of attitudes toward mathematics (Tapia, 1996).

Attitudes toward mathematics were very important in student achievement and participation. The following were some results of research about mathematics attitudes. A student's attitude towards mathematics was based on that student's perceived enjoyment, confidence and perceived usefulness of mathematics. All of these influenced that student's persistence in the subject (Stage in Klein, 1985). Also, Gallagher and DeLisi (1994) indicated that a positive attitude toward mathematics had a positive impact on performance on standardized mathematics. Research also indicated that more negative attitudes develop as students grew (Terwilliger & Titus, 1995). In a study conducted by Randhawa (1992) self-efficacy was found to be a significant indicator of mathematics achievement.

Throughout the research there were many surveys for a student's mathematics attitude. Three surveys that are used, in part, often are: Mathematics Attitude Inventory *(MAI)* written by the Minnesota Research and Evaluation Team in 1972, Mathematics Attitude Survey *(MAS)* written by Ethington and Wolfe in 1988, and the Mathematics Self-Efficacy Scale *(MSES)* modified from Betz and Hackett in 1983 (Randhawa, 1992).

Conclusion

In conclusion, mathematics education on the secondary level in this country went through slight changes in the last century. The most profound changes occurred in the last ten years because of the NCTM's *Standards*. A student's experiences in math class needed to change in order to better prepare the student for the future. Society and the world were requiring students to be better problem solvers. Many curricula projects were written to enable teachers and students meet these challenges. One such project was IMP. This study was performed to determine the differences in students' attitudes due to the change in curriculum at Pennsauken High School.

Chapter Three
Methodology

Introduction

The purpose of this chapter was to include an explanation of the population of the study and the survey instrument.

Population of the Study

The Pennsauken School District is a kindergarten through twelve grade school district. There is only one high school, Pennsauken High School. Pennsauken High School, opened in 1957, is located in Pennsauken, New Jersey – part of Camden County. The school consisted of approximately 1500 students in grades nine through twelve, with a population that had approximately 47% white, 29% black, 15% Hispanic and 9% Asian or American Indian students.

This study was conducted at Pennsauken High School. The students who were surveyed were in grades ten through twelve. Approximately forty of the students surveyed were enrolled in the Interactive Mathematics Program (IMP) level 1 during the school year 1998-1999 and IMP II during the school year 1999-2000. These students were the experimental group. The other students who were surveyed were enrolled in a college preparatory Algebra I class during the school year 1998-1999 and were enrolled in a college preparatory Geometry class during the school year 1999-2000. These students were the control group.

The study was conducted in January, 2000. The students received the surveys during their mathematics class and were asked to complete them and return them to their classroom teacher.

Description of Survey Instrument

The survey (see Appendix A) was comprised of a demographic section and a section on students' attitudes towards mathematics and IMP. The attitude section was composed of 17 questions. These questions were taken in part from surveys found in other literature (Simon & Schifter, 1993; Sandman, 1941; Tharp & Uprichard, 1992). For face validity purposes, the mathematics supervisor at Pennsauken High School, Alexis Kopperman, read the survey. Suggestions were made and changes were completed. Similar and opposite questions were repeated so that a student's bias can be minimized. Students were asked to answer the questions by the degree of their agreement with each statement using a five point Likert scale. For most of these questions, a score of one indicated strong agreement and a score of five indicated strong disagreement. Other questions (1, 3, 9, 12, 14 and 16) were negatively weighted so that the scoring is reversed.

The survey instrument that was used (see Appendix A) consisted of 5 demographic questions to determine if the student was in the control group or the experimental group, as well as age, gender and grade level. Then the two questions labeled a and b were asked to answer the following research question:

Do more students who are enrolled in IMP I/IMP II plan to study mathematics for more years in high school than those students who are enrolled in the traditional sequence?

The mean for these questions was computed and the means of the two groups were compared using a two-sample t-test at a .05 level of significance.

The students then answered 17 questions using a five point Likert scale on how they feel about mathematics. These questions were used to answer research questions one and two:

Is there a significant difference in the students' attitudes regarding the value of mathematics between students enrolled in the traditional sequence of Algebra I/Geometry and the students enrolled in IMP I/ IMP II.

Is there a significant difference in the students' attitudes regarding enjoyment of mathematics between students enrolled in the traditional sequence of Algebra I/Geometry and the students enrolled in IMP I/ IMP II.

From the survey, questions 5, 6, 12, 13, 14, 15 and 17 were used to determine how students value mathematics and questions 1, 2, 3, 4, 7, 8, 9, 10, 11 and 16 were used to determine how students enjoyed mathematics. The mean of each question was computed for the control group and the experimental group and a two-sample t-test at the .05 level of significance was performed to compare their responses to see if significant differences existed between the two groups.

To answer the remaining research question:

Is there a significant difference in the students' attitudes towards mathematics due to their enrollment in IMP?

The mean of each question for only the experimental group was used and a one-sample t-test was performed to compare their answers with a neutral response of '3'. This would determine if the sample mean differed significantly from a neutral response of '3' at the .05 level.

Chapter Four

Data Analysis

Introduction

This chapter included an analysis of the data from the surveys that were answered. This analysis included the mean score from each survey question, the standard deviation, t-value and the answers to the research questions.

Demographics

First, responses from the demographic questions on the survey were described. One hundred and one surveys were returned with 46 students enrolled in IMP II and 55 students enrolled in geometry. The demographics questions asked the students their age, gender and grade.

The students were asked to choose the category that best relates to them. For age, the categories were: 14-15, 16-17 and 18. For grade, the categories were: 10, 11 and 12. The results from the demographic section were listed in table 4.1 and they were compared in figures 4.1, 4.2 and 4.3.

Table 4.1: Summary of the Demographic Sections

AGE			
	IMP II	**GEOMETRY**	**TOTALS**
14-15	13	19	32
16-17	30	32	62
18	3	4	7
GENDER			
	IMP II	**GEOMETRY**	**TOTALS**
MALE	21	29	50
FEMALE	25	26	51
GRADE			
	IMP II	**GEOMETRY**	**TOTALS**
10	29	34	63
11	10	18	28
12	6	3	9

Analysis of Data

Attitude questions from the survey were used to answer the following research question:

> Is there a significant difference in the students' attitudes regarding the value of mathematics between students enrolled in the traditional sequence of Algebra/Geometry and the students enrolled in IMP I/ IMP II.

Survey questions # 5, 6, 12, 13, 14, 15 and 17 were used to determine how students value mathematics. The mean of each question was computed for the control and experimental

Figure 4.1: Bar Graph Comparing Ages in IMP II to Geometry

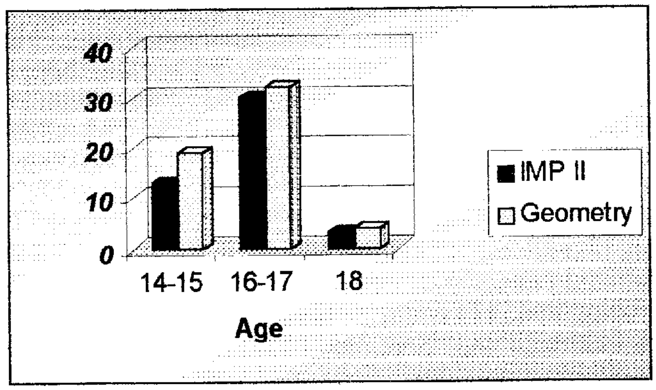


Figure 4.2: Bar Graph Comparing Gender in IMP II to Geometry

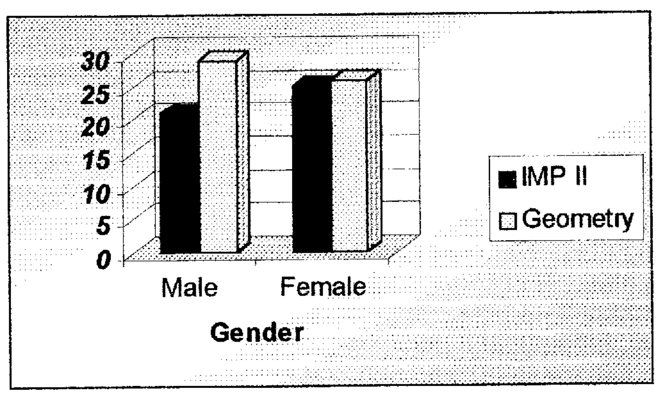
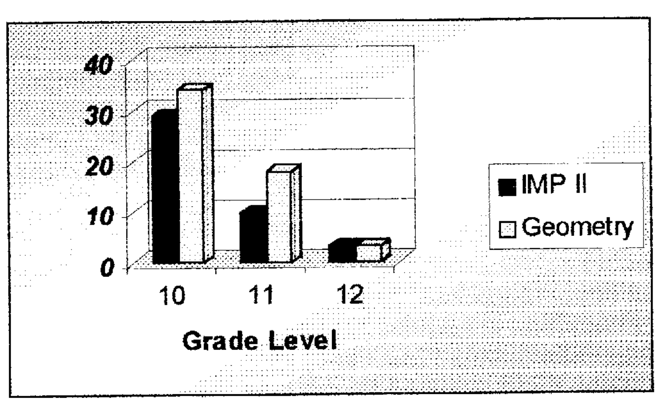


Figure 4.3: Bar Graph Comparing Grade Level in IMP II to Geometry



groups and a two-sample t-test at the .05 level of significance was performed to compare the responses and to determine if significant differences existed. These results were listed in table 4.2.

Table 4.2: Summary of Responses from Specified Survey Questions

	Mean		Standard Deviation		t-Value
	IMP II	GEOM	IMP II	GEOM	
SQ5	2.74	2.65	1.16	1.04	.382
SQ6	2.24	2.69	1.21	1.15	-1.905
SQ12	2.20	2.24	1.41	1.16	-.173
SQ13	2.24	2.28	.93	.99	-.198
SQ14	2.96	2.67	1.09	1.25	1.217
SQ15	2.41	2.35	1.17	1.06	.303
SQ17	2.41	2.33	1.00	.96	.436

The significance level for these values were greater than .05, therefore it could be determined that there were no significant differences in the students' attitudes on how they value mathematics based on the course in which they were enrolled.

The next research question that was to be answered from the survey was:

> Is there a significant difference in the students' attitudes regarding enjoyment of mathematics between students enrolled in the traditional sequence of Algebra/Geometry and the students enrolled in IMP I/IMP II?

Survey questions # 1, 2, 3, 4, 7, 8, 9, 10, 11 and 16 were used to determine how students enjoyed mathematics. Again, the mean of each question was computed and a two-sample t-test at the .05 level of significance was performed to see if significant differences existed between the two groups. The results were found in table 4.3.

Table 4.3: Summary of Responses from Remaining Survey Questions

	Mean		Standard Deviation		t-Value
	IMP II	GEOM	IMP II	GEOM	
SQ1	2.37	3.64	1.16	1.01	-5.797**
SQ2	2.11	2.33	.77	.90	-1.315
SQ3	2.85	3.40	.84	1.12	-2.831**
SQ4	2.46	2.85	.78	1.01	-2.235*
SQ7	3.28	3.38	1.22	1.18	-.413
SQ8	2.59	2.93	1.16	1.05	-1.744
SQ9	2.09	3.56	1.16	1.05	-6.741**
SQ10	3.15	2.98	.99	1.00	.856
SQ11	3.33	3.56	1.19	1.15	-1.012
SQ16	3.15	3.11	1.15	1.55	.152

* $p < .05$
** $p < .01$

According to these results, four survey questions showed that there were significant differences in the responses of the two groups.

Survey question #1, "Learning mathematics is mostly memorizing a set of facts and rules" was negatively weighed meaning that a value of 1 indicated strong disagreement and a value of 5 indicated strong agreement. The results showed that the students in IMP II (mean = 2.37) disagreed with this statement while the students in

Geometry (mean = 3.64) tended to favor agree as their answer. A summary of student answers were shown in table 4.4.

Survey question #3, "Learning math is learning a fixed set of rules that have not changed in years" was also negatively weighed. The results again show that the students in IMP II (mean = 2.85) tended to disagree with this statement while the students in Geometry (mean = 3.40) tended to agree.

Survey question #4, "Doing mathematics is discovering for oneself how and why things are related to one another" was positively weighed meaning that a response of 1 indicated strong agreement with this statement. The results showed that while both groups tended to agree with this answer, the students in IMP II (mean = 2.46) agreed more strongly. [Geometry (mean = 2.85)]

The last survey question which had significant results was survey question #9, "Most of our work in math class is the memorizing of information." This question was negatively weighed indicating that a response of 1 means strong disagreement and a response of 5 indicates strong agreement. Students in IMP II (mean = 2.09) answered that they tended to disagree with this statement while students in Geometry (mean = 3.56) tended to agree.

These results were important because most students in Geometry tended to feel that mathematics was memorizing information while the students in IMP II did not agree with this statement. They believed that math was discovering information for oneself, not memorize it. Students tended to not enjoy subjects that required them to memorizing information. Students seemed to enjoy learning and discovering on their own. A summary of the results from survey questions #1, 3, 4 and 9 were shown in table 4.4.

Table 4.4: Summary of Students' Responses

Response	Frequency (Percent)	
	IMP II	Geometry
SQ 1		
Strongly Agree	0 (0%)	7 (7%)
Agree	11 (10.8%)	32 (31.6%)
Neutral	9 (8.9%)	8 (7.9%)
Disagree	12 (11.9%)	5 (5%)
Strongly Disagree	14 (13.9%)	3 (3%)
SQ 3		
Strongly Agree	1 (1%)	8 (7.9%)
Agree	9 (8.9%)	22 (21.8%)
Neutral	19 (18.8%)	12 (11.9%)
Disagree	16 (15.8%)	10 (9.9%)
Strongly Disagree	1 (1%)	3 (3%)
SQ 4		
Strongly Agree	5 (5%)	5 (5%)
Agree	18 (17.7%)	14 (13.9%)
Neutral	20 (19.7%)	23 (22.8%)
Disagree	3 (3%)	10 (9.9%)
Strongly Disagree	0 (0%)	3 (3%)
SQ 9		
Strongly Agree	1 (1%)	9 (8.9%)
Agree	7 (7%)	25 (24.7%)
Neutral	5 (5%)	11 (10.8%)
Disagree	14 (13.9%)	8 (7.9%)
Strongly Disagree	19 (2%)	2 (2%)

The third research question asked:

> Do more students who are enrolled in IMP I/IMP II plan to study mathematics for more years in high school than those students who are enrolled in the traditional sequence?

This question was answered by the survey question in the demographics section which asked the students to indicate how many years of mathematics that they planned on studying while in high school. The means were computed and a two-sample t-test at the

.05 level of significance was performed to compare the responses. The results were listed in table 4.5.

Table 4.5: Data Regarding Numbers of Years a Student Plans to Study Mathematics

	Mean		Standard Deviation		t-Value
	IMP II	GEOM	IMP II	GEOM	
#of years that they plan to study math	3.96	3.91	.36	.62	.480

These results did not indicate that there were significant differences in their answers. Most of these students planned on studying mathematics for four years while in high school.

The last research question was:

> Is there a significant difference in the students' attitudes towards mathematics due to their enrollment in IMP?

To answer this question the mean of each survey question for only the experimental group was used and a one-sample t-test at the .05 level of significance was performed to compare their answers with a neutral response of '3'. These comparisons were shown in table 4.6.

For ten of these survey questions, there were significant differences between the mean response of the students and the neutral response of '3'. For questions # 6 (mean = 2.24), 13 (mean = 2.24), 15 (mean = 2.41) and 17(mean = 2.41), students indicated that they tend to value mathematics. They agreed that math is useful is everyday life; they felt that math is a practical subject; they agreed that it is important to study math every year; and they believed that math helps one to think better.

Table 4.6: Summary of all Responses
from Students in IMP II

	Mean	SD	t-Value
SQ1	2.37	1.16	-3.681**
SQ2	2.11	.77	-7.884**
SQ3	2.85	.84	-1.225
SQ4	2.46	.78	-4.723**
SQ5	2.76	1.16	-1.521
SQ6	2.24	1.21	4.2149**
SQ7	3.28	1.22	1.567
SQ8	2.59	1.00	-2.797**
SQ9	2.07	1.16	-5.454**
SQ10	3.15	.99	1.045
SQ11	3.33	1.19	1.853
SQ12	2.20	1.41	-3.874**
SQ13	2.24	.93	-5.432**
SQ14	2.96	1.09	-.269
SQ15	2.41	1.17	-3.415**
SQ16	3.15	1.15	.894
SQ17	2.41	1.00	-3.974**

** $p < .01$

Survey question # 12 (mean = 2.20), which was negatively weighed, indicated that students disagreed with the statement that there is little need for math in most jobs. This again showed that IMP II students value mathematics.

For questions # 2 (mean = 2.11), 4 (mean = 2.46) and 8 (mean = 2.59), students indicated that they tend to enjoy math. Students believed that math means exploring problems to discover and make generalizations for oneself. Questions # 1 (mean = 2.37) and 9 (mean = 2.07) were negatively weighed. Students disagreed with the statements that math is mostly memorizing information, facts and rules.

Survey questions # 1, 4 and 9 had significant results when the mean response of the IMP II students was compared to the mean response of the Geometry students. These survey questions also had significant results when the mean response was compared to a neutral response of '3'. These three survey questions asked students about how mathematics is learned in their classroom. IMP II students felt that math was discovering for oneself the relationship between mathematical topics, not just the memorization of information.

Chapter Five
Summary of Findings, Conclusions and Recommendations

Introduction

This chapter included the summary of findings, conclusions and recommendations for future research. The purpose of this study was to determine how the attitudes towards mathematics of the students enrolled in the first four classes of IMP I at Pennsauken High School were affected by the new mathematics curriculum and how their attitudes compare to the attitudes of students enrolled in the traditional sequence of Algebra/Geometry.

Summary of Findings

The research that has already been done on mathematics education clearly stated that reform was needed. IMP was one such reform. Lessons in IMP were not teacher-based lessons. Students played an active role in their learning in IMP.

According to Ohanian (1997), "mathematics lessons are based on a set of immovable facts and formulas, one separate from another. Students memorize and practice a set of strategies and then forget them, because learning in isolation is the least productive way" (p. 25). Alper, Fendel, Fraser and Resek (1997a) agreed that for students to develop "mathematics power" the focus must shift to the solving of complex problems instead of learning procedures. The skills which students needed to acquire included problem-solving, communication and reasoning skills and these skills were not provided in the typical high school program (Introduction and Implementation Strategies for the Interactive Mathematics Program, 1998). Leaders in business and in education supported a change in the curriculum. They wanted changes that balanced the information that was explained to the students and the opportunity for students to explore on their own. The belief was that this balance would produce students who were better able to adapt in the real world (Ohanian, 1997). Moreover, according to the NCTM (1998), "Mathematical content and processes are important if they build productively on students' prior knowledge and experience, engage their interest, and make sense" (p. 28). The goal of the IMP curriculum was to incorporate topics, such as probability, statistics, logic and number theory in the attempt to interest students and have them be productive and successful in the classroom and beyond.

From the research that was gathered in this survey, one could conclude that the students in IMP were more active in the learning process. Students in IMP felt that they were not just memorizing information that the teacher has given. These students indicated that they were exploring problems, discovering patterns and making generalizations about mathematics.

Survey question #1, "Learning mathematics is mostly memorizing a set of facts and rules" was negatively weighed meaning that a value of 1 indicated strong disagreement and a value of 5 indicated strong agreement. The results showed that the students in IMP II (mean = 2.37) disagreed with this statement while the students in Geometry (mean = 3.64) tended to favor agree as their answer. Survey question #3, "Learning math is learning a fixed set of rules that have not changed in years" was also negatively weighed. The results again show that the students in IMP II (mean = 2.85) tended to disagree with this statement while the students in Geometry (mean = 3.40) tended to agree. Survey question #4, "Doing mathematics is discovering for oneself how and why things are related to one another" was positively weighed meaning that a response of 1 indicated strong agreement with this statement. The results showed that while both groups tended to agree with this answer, the students in IMP II (mean = 2.46) agreed more strongly. [Geometry (mean = 2.85)] The last survey question which had significant results was survey question #9, "Most of our work in math class is the memorizing of information." This question was negatively weighed indicating that a response of 1 means strong disagreement and a response of 5 indicates strong agreement. Students in IMP II (mean = 2.09) answered that they do tended to disagree with this statement while students in Geometry (mean = 3.56) tended to agree.

Students in IMP believed that math was discovering information for oneself, not memorizing it. Students tended to not enjoy subjects that required them to memorize information. Students seemed to enjoy learning and discovering on their own. This indicated that possibly IMP was a program that will develop students who are more ready for the world that they will inherit.

Conclusions

From the data gathered in this study and from the statistical analysis performed, it could be said that there were significant differences in the attitudes between the students in IMP II and in Geometry at Pennsauken High School in New Jersey. There were significant differences in the responses between the students in IMP II and the students in Geometry regarding their enjoyment of mathematics. As to how students value mathematics, there were no significant differences between the two sets of students. Also, there were no significant differences in the number of years that a student plans to study mathematics while in high school between the two groups.

Recommendations

There are several recommendations that are suggested for future research. First, the number of students to be surveyed should be a larger sample. A larger sample would help to validate the conclusions made in this paper. Second, another survey could be conducted in the same school with the same students to determine if their attitudes regarding mathematics are the same or more positive. Also, a comparison of grades and standardized test scores could be performed between the students in IMP and the students in Geometry. Lastly, this exact survey and study could be reproduced in other areas of the country to determine if IMP has affected a larger and more diverse group of students.

APPENDIX

MATHEMATICS ATTITUDE SURVEY

Pennsauken High School

The following is survey on mathematics attitudes at Pennsauken High School. Approximately 100 students will be surveyed from Geometry and IMP II. The responses are anonymous and will be kept confidential.

Please circle the category which relates to you.

AGE:	**14-15**	**16-17**	**18**	
GENDER:	**Male**	**Female**		
GRADE:	**10**	**11**	**12**	
LAST MATH COURSE:		**IMP I**	**Algebra I**	**Algebra II**
CURRENT MATH COURSE:		**IMP II**	**Geometry**	

Please answer the following questions:

a. How many years of mathematics have you studied in high school? 0 1 2 3 4

b. How many years of mathematics do you plan on studying in high school? 3 4 5 6

Please answer the questions on the reverse side.

Please read each statement carefully and rate them in terms of how you feel by circling the appropriate choice for each statement.

SA = strongly agree A = agree N = neutral D = disagree SD = strongly disagree

1.	Learning mathematics is mostly memorizing a set of facts and rules.	SA	A	N	D	SD
2.	Learning math means exploring problems to discover patterns and make generalizations.	SA	A	N	D	SD
3.	Learning math is learning a fixed set of rules that have not changed in years.	SA	A	N	D	SD
4.	Doing mathematics is discovering for oneself how and why things are related to one another.	SA	A	N	D	SD
5.	I remember most of the things I learn in mathematics.	SA	A	N	D	SD
6.	Mathematics is useful for the problems of everyday life.	SA	A	N	D	SD
7.	Mathematics is something which I enjoy very much.	SA	A	N	D	SD
8.	In mathematics class we are expected to learn and discover many ideas for ourselves.	SA	A	N	D	SD
9.	Most of our work in math class is the memorizing of information.	SA	A	N	D	SD
10.	In mathematics class we are encouraged to work on our own projects or experiments.	SA	A	N	D	SD
11.	Working math problems is fun.	SA	A	N	D	SD
12.	There is little need for math in most jobs.	SA	A	N	D	SD
13.	Math is a practical subject.	SA	A	N	D	SD
14.	I would like a job that doesn't use any math.	SA	A	N	D	SD

15.	**It is important to take math every year until you are out of school.**	**SA A N D SD**
16.	**Math is boring.**	**SA A N D SD**
17.	**Math helps me learn to think better.**	**SA A N D SD**

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