AN INVESTIGATION OF THE EFFECTS OF EXPOSURE TO SAXON MATH TEXTBOOKS, SOCIOECONOMIC STATUS AND GENDER ON MATH ACHIEVEMENT SCORES

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CHAPTER 1

INTRODUCTION TO THE STUDY

Math achievement has been a topic of interest and debate in the field of education for many years. In addition, research on the pedagogical aspects of instruction, achievement testing, socioeconomic status (SES), gender issues and other possible factors affecting academic achievement continues to be conducted. Since the Congressional meeting resulting in the release of Goals 2000, efforts to improve math instruction to successfully achieve the stated goals have intensified. Increased opportunity for teacher's professional development, additional materials, curriculum modifications, instructional methodologies and textbook evaluations are but a few of the areas being investigated to help improve the academic achievement of students.

One of the most extensively researched areas related to academic achievement is SES. Studies from as early as the mid-1960's have indicated SES to have a significant impact on the academic achievement of students (Coleman et al., 1966). Further research has supported these initial findings, although the degree of influence has been debated. Differences seem to vary greatly depending on whether or not data were analyzed on an aggregate or individual level (White, Reynolds, Thomas & Gitzlaff, 1993). However, despite the type of data examined, all studies indicate a positive correlation between academic achievement and SES (Alspaugh, 1996; Coleman et al., 1966; Fetters & Peng, 1975; McCartin & Meyer, 1986; Sampson-Malone, 1985; Walsh, 1986; Walsh & Witte, 1985; White, et al., 1993).

In addition to SES, gender differences in mathematics achievement have been the focus of many studies. Historically, females in our society have exhibited lower

performance on math achievement measures than males. Research has suggested that these discrepancies may be attributed to factors such as learning style differences, socialization patterns, and teacher expectations, rather than innate ability (Schwartz & Hanson, 1992). However, in recent years, it seems this achievement gap between the genders is less pronounced. Studies have reported a decrease in the score discrepancies between male and female students over the last several decades (Benbow & Stanley, 1980; Feingold, 1988; Fennema, 1980; Fox & Cohn, 1980). This decrease could be a result of changing socialization patterns of society, increased gender equity in instructional settings, alternative assessment procedures or a combination of these and various other factors. As yet, the influence of textbook type and format has gained little attention. Further research is needed to determine the impact of these variables on gender differences in mathematics achievement.

Comparative studies on an international level have broadened the scope of research to encompass cultural and environmental differences, as well as academic variables. Controversy exists on how the U.S. actually compares to other countries in mathematics and other academic areas (Bracey, 1996; Stedman, 1997). Results of the Third International Math and Science Study (TIMSS) seemed to reveal U.S. students faring poorly compared to their counterparts in other industrialized countries. It has been suggested that various social factors, such as race, SES, parental education, type of community and the number of parents in the home may account for some of the discrepancies in achievement (Bracey, 1996). Opinions vary according to methods of data aggregation and analytical perspectives. There is consensus, however, that the educational structure and curriculum in the U.S. varies greatly from those in many other

countries. One main difference is in textbook format. Most textbooks used in the United States, attempt a comprehensive approach to instruction in which a multitude of topics are covered instead of focusing on the mastery of a more focused set of topics (Schmidt, McKnight, & Raizen, 1997).

In addition, U.S. textbooks spend more time on repetitive teaching and review of previously learned concepts (Schmidt, et al., 1996; Valverde & Schmidt, 1998). This type of curriculum and textbook format coincides with the spiral curriculum framework conceptualized by Jerome Bruner in 1960 (Dowding, 1993; Efland, 1995; Harden & Stamper, 1999). The intent of the spiral curriculum is to provide a basic foundation of knowledge and progressively build on that knowledge, increasing the complexity of the concepts at each level (Efland, 1995; Harden & Stamper, 1999). However, over the years, this initial concept seems to have been inadvertently misconstrued to equate with repetition and review (Silver, 1998). Some researchers believe this adapted version of the spiral curriculum apparent in many of the U.S. textbooks may actually hinder the progress of students (Jensen, 1990; McKnight, et al., 1987; Valverde & Schmidt, 1998). According to Valverde and Schmidt (1998), textbook choice is of vital importance to instructional success. Careful scrutiny of the textbooks utilized in the schools is imperative to provide educators with the information necessary to make effective and confident decisions regarding textbook selection.

Over the last two decades, in accordance with the concept of a spiral curriculum and its accolades of effectiveness, many districts throughout the United States have incorporated Saxon textbooks into their curriculum. The Saxon math program is based on the incremental development of math concepts presented in an instructionally prescriptive

manner. Topics are introduced in small increments in a predetermined, sequential order. These new skills are combined with previously learned material to provide continual review of all concepts. This spiraling technique supposedly provides students with the opportunity to automatize fundamental math skills so more abstract concepts can be learned. The prescriptive format and redundancy of content in Saxon textbooks have instigated criticism, as well as support, from many educators and researchers.

Statement of the Problem

Saxon mathematics textbooks are designed to provide an incremental approach to the development of math skills. Continual repetition and review of content is incorporated into the instructional format to reinforce and enhance retention of previously learned concepts in mathematics. Data are sparse as to the effect of this process over time. Preliminary studies indicate a gain in overall math scores for students taught with Saxon textbooks (Calvery, Bell, & Wheeler, 1993; McBee, 1984; Roberson, 1997). However, only one study has been conducted with younger students and none are currently available examining the longitudinal effects of Saxon textbook utilization.

Additionally, standardized assessment in mathematics achievement typically focuses on concepts, computation and problem solving skills. Due to the repetitious format of the Saxon texts, computational skills seem to be emphasized more heavily than concepts and problem solving skills. Studies evaluating Saxon to date have studied math achievement in terms of total math scores only, neglecting to determine specific achievement in concepts, computation and problem solving.

Because males and females excel in different areas of mathematics (Armstrong, 1981; Fennema & Tartre, 1985; Marshall, 1984), the impact of Saxon textbooks on math

achievement scores may be related to student gender. An investigation of math subtest scores (concepts, computation and problem solving) will help determine in what areas the achievement differences may occur. In addition, evidence suggests that academic achievement is positively correlated with socioeconomic status (Coleman, et al., 1966; Fetters & Peng, 1975; McCartin & Meyer, 1986; Walsh, 1986). Therefore, lower SES students may likely have lower achievement scores. As yet, it has not been determined if the prescriptive and repetitive format of the Saxon textbooks has a differential effect on the math achievement of students from different socioeconomic groups.

This study examined the cumulative effects of exposure to Saxon mathematics textbooks, gender and SES on the math achievement scores in three subtest areas (concepts, computation and problem solving) of a third grade population.

Purpose of the Study

The purpose of this study was to investigate the differential effects of length of exposure to Saxon math textbooks, SES and gender on the ITBS math concepts, computation and problem solving subtest scores of third grade students.

Studies pertaining to the use of Saxon mathematics textbooks are limited and have yielded inconsistent results. Furthermore, research has yet to investigate the effects of Saxon math textbook usage over time. Therefore, this study compiled three groups of students representing different levels of exposure to Saxon math textbooks (never, 1-2 years, and 3-4 years) to determine if consistent exposure to Saxon math textbooks over time had an effect on math subtest scores.

Math achievement, however, cannot be solely attributed to textbook selection. Research has consistently shown that SES and gender greatly influence math

achievement scores. Therefore, it was necessary to incorporate these additional two independent variables into the study.

Like the factors that influence math achievement, math achievement itself is not a single entity but rather a combination of various math skills. Previous research, however, has often measured math achievement with one overall score. This procedure fails to address the effects various factors may have on the specific math skills that make up the overall score. To avoid this problem, three dependent variables were incorporated into this study (concepts, computation and problem solving). By doing so, it was possible to investigate the effects of the independent variables on the specific math skill areas.

Definition of Terms

Iowa Tests of Basic Skills (ITBS): The ITBS is a standardized, norm-referenced achievement test distributed by Riverside Publishing Company. The purpose of the ITBS is to provide a comprehensive assessment of student progress in basic skills (Technical Summary I, p. 10).

Spiral Curriculum: The spiral curriculum is a hierarchical approach to learning that provides a basic foundation of knowledge and progressively builds on that knowledge, increasing the complexity of the concepts at each level (Efland, 1995; Harden & Stamper, 1999).

Significance of the Study

Results of this study will contribute to the limited amount of information available on Saxon mathematics textbook utilization and its effects on specific areas of math achievement. Since Saxon mathematics textbooks are based on the concept of a spiral curriculum, this study will also yield pertinent information on the feasibility of this type

of format as it relates to the population examined. In addition, literature on the current state of achievement differences in relation to socioeconomic status and gender will be provided.

The results of this study may also serve as a foundation for future, follow-up studies on related topics. Upon review of this study, findings may directly impact the decision-making process in regard to textbook selection, curriculum decisions and possible SES and gender issues on math achievement.

Assumptions

The cooperating school district in this study administers the ITBS to monitor the progress of students within the district. This instrument, along with the textbooks utilized in the schools, coincide with the curriculum guidelines set forth by the district. Therefore, it is assumed in this study that the ITBS is an accurate test of mathematics skill and effectively reflects the progress of subjects in this study.

In addition, the ITBS and the Saxon mathematics textbooks proclaim the use of a spiral approach to the design of their materials. Subsequently, it is assumed that findings of this study can therefore be linked to the feasibility of utilizing a spiral curriculum approach.

Limitations

The subjects for this study were conveniently selected from demographically similar public schools in a mid-sized, metropolitan area. Selection was based on length of exposure to Saxon math textbooks, school attended, length of time student remained in the district, and availability of ITBS math subtest scores for third grade. Due to the limited number of subjects meeting the selection requirements, all subjects meeting the

criteria were used. Therefore, results of this study can only be generalized to those individuals or groups with characteristics similar to those selected for this study.

Additionally, the subjects utilized in this study were compiled from archival information in the cooperating school district's databanks. Only student files that contained complete and accurate information could be included in the selection process. Subsequently, the number of subjects available for selection in this study was considerably reduced.

Organization of the Study

This study is organized into five main parts. Chapter one includes an introduction to the study in which the problem, purpose, assumptions, limitations, research question and other pertinent information regarding the overall scope of the study is described.

Chapter two is dedicated to the review of relevant literature. Topics include an overview of math achievement on an international level, math achievement as it relates to socioeconomic status and gender, aspects of the spiral curriculum and Saxon mathematics textbooks.

The third chapter describes the methodology followed in this study. A complete description of the design, subject selection, instrument used, procedures and data collection, and statistical techniques for the analysis of data are given. Lastly, it includes the hypotheses posed for the study.

Chapter four reports the results of the study. All statistical analyses and the corresponding results and interpretations are presented.

The last chapter provides an integrated overview of the entire study. It provides a summary of all findings from the study, conclusions based on these findings, and recommendations for future research.

Research Question

This study answered the following research question pertaining to the math achievement of third grade students:

Research Question

Do length of exposure to Saxon math textbooks, SES and gender have differential effects on the ITBS math concepts, computation and problem solving achievement scores of third grade students?

CHAPTER 2

REVIEW OF RELEVANT LITERATURE

The purpose of this study was to investigate the differential effects of length of exposure to Saxon mathematics textbooks, SES and gender on the ITBS math concepts, computation and problem solving scores of third grade students. In order to effectively pursue this goal, a review of literature examining the previous and current trends in math achievement, contextual factors and pedagogical aspects, both globally and nationally, was necessary.

Math Achievement

International Comparisons

Due to cultural diversity, countless differences exist in the educational structures and instructional methods implemented throughout the world. For this reason, many researchers have deemed it inappropriate to compare academic achievement at the international level. Nevertheless, attempts have been made to study differences, as well as similarities, to better understand cross-national discrepancies and identify the characteristics associated with exceptional instruction.

In 1988, the Educational Testing Service conducted its first International Assessment of Educational Progress (IAEP). The purpose of the study was twofold: 1.) To determine if the utilization of existing NAEP materials and procedures could reduce the overall time and expense of conducting international comparisons, and 2.) To make available NAEP technologies to other countries interested in exploring their appropriateness for local evaluation purposes (Lapointe, Mead, & Phillips, 1989).

Five countries and four Canadian provinces participated in the IAEP. A total of 24,000, 13 year- old students from public and private elementary, middle and secondary schools were assessed in mathematics and science. In addition to academic evaluations, students completed questionnaires pertaining to their school experiences and attitudes. Teacher data were also collected which rated students' exposure to test item concepts.

Results indicated that Korea outperformed the eleven other groups and the United States performed the lowest, with averages below the mean. Proficiencies within each topic varied from population to population, however, almost 100% of the students from each country or province showed mastery of basic addition and subtraction skills. Additional results revealed similar mathematics achievement between boys and girls with the exception of Korea and Spain. In those two countries, boys achieved significantly higher than girls (Lapointe, Mead, & Phillips, 1989).

Although many similarities existed in instruction and tasks, social and educational environments differed significantly. Introduction, emphasis, and sequencing of math topics varied from one country or province to another, which may account for some of the achievement discrepancies. In addition, opportunity to learn (OTL) and attitude were not consistent with performance. It was suggested that these results could be related to cultural differences (Lapointe, Mead, & Phillips, 1989).

Overall, this study provides a very thorough analysis of student mathematics and science achievement in the countries and provinces that participated. It is obvious from these results that the contextual and pedagogical aspects of educational systems differ a great deal. A more in-depth understanding of international similarities and differences is

needed for countries to obtain a global perspective of education and collaboratively develop optimal learning environments for children in all countries.

The Second International Mathematics Study was conducted on a larger scale and compared the international achievement of 20 countries. Results from this study, as with many of the other international assessments, have been rigorously debated. According to Bracey (1996), rankings and averages were widely publicized without regard to relevant information surrounding the results. For example, although the U.S. eighth graders seemed to fare poorly, many other countries had very similar scores which were not significantly different. Bracey (1996) contends that the tight clustering and small differences of the scores resulted in large differences in the rankings. Although the idea of using a ranking system to judge performance is indeed questionable, Stedman (1997) guards against totally disregarding the achievement discrepancies. He counters that most assessments reveal large achievement differences even with consideration given to the clustering of scores.

Furthermore, there has been contention that the general population of U.S. students has been compared to only the top ranking students of other countries. Ishizaka (1994) addressed the selection problems in Japan suggesting that access is granted only to those schools chosen by the government. This implies a sampling bias in which only the academic elite from the overall general population of Japanese students is chosen for the international comparisons. These sampling biases, also suspected in other countries, are supported by several other researchers as well (Berliner & Biddle, 1995; Geiger, 1994; Tanner, 1993). Stedman (1997), however, opposes this view, arguing that the U.S. also restricted the range of students being tested by only assessing those taking college

preparatory mathematics courses. This resulted in only 13% of the U.S. students being tested, which is comparable to many of the other nations (Keeves, 1992).

The Third International Mathematics and Science Survey (TIMSS) is the most recent international comparative study conducted by the International Association for the Evaluation of Educational Achievement (IEA). The TIMSS study gathered quantitative and qualitative data from over 40 countries at five different grade levels (3^{rd}, 4^{th}, 7^{th}, 8^{th}, and 12^{th}). It involved over half a million students from over 15,000 schools. It is by far the largest and most comprehensive educational achievement study ever conducted (Mullis, 1997).

Results indicated Singapore, Korea and Japan to be the top performing nations in mathematics. U.S. fourth graders scored above the international average but were still outperformed by eleven countries. In contrast, U.S. eighth graders scored below the international average of the 41 countries with numerous countries performing significantly higher. Scoring the lowest were students from Columbia and South Africa (Mullis, 1997). In addition to overall achievement rankings, TIMSS provides valuable information on performance within subject areas. Performance varies within content areas from country to country. There were also numerous contextual differences among countries in regard to curriculum guidelines, teacher qualifications, textbook format, instruction, scope and sequence, homework and extra-curricular activities (Mullis, 1997). Such data can be examined to gain insight for the improvement of educational practices and policies and to develop pedagogies that can enhance the education of students in all nations.

Interpretations of data collected from TIMSS have yielded conflicting views that seem to be dependent on the researcher's perspective. Methods of analyses and data aggregation have been challenged and alternative techniques proposed. Although opposing viewpoints exist, the importance of these findings is substantial and examination of the data pertaining to the contextual similarities and differences among the countries would prove a very fruitful and enlightening endeavor.

Math Achievement and Gender

An abundance of research has been conducted over the years related to gender differences in mathematics achievement. The literature is somewhat contradictory and various results have been reported. There are many research studies that have found no significant gender differences (Armstrong, 1981; Connor & Serbin, 1985; Holloway, 1986; Moore & Smith, 1987; Swafford, 1980). When gender differences do appear, it is usually not until junior high, boys are almost always favored and the differences are greater for very bright adolescents (Kimball, 1989). In the occasion of sex-related differences in younger children, girls often perform better on computation and rote learning tasks (Armstrong, 1981; Fennema & Carpenter, 1981; Fennema & Tartre, 1985; Marshall, 1984), while boys outperform on problem solving, math application and math reasoning (Armstrong, 1981; Fennema and Sherman, 1978; Marshall, 1984). Many hypotheses have been posed to explain these differences such as socialization, type of assessment, sample selection and differences in learning styles between the genders (Schwartz & Hanson, 1992). As yet, the effects of textbook type and format on gender differences have not been extensively researched.

Research has also shown that the discrepancy in achievement between boys and girls is decreasing. In 1988, Feingold found the male advantage on the Preliminary Scholastic Aptitude Test-Quantities (PSAT-M) to decrease from .34 in 1960 to .12 in 1983. Similarly, Fennema (1980) found a lesser discrepancy in gender differences from a 1960 sample and a 1975 sample. Furthermore, a similar decrease was found in the SMPY sample. In 1972, 19 percent of the boys scored higher than the highest scoring girl on the SAT-M. This was reduced to 2 percent in 1976 and, by 1979, only one boy outscored the highest scoring girl (Fox & Cohn, 1980). Over this time period, the boys' high scores have remained fairly consistent ranging from 780 to 790, while the girls' high scores show a marked increase ranging from 600 to 760. In addition, the group means show a similar pattern with the gender gap in achievement narrowing (Benbow & Stanley, 1980; Benbow & Stanley, 1983).

Research on the gender differences in mathematics has expanded in recent years to investigate possible factors related to this discrepancy. One area that has been researched extensively is the socialization patterns of males and females within the classroom and environment. Many studies have shown the ways in which teachers interact with girls differs greatly than how they interact with boys (Brophy, 1986; Eccles & Blumenfeld, 1985; Leder, 1987; Sewald & Engle, 1979). Boys receive more attention from the teacher than girls, teachers interact more frequently with boys and teachers tend to solicit answers from boys more often (Brophy, 1985; Brophy, 1986; Eccles & Blumenfeld, 1985). In addition to the unbalanced distribution of teacher attention, the content of teacher comments is also inequitable. Boys receive more constructive criticism, more precise feedback and a greater amount of praise, while girls receive more

negative feedback and are called on less frequently (Brophy, 1985; Eccles & Blumenfeld, 1985; Fennema & Peterson, 1985). These differences have a great deal of impact on the achievement of female students, their attitude toward mathematics, and pursuit of additional mathematics courses later in their academic career.

Besides classroom and environmental factors, learning styles may also account for a portion of the observed differences in achievement. Research on the preferred learning styles of males and females indicate that girls prefer a cooperative learning environment, same-sex work groups, and general and abstract test questions, while boys tend to function better in a competitive environment and prefer specific and concrete test items, (AAUW, 1992; Fennema & Peterson, 1985). In a 1992 review of major studies related to girls and education by the American Association of University Women (AAUW), the researchers found the design and structure of lessons to influence performance. When the instructional sequence of the math lessons were rearranged so that students read the material and completed problems first and then had classroom discussion, the girls outperformed the boys in two of five areas and remained equal on the other three. This indicates that format and sequence of textbook and instruction may play a considerable role in student achievement.

To further support gender related differences in learning styles, results of a recent study indicate that cognitive strategies used by males and females, as well as goal orientations, may also account for differences in achievement. In a path analysis conducted by Dowson and McInerney (1998), the variations in student academic motivation, cognition and achievement in relation to their age, gender, culture and SES were investigated. Results indicated that students learning strategies for academic

achievement varied as a function of gender. This may indicate that male and female students approach learning tasks differently in different curricular areas (Dowson & McInerney, 1998).

Differences in achievement scores may also be dependent on the type of assessment used. Typically, studies utilize some form of standardized test scores for comparisons. However, recent studies have shown that, although boys outperform girls on standardized tests, girls actually obtain higher grades in school (Kimball, 1989). Furthermore, in light of the study conducted by Dowson and McInerney (1998), which indicated gender related differences in the utilization of cognitive strategies it is conceivable that males and females also approach assessment situations differently.

Due to the differences evident in the learning styles of males and females, it is conceivable that textbook format may impact a students' performance. Therefore, research in this area could provide relevant information regarding the positive and negative aspects of utilizing a repetitive and prescriptive textbook format, such as Saxon, on the math achievement of male and female students.

Math Achievement and Socioeconomic Status

Researchers have been investigating the possible effects of socioeconomic status (SES) on academic achievement since at least the mid-sixties when Coleman et al. (1966) reported a strong relationship between SES and academic achievement. This sparked a great deal of enthusiasm for the topic and studies have continued to be conducted.

It has become widely accepted that SES and academic achievement are positively correlated. Based on this premise, it is generally assumed that the academic achievement of low SES students will be lower than their more privileged counterparts. However, the

degree to which SES influences achievement has varied considerably. Studies that use aggregate data at the school or community level show a stronger relationship than those using data at the individual student level (White et al., 1993).

To emphasize the differences between using individual or aggregated data, White et al. (1993), replicated studies conducted by Walsh (1986) and Walsh and Witte (1985). Data were reanalyzed on an individual level as opposed to the school level in the original study. Results indicated that the percentage of variance in achievement explained by SES is greatly overestimated when using aggregated student data. Among all the schools using aggregated data, analyses indicated 72% of the variance could be attributed to SES, while only 20% was calculated when using individual student data (White, et al., 1993).

Review of previous studies lends support to White's claim. In studies analyzing aggregate data, the strength of the relationship between SES and academic achievement ranged from a low of .263 to a high of .96 (Brooks, 1988; Jencks, 1972; Klein, 1971; Walsh, 1986; Walsh & Witte, 1985). However, studies analyzing individual data ranged from a low of .136 to a high of only .495 (Fetters & Peng, 1975; McCartin & Meyer, 1986; Sampson-Malone, 1985).

Although the strength of the relationship between SES and achievement may vary, the positive correlation of the two variables is still evident in all the studies reviewed. More recent research is also consistent with previous findings. In a longitudinal study conducted by Alspaugh in 1996, an achievement gap between low and high SES groups was consistently evident over a five year period.

An interesting study by Caldas and Bankston III (1997) incorporated another dimension into the ongoing research on SES and achievement. They hypothesized that

not only would a student's SES have an impact on achievement, but the SES of their peers would influence achievement as well, despite the SES of the individual. Caldas and Bankston III posed that students create their own social context apart from their individual backgrounds, which strongly influences individual achievement. Results revealed that individual family SES is positively correlated with academic achievement. Also, the social status of the family has an even greater impact. Furthermore, the SES of classmates did have an effect on the academic achievement of students. Students who attend school with classmates from a higher SES than their own show significantly higher academic achievement; although, to a lesser extent than the influence of their own family. Inversely, those who attend school with lower SES classmates would show lower academic achievement (Caldas & Bankston III, 1997). These results open an interesting avenue for future research.

Overall, it is evident that the SES of a student has a significant influence on their academic achievement. It is also apparent that studies utilizing individual student data provide a more realistic representation of the relationship between the two variables. By using aggregated data there is less variance in the scores than with individual scores. Due to this limited range of variance, one variable is able to account for a larger portion of the variance (White, et al., 1993). Hence, results tend to be overestimated. It is also apparent that SES is not the sole predictor of academic achievement. Future studies need to incorporate variables in addition to SES to gain a greater understanding of the multitude of factors that impact academic achievement.

Curriculum/Textbooks

The Spiral Curriculum

The spiral curriculum was first conceptualized by Jerome Bruner in 1960. The hierarchical approach to learning provides a foundation of knowledge, which is enhanced and built upon throughout the various levels of instruction. New material is linked to previous knowledge to expand the student's conceptual framework (Dowding, 1993; Efland, 1995; Harden & Stamper, 1999).

In the following decades, many schools incorporated textbooks based on the spiral approach to instruction. Some efforts focused on intertwining educational topics with the philosophical and cultural aspects of society, while others utilized it as a guide to organize the scope and sequence of subjects within the curriculum (Beane, Toeppfer, & Alessi, 1989; Romiszowski, 1981; Taba, Durkin, Fraenkel & McNaughton, 1971). The spiral curriculum has been implemented at all age levels and areas of study. It has become the basis for many of the textbooks and curriculums in U.S. schools.

However, over the years, the spiral curriculum has been inadvertently equated with repetition and review (Silver, 1998). Some researchers and educators believe the curriculum has been spiraled to such an extent that it is hindering the progress of students (Jensen, 1990; McKnight, et al., 1987; Valverde & Schmidt, 1998). In an attempt to investigate this problem, Flanders (1987) examined the amount of new and redundant content in three popular math textbooks. Results indicated the average percentage of new content was only 44 percent in the fourth grade and dropped as low as 31 percent in eighth grade.

Furthermore, there is a sharp contrast between the textbooks and curriculums utilized in the U.S. and those of other top performing counties. The U.S. has a long history of content fragmentation and lack of central focus (Schmidt, McKnight & Raizen, 1997). Textbooks tend to attempt an inclusive approach in which students are taught a multitude of topics within a given year. This provides students with only minimal conceptualization and practice before moving on to a new topic. Subsequently, an exorbitant amount of time is spent at the beginning of each year on repetitive teaching and review of previously learned material (Schmidt, et al., 1996; Valverde & Schmidt, 1998). Furthermore, research has indicated that not only do U.S. textbooks include more topics than typical in other countries, topics are retained for a greater length of time (Schmidt, McKnight & Raizen, 1997). An analysis of textbooks used in the TIMSS study indicates that in the United States, the top five topics in mathematics textbooks only accounted for 60% of the book, whereas, the same topics accounted for 85% of the books in other countries. In essence, U.S. textbooks frequently add topics, but seldom drop them. This is contradictory to NCTM recommendations, which endorse devoting more time to primary content and less to topics deemed less central. In contrast, textbooks and curriculum formats in other countries tend to focus on the in-depth learning of a narrower set to topics (Schmidt, McKnight & Raizen, 1987). This mastery approach to learning reduces the amount of review necessary at the onset of each year and provides a greater foundation of knowledge to build upon.

Jensen (1990) recommends three guidelines for curricular reform to rectify the redundancy inherent in current curriculums. They include: a) making new content the focus of instruction each year, b) eliminate the fragmentation of topics into dependent,

single-day lessons, and c) provide in-depth learning of each topic to promote understanding and connectivity of concepts.

There is much to learn about the most effective methods of instruction and curriculum design. International studies such as TIMSS and NAEP can be extraordinary means of gaining information about the topic. Examination of the scope and sequence of curriculums and textbook formats from various countries can provide useful information that can benefit educational systems throughout the world.

Saxon Math

In 1970, John Saxon retired from the Air Force and began teaching algebra at a junior college in Oklahoma. Lack of student achievement prompted him to write his own math problems for the class. The results were quite effective and students successfully learned the algebra content. Subsequently, John Saxon continued to produce math materials and authored textbooks for the junior college level, which were published by a major publisher. He later adapted his work to produce a high school level algebra text and enlisted several Oklahoma teachers to try it. Reports of success led him on a search for a publisher. After consistent rejection, Saxon decided to pool his personal resources and establish his own publishing company, Grassdale Publishers. Traveling throughout Oklahoma, Saxon recruited 20 teachers to try his text concurrently with the regular math text and compare the results. Approximately 14,000 students participated in this pilot program. Results indicated improvement in the number of problems Saxon students were able to complete compared to their counterparts who used the alternate text (Saxon Publishers, 1999). Response to the textbooks was extremely favorable by teachers, however, the reaction from math experts was quite negative. Saxon's persistence and

controversial nature earned him an unfavorable reputation. Despite these conflicts, Saxon continued to produce textbooks and currently publishes mathematics textbooks for grades K-high school. In 1996, he changed the name of his company to Saxon Publishers, Inc. Today, districts throughout the United States and several foreign countries utilize Saxon math textbooks (Saxon Publishers, 1999).

The Saxon math program is based on an incremental approach to instruction; similar to the curriculum spiraling proposed by Bruner. Lessons are sequential and prescriptive in nature with one segment of a concept presented at a time. New concepts are built on previously learned material with continual review incorporated throughout the text. This spiraling technique is designed to allow students to gradually develop math concepts while the previously learned skills become automatic through continual review. By automatizing the previously learned material, students can concentrate more fully on new, more complex concepts (Saxon Publishers, 1999). Saxon Publishers are committed to this style of instruction and "are dedicated to turning around education by publishing textbooks and instructional materials that have proven records of success in the classroom" (Saxon Publishers, 1999).

Limited research is available on the effects of the Saxon math program on student math achievement scores. In addition, the studies that have been conducted report inconsistent results (Calvery, Bell, & Wheeler, 1993; McBee, 1983; Roberson, 1997).

A study conducted by Calvery, Bell, and Wheeler (1993) compared the math achievement scores of 2nd and 3rd grade students using Saxon textbooks with those using Holt textbooks. Approximately 190 students were divided into four groups of 24 students each for both 2nd and 3rd grade. One section in each grade was taught with Saxon

textbooks while the other three sections were taught with Holt textbooks. Total battery scores from the Stanford Achievement Test were used to assess student math achievement. Results indicated no significant differences in math achievement scores between the textbook groups for either grade. However, for each group, the Saxon students began with lower group means than the Holt group but managed to catch up and surpass the Holt group by the end of the study. Although overall scores were not significant, the Saxon students made a significant gain in group means. According to the researchers, these results indicate that the Saxon math program may be appropriate for underachieving students (Calvery, Bell, & Wheeler, 1993). However, students were not initially differentiated by ability level. Group means were utilized, which could have been influenced by several very low or very high achieving students within the group. Therefore, assumptions regarding underachieving students need further investigation. However, the statement does present an interesting consideration for the utilization of Saxon textbooks. Follow-up studies should be conducted that take into account the initial ability of the students to further examine the effects of Saxon textbooks on varying ability levels.

A more comprehensive study was conducted by McBee (1984), which examined math achievement differences between algebra students taught with Saxon and Dolciani textbooks. The study also investigated differences in student absences, rate of turning in homework, ability level of the students and teacher's comments. Approximately 165 students from seven schools participated in the study. Students from each school were divided into two separate algebra sections. One section was taught with Saxon textbooks and the other with Dolciani textbooks. Students' scores on the California Achievement

Test (CAT) were used as a covariate to account for initial differences in ability level. A locally constructed comprehensive exam was used to assess student achievement at the end of the study.

Results indicated students using the Saxon texts to have significantly higher mean scores than those using Dolciani texts. Although significant differences existed between the group means based on textbook, there was no significant interaction between textbook and ability. In addition to overall group means, performance on specific topics were also evaluated. Out of the 21 topics covered on the test, Saxon students scored significantly higher on 11 of the topics, while Dolciani students scored significantly higher on only 1 of the topics. There were no significant differences between the groups on the remainder of the topics (McBee, 1984). The 11 topics Saxon students outperformed on seemed to consist mainly of computational skills with only 1 of the topics consisting of word problems. Furthermore, no relationship was found between the comprehensive exam, absences, homework rates and time blocks missed.

Reports on teacher comments are somewhat inconsistent. Most teachers seemed to prefer the Saxon text for low, average and high ability students. However, the repetitive nature of the Saxon text was listed as a weakness for high achieving students. Students needing motivation to read the text is also reported as a weakness, yet one of the strengths noted was that the Saxon text was more motivating than the Dolciani. Interestingly, teachers also reported one of the strengths of the Saxon text to be "no hard word problems" (McBee, 1984). With emphasis being placed on developing a more challenging curriculum for students in the United States, lower difficulty levels of problems seems contradictory to this goal. It is also disturbing that this was considered a

strength by teachers. This leads one to question the mathematical and instructional abilities of the teachers.

This study provides some valuable information on the use of Saxon textbooks, as well as, interesting qualitative data. The topical analysis of data provides a good basis for future comparative studies. It is also useful in determining which texts emphasize the acquisition of specific skills when evaluating textbooks with predetermined curriculum goals in mind. Additional information of this nature on Saxon and other commonly used textbooks needs to be gathered in an effort to evaluate which ones are the most effective for decreasing the various achievement discrepancies both domestically and internationally.

The most recent study reviewed was conducted by Roberson in 1997. The purpose of her study was to determine if using Saxon textbooks would affect the mathematics achievement of 8th grade students. Fifty-two eighth grade students were divided into two math groups, one using Saxon textbooks and one using an existing text. Results indicated no significant differences in the math achievement of students taught with the Saxon text and those taught with the existing text (Roberson, 1997).

However, results of this study should be considered with caution. There are many limitations to this study, which undermine the usefulness of its results. For example, the study was only conducted for a three-week period during the latter half of the school year. Although this was deemed an appropriate amount of time by the researcher, it is considered extremely inadequate by this author. In addition, math classes were conducted at different times of the day for each group, the experimental (Saxon) group had been using the existing text prior to the study (which constitutes most of the school year),

ability of the students was not objectively determined before group assignation and grades of some students affected eligibility for the following year. The implications associated with these limitations are of such magnitude that the results should be considered with caution.

Due to the lack of empirical studies associated with the effects of Saxon math textbooks on math achievement, further research is warranted. To provide more detailed information, data should be analyzed according to specific skill areas instead of a total math score to more efficiently determine the strengths and weaknesses of the text and student abilities. Interactions between achievement, gender, and SES should also be investigated to provide information regarding the effects of the textbook format on various populations.

Summary/Conclusions

The inadequate performance of U.S. students on international comparisons of academic achievement, especially in science and math, have sparked a great deal of controversy over the educational system, from the federal to the local level. The release of Goals 2000 has prompted reform and review at all levels of the educational system. Policies and standards were reevaluated to meet the challenge set forth by the President to be "first in the world in science and mathematics by the year 2000" (Hawkes, Kimmelman, & Kroeze, 1997).

Many aspects of a student's background and environment affect their academic achievement. Thus far, research has indicated that academic achievement is strongly influenced by the SES of the student (Coleman, et al., 1966). However, research related to the relationship between SES and academic achievement has revealed varying results

dependent on the type of data used. Although the degree of the relationship has been disputed, the direction is consistent in all studies reviewed; SES does positively correlate with academic achievement. Due to the inconsistent findings related to the degree of influence SES has on academic achievement and the lack of information on the role textbook format may play with various SES levels, further studies need to be conducted to provide a clearer picture of possible relationships.

In addition to SES, studies have shown that gender has a significant influence on mathematics achievement as well. Males have historically outperformed females on measures of achievement. Although, recent research has indicated that girls obtain consistently higher grades in the classroom (Kimball, 1989). It has been suggested that gender discrepancies may be attributed to differences in learning styles, socialization patterns, and assessment procedures (Schwartz & Hanson, 1992). Additional studies that examine math achievement in various skill areas will contribute to the information available on the skill dominance of each gender and the extent to which gender discrepancies exist

Lastly, the type of curriculum and textbooks utilized in the schools influence the mathematics achievement of students. The overemphasis of spiraling in many of the textbooks has been widely criticized (Jensen, 1990; McKnight, et al., 1987; Valverde & Schmidt, 1998). Subsequently, the influence of textbooks based on a spiral curriculum need to be evaluated to determine the effect they have on overall mathematics achievement, as well as, specific skill areas. It is equally important to determine if textbook format influences the achievement of various gender and SES groups differently.

Obviously, the interplay of many factors contributes to the mathematics achievement of students. Therefore, further research is necessary to fully understand the influence of each, as well as the combined effects. Based on the review of literature, it appears that SES and gender play an important role in mathematics achievement. There is also evidence suggesting that textbook format may also impact performance. The combined role of these variables warrant further investigation. Therefore, this study will investigate the relationship of all these factors by examining the differential effects of Saxon math textbooks, SES and gender on the mathematics achievement subtest scores (concepts, computation and problem solving) of third grade students.

CHAPTER 3

METHODOLOGY

The purpose of this study was to investigate the differential effects of length of exposure to Saxon math textbooks, SES and gender on the ITBS math subtest scores of third grade students. In order to achieve this goal, groups of subjects were selected based on their length of exposure to Saxon math textbooks. To more effectively determine where differences in math skills may exist, scores were examined in three subtest areas: math concepts, computation and problem solving. This chapter will provide pertinent details of the study regarding subject selection procedures, instruments used, data collection methods and statistical analysis of data.

Design

In 1994, a Midwestern, metropolitan school district incorporated Saxon math textbooks into the mathematics curriculum for a group of four pilot schools. This study determined if any significant differences existed in the math achievement subtest scores (concepts, computation and problem solving) of third grade students based on their length of exposure to Saxon math textbooks, SES and gender. Three groups of third grade subjects were conveniently selected from archival records in the school district's database. Selection was based on exposure to Saxon math textbooks, school attended, length of time student remained in the district and availability of ITBS math subtest scores for third grade. One group had no exposure to Saxon math textbooks and the other two groups had 1-4 years in length of exposure. Once selected, the subject's gender and

SES were also recorded. SES was based on whether or not the student received lunch assistance. Students who received any type of lunch assistance were categorized as "low SES" and students who received no lunch assistance were categorized as "not low SES".

To determine the effects among Saxon textbook exposure, SES and gender on math achievement subtest scores, a causal/comparative, 3x2x2 multivariate analysis of variance (MANOVA) was performed. This technique provided more detailed information by analyzing the data according to specific skill areas (i.e. computation, concepts and problem solving) instead of total math scores to more efficiently determine the influence of the independent variables on each subtest area. Interactions between textbook exposure, SES and gender were also considered with this technique to provide information on the combined effects these variables may have on the math achievement subtest scores.

Subject Selection

Subjects for this study were conveniently selected from a large database of students enrolled in public school from a Midwestern, metropolitan area. Three groups of third grade students from demographically similar schools were compiled using archival data from the participating school district's database. Selection was based on exposure to Saxon math textbooks, school attended, length of time student remained in the district, and availability of ITBS math subtest scores for third grade.

The first group consisted of all third grade students from schools other than the pilot schools from 1994-1997 who had remained within the district from first to third grade and had ITBS math subtest scores on record for third grade. This was done to

ensure that the students selected had consistently remained in schools within the district but had no Saxon math textbook exposure.

The second group consisted of all third grade students who attended any of the Saxon pilot school in 1994 and 1995, had remained within any of the pilot schools from first to third grade (to determine length and consistency of Saxon exposure) and had ITBS math subtest scores available for third grade. Subjects from this group had 1-2 years of exposure to Saxon math textbooks.

The third group selected consisted of all third grade students who attended any of the pilot schools in 1996 and 1997, had remained within any of the pilot schools from first to third grade (to determine length and consistency of Saxon exposure) and had ITBS math subtest scores on record for third grade. Subjects selected for this group had 3 years of Saxon textbook exposure or a possible fourth year if the students attended the same school for Kindergarten. By selecting male and female students from low and not low SES from various years, the longitudinal effects of math achievement, which may have resulted from cumulative exposure to Saxon mathematics textbooks could be examined.

One school within the district incorporated Saxon math textbooks after 1992 but before the other schools in 1998. Students from this school were omitted from the selection process to eliminate any possibility of confounding data.

Instrument

The mathematics portion of the Iowa Tests of Basic Skills (ITBS), Form L, Level 8 was used in this study to assess mathematics achievement. Scores from the ITBS tests were chosen because it is the standard achievement test administered by the cooperating

school district to measure basic achievement and progress of students. The ITBS is administered by this district, at the elementary school level, to second through fifth grade students in the spring and fall of each school year.

The ITBS is a standardized, norm-referenced achievement test distributed by Riverside Publishing Company. The purpose of the ITBS is to provide a comprehensive assessment of student progress in basic skills (Technical Summary I, p. 10). According to the Technical Summary I, basic skills are defined as "the entire range of skills a student needs to progress satisfactorily through school" (p.15). A Core Battery, Complete Battery and Survey Battery are available for all ten levels of the test. The Core Battery consists of tests for Listening (levels 5-8 only), Word Analysis (levels 5-8 only), Vocabulary, Reading/Reading Comprehension, Language, and Mathematics. The Complete Battery includes all of the Core Battery tests along with a Social Studies and Science test. Optional Listening and Writing assessments are also available for levels 9-14. The Survey Battery is a streamlined assessment of the Reading, Language and Mathematics tests designed to provide an overview of basic skills using a minimal testing time (Brookhart, 1998).

For the purpose of this study, only results from the mathematics tests were utilized. The mathematics section at the third grade level consisted of three subtests: Concepts, Problem Solving and Computation. The Computation test is considered an optional assessment by ITBS guidelines but was consistently administered by the cooperating district and included in the data analyzed in this study.

The ITBS has been in existence since 1935 (then referred to as the Iowa Every Pupil Test of Basic Skills) and has undergone a series of updates and revisions. Forms K

and L were normed in 1992 and all new score scales were formed. Scaling tests were used to produce a single common score scale across all levels of both forms. This common scale score is referred to as the Developmental Standard Score (DSS) scale (Technical Summary I, p.68). Raw scores can be converted to DSS scores, which in turn can be converted to Grade Equivalents (GE) or national percentile ranks. The norming sample used to develop this new scale consisted of 136,934 students in which 13,468 were Catholic school students and 5,642 were private, non-Catholic school students. There are separate norms available for large city schools, Catholic/private schools, low SES schools and international schools.

Content validity of the ITBS is primarily based on the item development process. Development of the ITBS content was based on the review of professional literature, an analysis of state and local curriculum guidelines, a comprehensive review of instructional materials and consultation with teachers and curriculum specialists. All items were specifically developed for the ITBS test batteries and are never replicated in any other tests. Item development involved a three-step process, which consisted of developing content specifications and writing test items, editorial review, and field testing. Selection, placement and emphasis of items were dependent on predetermined criteria as outlined in the Technical Summary I (p. 12). These criteria include: review of current instructional materials, recommendations of specialists, word frequency studies, error frequency studies, skill importance based on usage, assessment research studies, cultural fairness of materials, user input and subject-matter standards. Selected items were field tested and final selection was based on professional judgment in conjunction with statistical evidence. Research studies were also conducted to determine the content validity of the

items, interrelationships and uniqueness of tests, and appropriateness of content and administration procedures for special populations (Technical Summary I, p.14).

The content of the ITBS is consistent with the curriculum guidelines and approved textbook selections for the state involved in this study. Content validity was verified by communications with the corresponding State Department of Education (personal communication, June 19, 2000).

Construct validity has been established through the study of the "basic skills" construct. Subtest intercorrelations and correlations with other basic skills assessments, such as the Cognitive Abilities Test (CogAT), correlations with future grade and test predictions, bias studies and studies of parent and teacher interpretation and understanding were investigated. All information provided positive results and support for the validity of the ITBS, if used in the manner intended by the authors (Brookhart, 1998).

ITBS has a long history and test reliability is more than adequate. Reliability coefficients (KR20) were calculated based on scores from the weighted spring and fall samples. Internal consistency reliabilities from the majority of subtests tend to be between .85 and .92 (Cross, 1998). Specifically, for the Level 8 mathematics subtests, the reliability coefficients are .81 for Concepts, .87 for Problem Solving, and .83 for Computation (Technical Summary I, p.78). In addition, equivalent forms reliabilities are also provided. These estimates range between .68 and .93 for the Complete Battery and are somewhat lower for the Survey Battery (Cross, 1998).

Procedures/Data Collection

Permission was granted by the participating school district to access archival data necessary for the completion of this study. The data collection methods used in the

context of this study included the retrieval of archival information from district databases regarding student ITBS (Iowa Tests of Basic Skills) math scores, grade level, gender, SES and school attended (see Appendix A). SES was determined on the basis of lunch assistance. Students receiving any type of lunch assistance were categorized as "low SES" and students receiving no assistance were categorized as "not low SES".

Analysis of Data

Data were analyzed using a 3x2x2 multivariate analysis-of-variance (MANOVA). This technique takes into consideration the intercorrelations among the dependent variables and provided a more complete picture of the relationships among the variables and how they influenced the math achievement subtest scores of the subjects.

The three dependent variables in this analysis were the ITBS subtest scores, which included a score for each subject in math concepts, computation, and problem solving. Independent variables evaluated were length of exposure to Saxon math textbooks, SES and gender.

Hypothesis

Based on the review of literature, the following multivariate null hypothesis was posed:

Multivariate Hypothesis:

There are no significant differences across math achievement student profiles due to changes in the length of exposure to Saxon math textbooks, SES and gender.

CHAPTER 4

RESULTS

The purpose of this study was to investigate the differential effects of length of exposure to Saxon math textbooks, SES and gender on the math concepts, computation and problems solving ITBS subtest scores of third grade students. Archival data from a Midwestern, metropolitan public school district were utilized to conveniently select third grade subjects on the basis of length of exposure to Saxon math textbooks, school attended, length of time student had remained in the district and availability of ITBS math subtest scores for third grade. The selection process yielded 424 subjects meeting the aforementioned criteria. Descriptive statistics are presented in Table 1.

Table 1

Descriptive Statistics of Data

Gender	Male				Female			
SES	Low		Not Low		Low		Not Low	
	n	%	n	%	n	%	n	%
Saxon Exp.								
Never	59	63	34	37	64	54	55	46
1-2 years	15	43	20	57	24	44	30	56
3-4 years	41	67	20	33	49	79	13	21

Total N = 424

The largest group consisted of students who had never been exposed to Saxon math textbooks. Of the 212 students in this group, 44% were males, with 63% of the males from a low SES environment and 37% from a not low SES environment. The females made up 56% of the never group, with 54% of the females from low and 46%

from not low SES backgrounds. The females in this group had a relatively even number of low and not low students, however, the males had a much larger percentage of low SES students. The total percentage of male and female students combined from low and not low SES environments that had never been exposed to Saxon math textbooks were 58 and 42, respectively.

Students who had been exposed to Saxon math textbooks for one to two years resulted in the smallest group of students (n=89), with 39% of the group consisting of males and 61% females. Forty-three percent of the males and 44% of the females were from low SES environments and 57% of the males and 56% of the females came from a not low SES environment. Although only slightly higher, this is the only group that contained a larger number of students from a not low SES than a low SES environment.

The students with three to four years length of exposure to Saxon math textbooks consisted of an even dispersion of 50% males and 50% females. Out of the males, 67% were from low SES and 33% were from not low SES environments. Furthermore, the females consisted of 79% low SES and 21% not low SES students. This group contained the largest percentage of low SES students for both males and females than the other two groups, as well as, the largest combined total of low SES with, 73% of the students categorized as low SES.

MANOVA

A 3x2x2 MANOVA was conducted on the data with the dependent variables consisting of ITBS subtest scores for concepts, computation and problem solving. The independent variables were length of exposure to Saxon math textbooks (never, 1-2 years, 3-4 years), SES (low and not low) and gender. Results, shown in Table 2, indicated

no statistical significance for any of the comparisons. This indicates that length of exposure to Saxon math textbooks, SES and gender had no statistically significant impact on the set of dependent variables evaluated in this analysis (concepts, computation and problem solving scores). The means and standard deviations for the data can be seen in Table 3.

Table 2

Summary Table of Multivariate Tests

Effect	Wilks' Λ	F	Hypothesis df	Error df	Sig.
SES	.995	.634	3	410	.594
Gender	.993	.966	3	410	.409
SaxonExp	.990	.657	6	820	.684
SES*Gender	.981	2.601	3	410	.052
SES*SaxonExp	.986	.963	6	820	.449
SES*SaxonExp	.994	.423	6	820	.864
SES*Gender* SaxonExp	.985	1.055	6	820	.388

Table 3

Means and Standard Deviations of Dependent Variables by Saxon Exposure, SES and Gender

	Saxon Exposure			SES		Gender	
	Never	1-2	3-4	Low	Not Low	Male	Female
Computation							
Mean	59.72	59.01	62.15	61.36	58.68	59.63	60.79
SD	20.10	20.54	20.07	19.90	20.52	20.96	19.54
Concepts							
Mean	57.13	59.51	60.14	58.91	57.91	59.39	57.79
SD	19.48	20.41	19.39	18.49	21.29	20.98	18.54
Problem Solving							
Mean	52.77	53.29	53.87	53.51	52.75	54.15	52.44
SD	20.01	20.66	19.77	19.96	20.20	19.96	20.10

Mean = 50 SD = 21.06

Due to the lack of significant findings in the multivariate analysis and the limited amount of literature available on the effects of length of exposure to Saxon math textbooks, SES and gender on mathematics scores, further exploratory analysis was deemed appropriate. Subsequent analyses investigated the effects of length of exposure to Saxon math textbooks, SES and gender on the ITBS concepts, computation and problem solving subtest scores at a univariate level. Three ANOVA's were conducted, one for each dependent variable. Results of each univariate analysis are summarized below.

ANOVA #1: Math Concepts

The first ANOVA analyzed the effects of length of exposure to Saxon math textbooks, SES and gender on the ITBS math concept scores of third grade subjects. The independent variables consisted of length of exposure to Saxon math textbooks, SES and gender. The dependent variable was the third grade ITBS math concept scores. The hypothesis for the first ANOVA is as follows:

Hypothesis #1: Length of exposure to Saxon math textbooks, SES and gender will have no effect on the ITBS math concept scores of third grade subjects.

As can be seen in Table 4, results of the analysis revealed no statistically significant 3-way interaction between length of exposure to Saxon math textbooks, SES and gender [F(2,412)=.957, p=.385]. There were also no significant 2-way interactions between length of exposure to Saxon and gender [F(2,412)=.519, p=.596], length of exposure to Saxon and SES [F(2,412)=.530, p=..589], or SES and gender [F(1,412)=.076, p=.782]. In addition, no significant main effects were found for length of exposure to Saxon math textbooks [F(2,412)=1.023, p=.361], SES [F(1,412)=.641, p=.424] or gender [F(1,412)=1.713, p=.191]. Therefore, the null hypothesis fails to be rejected. There are no statistically significant differences in the ITBS math concept scores of third grade students due to changes in length of exposure to Saxon math textbooks, SES and gender.

Table 4

ANOVA #1 Summary Table: Concepts

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Sig.
SES	249.777	1	249.777	.641	.424
Gender	667.445	1	667.445	1.713	.191
SaxonExp	796.754	2	398.377	1.023	.361
SES*Gender	29.769	1	29.769	.076	.782
SES*SaxonExp	412.623	2	206.312	.530	.589
Gender*SaxonExp	403.983	2	201.992	.519	.596
SES*Gender* SaxonExp	745.946	2	372.973	.957	.385
Error	160492.422	412	389.545		
Total	1614557.00	424			

ANOVA #2: Math Computation

The second ANOVA analyzed the effects of length of exposure to Saxon math textbooks, SES and gender on the ITBS math computation scores of third grade students. The independent variables in the analysis were length of exposure to Saxon math textbooks, SES and gender. The dependent variable was the ITBS math computation scores. The following hypothesis was posed for this analysis:

Hypothesis #2: Length of exposure to Saxon math textbooks, SES and gender will have no effect on the ITBS math computation scores of third grade subjects.

Results, shown in Table 5, revealed a statistically significant interaction by SES and gender $F(1,412)=5.568$, $p=.019$]. This significant interaction effect suggests that SES

and gender combine to influence computation scores. The means and standard deviation scores of computation by gender and SES are presented in Table 6 and a graphical representation can be seen in Appendix B. As shown in Table 6, the computation scores of males were relatively consistent regardless of SES, whereas, female students from a low SES scored much higher than those from a not low SES. Interestingly, these results are inconsistent with previous studies on the effects of SES and gender on math achievement. Results however, did not reveal a main effect on computation by gender [F(1,412)=.003, ns] or by SES [F(1,412)=1.830, ns]. Due to the statistically significant interaction of SES and gender on the math computation scores, the null hypothesis for this analysis was rejected.

Table 5

ANOVA #2 Summary Table: Computation

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Sig.
SES	739.426	1	739.426	1.830	.177
Gender	1.015	1	1.015	.003	.960
SaxonExp	209.560	2	104.780	.259	.772
SES*Gender	2250.494	1	2250.494	5.568	.019*
SES*SaxonExp	1388.933	2	694.467	1.718	.181
Gender*SaxonExp	1.200	2	.600	.001	.999
SES*Gender* SaxonExp	29.416	2	14.708	.036	.964
Error	166510.799	412	404.152		
Total	1712476.00	424			

Table 6

Means and Standard Deviations of Computation Scores by Gender and SES

	Gender			
	Male		Female	
	Mean	Std. Deviation	Mean	Std. Deviation
SES				
Low	58.34	20.51	63.90	19.08
Not Low	61.64	21.64	56.45	19.46

Mean = 50 SD = 21.06

ANOVA #3: Math Problem Solving

The third and last ANOVA investigated the effects of length of exposure to Saxon math textbooks, SES and gender on ITBS math problem solving scores of third grade students. The independent variables in the analysis were length of exposure to Saxon math textbooks, SES and gender. The dependent variable was the ITBS math problem solving scores. The following hypothesis was posed for this analysis:

Hypothesis #3: Length of exposure to Saxon math textbooks, SES and gender will have no effect on the ITBS math problem solving scores of third grade subjects.

Results, presented in Table 7, revealed no statistically significant 3-way interaction between length of exposure to Saxon math textbooks, SES and gender [F(2,412)=.668, p=.513]. There were also no significant 2-way interactions between length of exposure to Saxon and gender [F(2,412)=.041, p=.960], length of exposure to Saxon and SES [F(2,412)=1.855, p=.158], or SES and gender [F(1,412)=.157, p=.692].

In addition, there were no significant main effects found for length of exposure to Saxon math textbooks [F(2,412)=.127, p=.880], SES [F(1,412)=.396, p=.529] or gender [F(1,412)=1.02, p=.313]. This indicates that the length of exposure to Saxon math textbooks, SES and gender had no influence on the ITBS math problem solving scores for the third grade population utilized in this study. Therefore, the null hypothesis for this analysis fails to be rejected.

Table 7

ANOVA #3 Summary Table: Problem Solving

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Sig.
SES	160.875	1	160.875	.396	.529
Gender	414.035	1	414.035	1.020	.313
SaxonExp	103.429	2	51.714	.127	.880
SES*Gender	63.805	1	63.805	.157	.692
SES*SaxonExp	1505.909	2	752.954	1.855	.158
Gender*SaxonExp	33.067	2	16.534	.041	.960
SES*Gender* SaxonExp	542.492	2	271.246	.668	.513
Error	167198.175	412	405.821		
Total	1369859.00	424			

Summary

Third grade ITBS math subtest scores for concepts, computation and problem solving were evaluated to determine if there were any differential effects of length of

exposure to Saxon math textbooks, SES and gender on the subtest scores. The initial multivariate analysis yielded no statistically significant results. This indicates, that when considered simultaneously, length of exposure to Saxon math textbooks, SES and gender have no significant impact on the concepts, computation and problem solving scores of the third grade subjects utilized in this study.

Further exploratory analysis was conducted to investigate the effects of each dependent variable individually. A univariate analysis was conducted for each dependent variable. Results revealed no significant differences in subtest scores for concepts and problem solving. However, a statistically significant interaction by SES and gender was found on computation scores. The significant interaction effect suggests that SES and gender combine to influence the ITBS math computation scores for the third grade subjects in this study. Conclusions based on these results along with recommendations for future research are provided in the following chapter.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This study investigated the differential effects of length of exposure to Saxon mathematics textbooks, SES and gender on the ITBS math concepts, computation and problem solving subtest scores of third grade students.

According to international studies, such as NAEP and TIMSS, the United States is not among the top performing nations in mathematics achievement. These results have provoked a great deal of interest in comparisons of the educational systems and environments in other top performing nations to determine why such achievement discrepancies exist. It has been suggested that differences may be the result of various factors such as, race, SES, gender, home environment and social and cultural differences (Bracey, 1996). Differences in the introduction, emphasis and sequencing of topics within the curriculum have also been noted (Lapointe, Mead & Phillips, 1989). Opinions are varied and remain the focus of many debates. However, there is consensus that the educational structure and curriculum in the U.S. varies greatly from those in many other countries. Most U.S. textbooks attempt a comprehensive approach with many topics covered at each level instead of focusing on the mastery of fewer topics (Schmidt, McKnight & Raizen, 1997). In addition, more time is spent on repetitive teaching and review of previously learned concepts and skills (Schmidt, et al., 1996; Valverde & Schmidt, 1998). This textbook format is the result of attempts to implement a spiral curriculum as conceptualized and endorsed by Jerome Bruner (1960). The intent of the spiral curriculum is to provide a basic foundation of knowledge and incrementally build on that knowledge while progressively increasing the complexity of concepts at each

level (Efland, 1995; Harden & Stamper, 1999). Subsequently, many textbooks include an excess amount of repetition and review. Many researchers believe this spiral format hinders the progress of students by spending too much time on previously learned concepts (Jensen, 1990; McKnight, et al., 1987; Valverde & Schmidt, 1998). Since textbook format plays a vital role in the academic achievement of students (Valverde & Schmidt, 1998), it is imperative to investigate differing textbook formats and their effects on academic achievement to determine which provides the most benefit for the enhancement of achievement. Few studies have focused on the effects of textbook format on the mathematics achievement of students and therefore, further research is warranted.

One textbook series that advocates success through the use of a spiral and prescriptive format is the Saxon mathematics textbooks. Saxon mathematics textbooks are premised on the concept of a spiral curriculum. Repetition and review of previously learned skills are embedded in an incremental and prescriptive instructional format (Saxon Publishers, 1999). Saxon purports that this format increases the academic achievement of students. Few studies have been conducted to determine the effects of Saxon textbooks on math achievement. Furthermore, the studies that do exist have all been conducted with different age levels over short periods of time and only one compared the differences in various skills areas as opposed to the less desirable overall achievement score (Calvery, Bell & Wheeler, 1993; McBee, 1984; Roberson, 1997). Subsequently, these studies have yielded inconsistent results. Further research is needed to determine the effects of exposure to Saxon mathematics textbooks over time and in regard to specific skill areas. However, investigations on the effects of textbook format

cannot be successfully conducted without consideration given to other predetermined variables that may have an impact on the mathematics achievement of students.

Mathematics achievement has been researched extensively over the last several decades. Two variables that seem to emerge consistently in relation to math achievement are gender and SES. Studies on the influence of SES on the academic achievement of students were conducted as early as the mid-1960's (Coleman et al., 1966). Results of these studies and many others that followed indicate a positive correlation between the academic achievement of students and their SES (Alspaugh, 1996; Fetters & Peng, 1975; McCartin & Meyer, 1986; Sampson-Malone, 1985; Walsh, 1986).

A substantial number of studies have also been conducted on gender differences and mathematics achievement. Early studies consistently indicate lower performance levels for females than males on most math achievement measures. However, more recent research has revealed gender discrepancies to be much less pronounced (Benbow & Stanley, 1980; Feingold, 1988; Fennema, 1980; Fox & Cohn, 1980). It has been suggested that this narrowing achievement gap could be due to factors other than innate ability, such as socialization patterns, instructional settings, curriculum format and learning style differences (Schwartz & Hanson, 1992). Further research is needed to determine if textbook format plays a significant role in different areas of mathematics achievement of male and female students from differing socioeconomic levels.

This study was designed to determine if the spiral and prescriptive nature of the Saxon mathematics textbooks have an effect on mathematics achievement scores over time. It also focused on how this extended exposure affected the achievement scores of students in relation to their gender and SES in three different skill areas. Results will

contribute to the limited literature base available on this topic and provide valuable information on the combined effects of these variables.

Archival data was retrieved from a Midwestern, metropolitan public school district that initiated a pilot program using Saxon mathematics textbooks. Third grade subjects were conveniently selected on the basis of length of exposure to Saxon math textbooks, school attended, length of time student had remained in the district and availability of ITBS math subtest scores. Four hundred twenty-four students met the criteria and were categorized into one of three groups. The first group consisted of students who had never been exposed to Saxon math textbooks, the second group consisted of students who had 1-2 years of exposure to Saxon math textbooks and the third group had students with 3-4 years of exposure to Saxon textbooks. The gender and SES (low or not low) of each subject was also recorded.

A 3x2x2 multivariate analysis of variance was conducted to analyze the data. The independent variables were length of exposure to Saxon mathematics textbooks, gender and SES. The three dependent variables were scores from the math Concepts, Computation and Problem Solving subtests of the ITBS.

For exploratory purposes, a univariate analysis was conducted for each dependent variable. The independent variables for all three ANOVA's were length of exposure to Saxon math textbooks, SES and gender. The dependent variable for the first ANOVA was the ITBS math concept scores. The dependent variable for the second ANOVA was the ITBS math computation scores and the dependent variable for the third ANOVA was the ITBS math problem solving scores.

Summary of Findings

Results of the initial MANOVA yielded no statistically significant effects for any of the comparisons (see Table 2). This indicates that, when considered simultaneously, length of exposure to Saxon math textbooks, SES and gender had no impact on the ITBS math concepts, computation or problem solving scores of the third grade subjects in this study.

The first ANOVA performed indicated no statistically significant interactions or main effects on math concept scores (see Table 4). Therefore, length of exposure to Saxon math textbooks, SES and gender had no effect on the ITBS math concept scores of the subjects in this study.

Results of the second ANOVA, however, found a statistically significant interaction by SES and gender on computation scores (see Table 5). This significant interaction suggests that SES and gender combine to influence math computation scores. Further discussion of these results will be addressed in the following section.

The third ANOVA conducted yielded no significant interactions or main effects on problem solving scores (see Table 7). Therefore, ITBS math problem solving scores are not influenced by the length of exposure to Saxon math textbooks, SES or gender of the subjects.

Conclusions

The multivariate null hypothesis for this study posed that there are no significant differences across math achievement student profiles due to changes in the length of exposure to Saxon math textbooks, SES and gender. Analysis of data indicated no

statistical significance for any of the comparisons. Therefore, the multivariate null hypothesis for this study fails to be rejected.

There are a number of possible reasons for these insignificant findings. For example, it is possible that these results are due to the limited number of subjects available for this study, as well as, the type of community from which the subjects were selected. A larger sample encompassing a wider range of geographical areas, types of communities and student populations may yield different results.

It is also conceivable that teacher effectiveness and attitudes toward students, textbooks and other school dynamics could have influenced the progress of students. Due to the use of archival data, it was not possible to investigate these variables.

In addition, research has shown that the achievement gap between the genders is decreasing (Feingold, 1988; Fennema, 1980; Fox & Cohn, 1980). The results from this multivariate analysis lend support to these previous findings.

Out of the three ANOVA's conducted, only one found statistically significant results. The second ANOVA found a significant interaction by gender and SES on math computation scores. As can be seen in Table 6, male computation scores remained relatively consistent regardless of SES, whereas female students from a low SES scored much higher than females from a not low SES.

These findings are rather interesting considering the abundance of literature supporting a positive correlation between academic achievement and SES (Brooks, 1988; Coleman et al., 1966; Walsh, 1986; Walsh & Witte, 1985). Based on previous studies, one would have expected the low SES students to perform lower regardless of gender. These results could be due to the sample population utilized in this study. The majority of

the sample population selected consisted of low SES students (see Table 1). Also, previous research by Caldas and Bankston III (1997) found that the SES of classmates had an effect on the academic achievement of students. Students who attended school with classmates from a higher SES than their own showed higher achievement and those who attended school with lower SES classmates showed lower achievement. Perhaps the large number of low SES students in this sample influenced the achievement of the higher SES students.

Research has also shown that females typically perform better than males on computation tasks (Armstrong, 1981; Fennema & Carpenter, 1981; Fennema & Tartre, 1985; Marshall, 1984). In this study, however, the highest mean scores for males and females were on computation with both overall computation means (low and not low students combined) at approximately sixty. It is possible that these findings were simply a result of characteristics unique to the sample population used in this study. It is also possible that the particular school district utilized in this study focused heavily on computation skills and emphasized the development of those skills to their teachers. These findings, along with the non-significance of gender effects in the other analyses in this study lend additional support to previous studies indicating a decrease in the achievement gap between males and females.

The length of exposure to Saxon mathematics textbooks had no impact on the math achievement subtest scores in any of the analyses conducted. These results are consistent with those found with second and third grade students in a study by Calvery, Bell and Wheeler (1993), which also showed no differences in math achievement scores of students using Saxon textbooks. This implies that the repetitive nature and prescriptive

format of the Saxon textbooks yields no apparent benefit to the students and, therefore, should not be a main point of consideration during textbook selection.

Although no statistical significance was found, it is interesting to note the mean scores for the three levels of Saxon exposure (see Table 3). Across all three subtests, there is a consistent increase in the mean scores as the length of exposure to Saxon textbooks increases. A graphical representation of the subtest mean scores by length of exposure to Saxon can be seen in Appendix C.

These results are again consistent with those of Calvery, Bell and Wheeler (1993), who also found a non-significant increase in mean scores for students using Saxon textbooks. This may indicate that continual exposure to Saxon mathematics textbooks may have a small, cumulative effect. Additional longitudinal studies are needed to investigate the possible long-term effects of Saxon textbooks on math achievement scores.

The data available for this study offered the unique opportunity to investigate the possible effects of length of exposure to Saxon mathematics textbooks, gender and SES on mathematics achievement scores. However, several factors could have influenced the results of this study that warrant discussion. The data utilized in this research was retrieved from archival databanks. Therefore, randomization and manipulation of variables was not possible. Groups were determined by the information available in the databanks for each subject and all students who met the predetermined criteria were selected for the study. Consequently, certain aspects of the study were beyond the researcher's control. The following section provides recommendations for future research to improve the design of follow-up studies and build upon the results found in this study.

Recommendations

Results of this study indicate that length of exposure to Saxon math textbooks, SES and gender had no effect on the math achievement scores for concepts, computation or problems solving for the population examined. However, SES and gender did have an effect on the computation scores. Subsequently, it is advisable that gender equity within the instructional setting and environment of the students be more heavily considered when making a textbook selection and determining the most effective way to increase math computation scores.

Based on the results of this study and relevant literature, the following recommendations for further research are suggested:

1. Due to the use of archival data, the subject selection process for this study was reliant on the availability and completeness of subject information recorded in the cooperating school district's databases. Only subjects with recorded information on the length of exposure to Saxon textbooks, school attended, length of time in the district and third grade ITBS math subtest scores could be utilized. This downsized the subject pool to an extent that all subjects fitting the criteria were included in the study. It is recommended that future studies collect or ensure access to a larger number of potential subjects. With a larger number of subjects available, a randomized selection process could be employed which would improve the generalizability of the results.
2. Another recommendation for follow-up research is to design a study that allows the use of a control group. This will allow the researcher to manipulate the variables, which may provide a clearer picture of group differences or effects.

3. Given the preliminary suggestion of possible cumulative effects of Saxon textbook usage, a longer-term longitudinal study is recommended. This will allow researchers to determine if the small, cumulative effects manifest significant benefits later on. It would be even better if data from the same students could be collected throughout their elementary, middle and high school experience.
4. The use of Saxon textbooks as a possibility for underachieving or special education students was presented. One avenue for future studies could be to focus on this question and investigate the effects of Saxon math textbooks on underachieving students, at-risk students and other special needs populations. The spiral nature of the Saxon textbooks, along with the added repetition and review may provide the structure and reinforcement needed by some students.
5. The use of archival information prevented investigation of additional variables that have been deemed in the literature to impact the academic achievement of students. For example, many studies have found teacher interaction to play a significant role in achievement (Brophy, 1986; Eccles & Blumenfeld, 1985; Leder, 1987). In addition, Robinson and Forsythe (1984), found that the number of parents in the home, level of parental education, type of community and state poverty rates accounted for a large portion of the variance in NAEP scores. Studies to further investigate these variables as they relate to Saxon and various math skill areas are recommended.
6. The last recommendation is based on the observations of international comparisons noting the differences in the format, scope and sequence of textbooks used in the United States and those of other top performing nations

(Schmidt, McKnight & Raizen, 1997). It is suggested that textbooks of varying formats, scopes and sequences be examined to determine which ones are the most beneficial for the majority of students and which ones are more appropriate for use with special populations.

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APPENDIX A

DATA RECORD REVIEW LIST

Data Record Review List

The variables to be extracted from existing databanks for the purpose of this study are listed below. To ensure anonymity of the subjects, no identifying characteristics or names will be used.

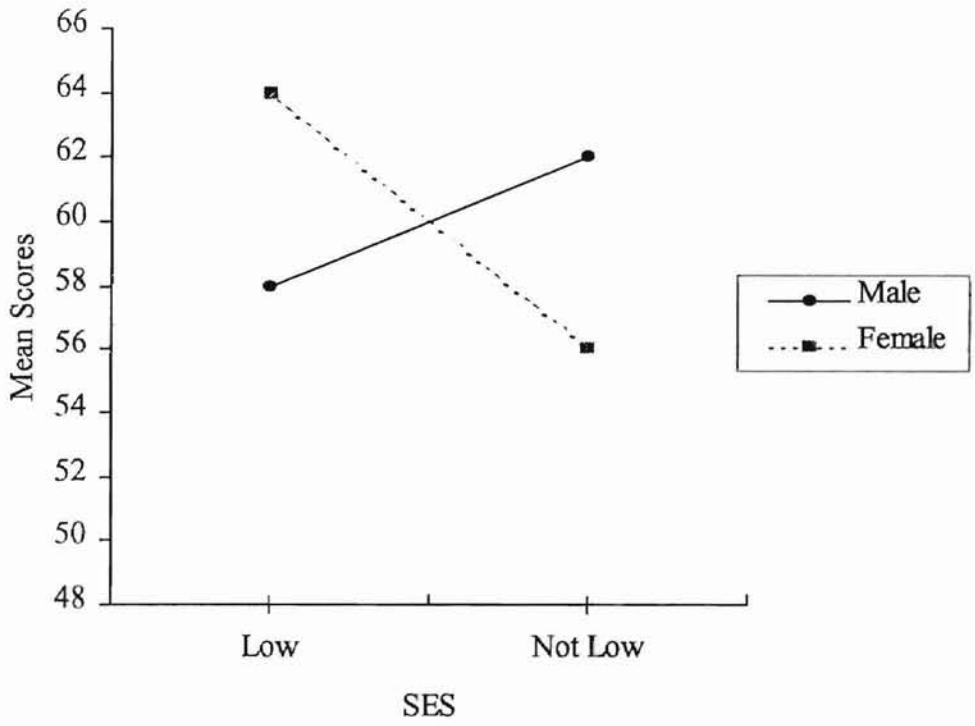
Variables

1. Gender: male or female
2. SES: "low" or "not low" (determined by lunch assistance)
3. School attended: (to differentiate between subjects who attended pilot or non-pilot schools)
4. ITBS subtest scores for third grade: concepts, computation and problem solving
5. Grade level of subjects: only third grade students

APPENDIX B

GRAPH OF MEANS AND STANDARD DEVIATIONS OF COMPUTATION SCORES BY GENDER AND SES

Means and SD of Computation
Scores by Gender and SES

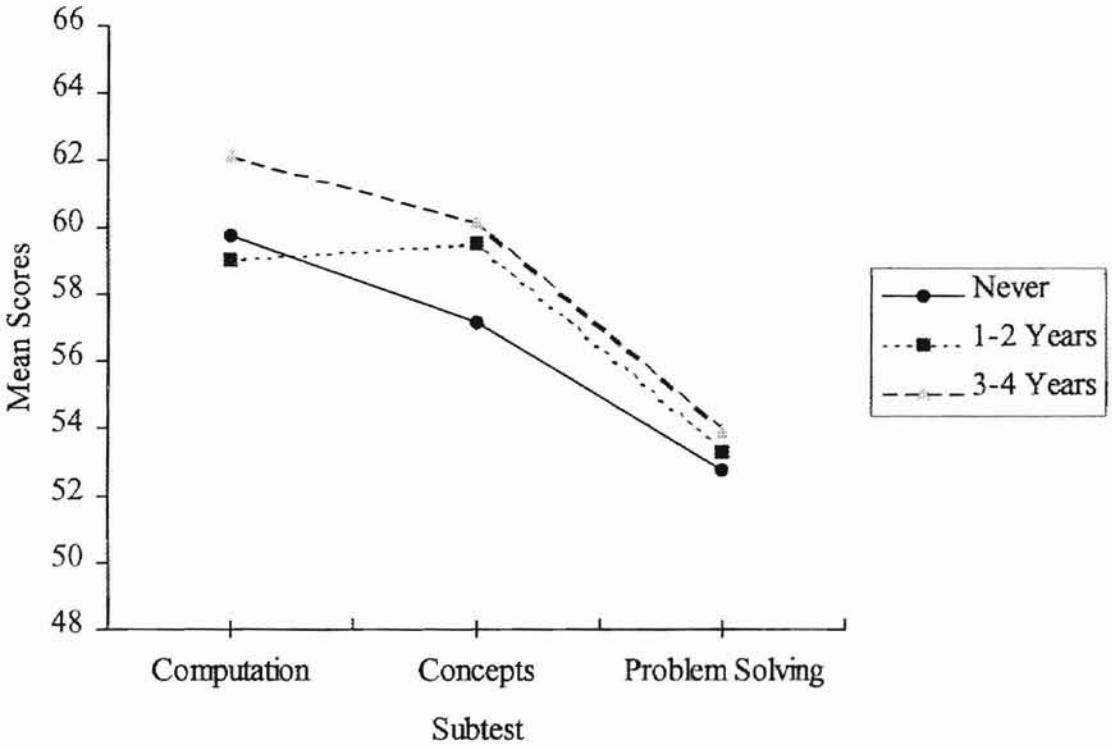


APPENDIX C

GRAPH OF SUBTEST MEAN

SCORES BY SAXON EXPOSURE

Subtest Mean Scores by Saxon Exposure



APPENDIX D

IRB APPROVAL FORM

Oklahoma State University
Institutional Review Board

Protocol Expires: 8/15/01

Date Wednesday, August 16, 2000 IRB Application No ED0115

Proposal Title AN INVESTIGATION OF THE EFFECTS OF LENGTH OF EXPOSURE TO SAXON MATH TEXTBOOKS, SOCIOECONOMIC STATUS AND GENDER ON MATH ACHIEVEMENT SCORES

Principal Investigator(s)

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Edmond, OK 73003

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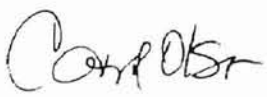
424 Willard
Stillwater, OK 74078

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

Signature 

Carol Olson, Director of University Research Compliance

Wednesday, August 16, 2000
Date

Approvals are valid for one calendar year, after which time a request for continuation must be submitted. Any modifications to the research project approved by the IRB must be submitted for approval with the advisor's signature. The IRB office MUST be notified in writing when a project is complete. Approved projects are subject to monitoring by the IRB. Expedited and exempt projects may be reviewed by the full Institutional Review Board

VITA

Allison J. Fahsl

Candidate for the Degree of

Doctor of Philosophy

Thesis: AN INVESTIGATION OF THE EFFECTS OF EXPOSURE TO SAXON MATH TEXTBOOKS, SOCIOECONOMIC STATUS AND GENDER ON MATH ACHIEVEMENT SCORES

Major Field: Educational Psychology

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Professional Affiliations: Kappa Delta Pi, Learning Disabilities Association, American Evaluation Association, Oklahoma School Psychological Association.