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COMPARING MATH SELF-EFFICACY IN MIDDLE SCHOOL GIRLS

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**Thesis submitted to the
College of Human Resources and Education
at West Virginia University
in partial fulfillment of the requirements
for the degree of**

**Master of Arts
in
Educational Psychology**

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Department of Advanced Educational Studies

**Morgantown, West Virginia
2003**

**Keywords: mathematics self-efficacy, middle school girls, single-sex education,
science and technology careers.**

ABSTRACT

Comparing math self-efficacy in middle school girls.

Ana Gloria Rodriguez

There have been no previous studies in the self-efficacy or single-sex schools literature that have looked at the possible relationship between self-efficacy expectations and type of school. This study compared mathematics self-efficacy of sixth, seventh, and eighth grade girls in a single-sex and a co-educational school. Four measures, including a personal background questionnaire, were used to collect data. Results showed a correlation for type of school and importance of mathematics. Contrary to assumptions made by the researcher, girls in the co-educational school scored consistently higher on all measures used. The results of this research suggest that it will take more than single-sex schooling to improve girls' attitudes about math and their participation in technological careers.

Dedication

This work is dedicated to my family; in particular my mom and dad whose love, support, encouragement, and discipline have helped me become the success I am today.

Acknowledgements

I thank my family and friends who have encouraged and supported me throughout this process. In particular I want to acknowledge my beloved husband who has always loved and supported me. Very special thanks go to Dr. Ying-Ying Kuo whose help I could not have done without. I am also grateful to my committee, Dr. Andrew Katayama, Dr. Neal Shambaugh, Dr. Patricia Haught, and Dr. Anne Nardi for their help and encouragement. Dr. Paula Nisan-Nelson I owe a special thanks for her help with developing the math self-efficacy instrument and answering other math questions. Finally, I am grateful to Ann Crabtree for always lending an ear and giving encouragement. I could not have done this without all of you. My success rests on your shoulders. Thank you.

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Chapter 1

Introduction

There has been concern for some time that although women make up about fifty percent of the population and are making strides in many professional fields, there is still a discrepancy between the number of technology jobs available and the representation of women in those jobs that require strong math and science backgrounds (Singh & Valentine, 2001). Many studies have tried to answer why women do not enroll in higher-level math, science, and technology courses or choose careers in fields that require strong backgrounds in those disciplines (e.g., Campbell, 1991; Linn & Hyde, 1989; Lopez & Lent, 1992; Silverman & Pritchard, 1996; Singh & Valentine, 2001). What many of these studies have concluded is that attitudes about math, science and technology acquired in schooling are responsible for career choice. These attitudes are acquired as a result of several factors, including 1) the way in which teachers interact with girls compared with boys—particularly in math, science, or technology classes (American Association of University Women Educational Foundation, 1992; Rennie & Parker, 1987; Streitmatter, 1998), 2) sexist language and behavior (Silverman & Pritchard, 1996), 3) gender stereotypes (Colley, Comber, & Hargreaves, 1994), and 4) familial expectations (Silverman & Pritchard, 1996). When these findings were published, the public began to look at single-sex schools as a way to ameliorate girls' attitudes of math and science. Although there are long-established single-sex girls' schools, for example the Louise S. McGehee School in New Orleans, Louisiana, open since 1912, three particular single-sex girls' schools opened after the AAUW report with math, science, and technology as their main focus. One is the Julia Morgan School for Girls (est. 1999)

in Oakland, California, another is the Girls' Middle School (est. 1998) in Mountain View, California, and the other is the Atlanta Girls School (est. 2000) in Atlanta, Georgia. The goal of schools such as these is to allow girls to build confidence in their understanding of math and science. It is believed by some that allowing this confidence to build will open up for girls the same opportunities that exist for boys and lead more girls into careers in math, science, and technology (Hafner, 1999).

Social cognitive theory supports this belief. Social cognitive theorists would label "confidence" as "self-efficacy". Self-efficacy, in social cognitive theory, influences the choices people make, the effort they expend, and the perseverance they exhibit in the face of challenges (Pajares & Miller, 1994). Self-efficacy of mathematics performance is of particular interest because, as stated earlier, skills in mathematics are key requirements for success in the areas of technology and engineering (O'Brien, Martinez-Pons, & Kopala, 1999). Self-efficacy research suggests that because mathematic skills are required for such work, lowered mathematics self-efficacy is a likely contributor to the relatively low numbers of women in those fields (cited in O'Brien, et. al.). Many studies have found support for the central mediational role of mathematics self-efficacy in the development of math-related careers (e. g., Betz & Hackett, 1983; Hackett, 1985; Multon, Brown, & Lent, 1991). These studies have also found that self-efficacy expectations are consistently higher for males than females. Since self-efficacy beliefs are acquired and modified through four primary sources: vicarious learning, social persuasion, past performance accomplishments, and emotional arousal (physiological states and reactions) (Lent, Lopez, Brown, & Gore, Jr., 1996), is it possible that the single-sex environment of girls' schools foster high math self-efficacy?

Statement of the Problem

There have been no studies in the self-efficacy or single-sex schools literature that have looked at the possible relationship between self-efficacy expectations and type of school even though the self-efficacy literature recommends exploration of the situational conditions that affect math self-efficacy (Campbell & Hackett, 1986). It is important to study single-sex schools to see if single-sex environments foster math efficacy levels among female students and if these environments affect attitudes about math and subsequent career choice. The years in middle school are particularly significant for girls because during this time self-perceptions of ability emerge and girls in middle school are “thought to show less interest in math and report higher levels of anxiety (Catsambis, 1994, as cited in Pajares & Graham, 1999, p. 125)”. Consequently, this study investigated the relationships between type of middle school, single-sex and co-educational, and sources of mathematics self-efficacy, math self-efficacy, and how female students felt about the importance of mathematics. If girls in single-sex schools exhibit more positive attitudes about math because of the environment, then this should show in survey measures such as the Math Self-Efficacy Scale and the Importance of Mathematics Scale. Finally, since this research looked at identifying factors that might underlie self-efficacy development and maintenance, it may aid in the design of efficient career and educational interventions in regards to women in math and technology fields (Lent, Lopez, Brown, & Gore, 1996).

Research Questions and Objectives

- 1) Does a significant relationship exist between type of middle school, single-sex or co-educational, and sources of math self-efficacy (SMSE), math self-efficacy (MSE), and beliefs about the importance of mathematics (IOM)?
- 2) Are the sources of math self-efficacy different for girls in single-sex middle schools than for girls in co-educational schools?
- 3) Is there a difference in the math self-efficacy of girls in single-sex middle schools and those in co-educational schools?
- 4) Is there a difference in perception of the importance of mathematics between girls in single-sex schools and girls in co-educational schools?
- 5) Is there an interaction between type of school environment (single-sex or co-educational) and grade levels (sixth, seventh, and eighth) on student confidence scores on the MSE.

Hypotheses

H_{A1}: There is a relationship between type of middle school (single-sex or co-educational) and female students' scores on the Sources of Math Self Efficacy Scale (SMSE), Math Self-Efficacy Scale (MSE), and the Importance of Mathematics Scale (IOM).

H_{O1}: There is no statistically significant correlation between type of middle school (single-sex or co-educational) and female students' scores on the Sources of Math Self Efficacy Scale (SMSE), Math Self Efficacy Scale (MSE), and the Importance of Mathematics Scale (IOM).

H_{A2}: The scores on the SMSE will be different for girls from single-sex middle schools than for girls from co-educational schools.

H_{O2}: There is not a statistically significant difference in SMSE scores between girls in single-sex and co-educational middle school.

H_{A3}: Math self-efficacy scores will be higher for girls in single-sex school than for girls in co-educational schools.

H_{O3}: There is not a statistically significant difference in Math self-efficacy scores between girls in single-sex school and girls in co-educational school.

H_{A4}: There is a difference in perception of the importance of mathematics between girls in single-sex middle schools and girls in co-educational middle schools.

H_{O4}: There is not a statistically significant difference in perception of the importance of mathematics between girls in single-sex schools and girls in co-educational schools.

H_{A5}: There is an interaction between type of school (single-sex or co-educational) and grade levels (sixth, seventh, and eighth) on student confidence scores on the MSE.

H_{O5}: There is no statistically significant interaction between type of school (single-sex or co-educational) and grade levels (sixth, seventh, and eighth) on student confidence scores on the MSE.

The goals of this research were to 1) look at the possible relationship between type of school and sources of mathematics self-efficacy beliefs, 2) identify any differences in the beliefs about the importance of mathematics in middle school girls from both single-sex and co-educational schools, and 3) to investigate the sources of math self-efficacy of girls from single-sex and co-educational middle schools.

Variables

Independent variables. The independent variable is type of school—co-educational or single-sex middle school, which includes grades six through eight. Single-sex schools are those that have “single-sex learning environments” with the “absence of other-sex peers, especially within academic classes” (Jimenez & Lockheed, 1989, p. 24). Co-educational schools include both sexes in the learning environment.

The middle school grade levels of sixth, seventh, and eighth grade.

Dependent variables. Scores on the Sources of Math Self-Efficacy Scale (SMSE), the Importance of Mathematics Scale (IOM), and the Math Self-Efficacy Scale (MSE) are the dependent variables.

Control variables. Sex and age are the control variables.

Moderator variables. Instruction, parents’ occupation and education (SES) are moderator variables.

Intervening variables. The characteristics of the school, such as “resources available within the schools, differences in governance, and organizational characteristics, and differences in classroom ‘climate’ for girls” (Jimenez & Lockheed, 1989, p. 122), class size (number of students), school size, the number of teachers qualified to teach science, math, and technology subjects, proportion of female teachers, and curriculum are intervening variables. Other intervening variables include teacher classroom teaching practices such as teaching processes, teacher’s attention, time spent in maintaining discipline, and teacher’s attitudes such as comfort in teaching subject area. The personal characteristics of students such as ability levels, attitudes, and motivation will also affect the scores on the survey instruments along with students’ backgrounds

such as SES. For example, “students in single-sex schools may come from more advantaged backgrounds than those from coeducational schools, because a higher proportion of single-sex schools are in the private sector” (Jimenez & Lockheed, 1989, p.122). Related to SES are other intervening variables such as family educational resources such as calculators, computers, and encyclopedias.

These intervening variables are not being controlled for in the design. However, it is important to acknowledge that these variables might have an effect on survey instrument scores.

Operational Definitions

Single-sex middle schools are those that exclude the other gender in classes and enrollment. For this study, the middle school years are defined as the sixth, seventh, and eighth grades. Single-sex middle schools have “single-sex learning environments” with the “absence of other-sex peers, especially within academic classes” (Jimenez & Lockheed, 1989, p. 124); the “school organization is by gender” (Lee & Marks, 1990, p. 578). For this study the single-sex school in particular is the Louise S. McGehee School in New Orleans, LA.

Personal Background Questionnaire (Appendix A) is a self-report form that is used to gather demographic information such as students’ age, sex, ethnicity, grade level, career interests, role models, family members in science or technology related jobs, number of siblings, and birth order.

Importance of Mathematics Scale (IOM) (Appendix B) was developed by Shell, Murphy, and Bruning (1989), this is a ten-item Likert-type scale that asks students to rate on a scale from one to eight how important they think skill in mathematics is for

achieving things in life, such as making new friends, being a good citizen, getting a job, and learning new things. Higher total scores indicate strong perceptions in the usefulness and value of mathematics.

Sources of Mathematics Self-Efficacy Scale (SMSE) (Appendix C) is a modified scale of Lopez & Lent's (1992) forty-four-item instrument that was developed for high school students. The instrument used in this study has been modified for middle school students and hence includes only thirty-eight of the questions. The questions correspond to the four primary sources of efficacy described by Bandura (1986): vicarious learning, past performance, social persuasion, and emotional arousal. Using a Likert scale, students are asked to rate their level of agreement with each statement.

The Math Self-Efficacy Scale (SE) (Appendix D) was developed by a mathematics expert, Nisan-Nelson (2002), using the sixth, seventh, and eighth grade Mathematics Instructional Goals and Objectives for the state of West Virginia and validated for content by a math teacher in the Atlanta Girls' School, this twenty-item scale ask students to rate their confidence in being able to solve math problems that they have had previous experience with, such as decimals, square roots, algebraic equations, and fractions. An example of a typical math problem is, "Solve for X if $X+2=8$." Students are instructed to look at each item and rate their confidence in solving each problem. A ten-point Likert-type scale is used with zero being *no confidence at all* to nine being *complete confidence*. A high total score indicates strong math self-efficacy.

Chapter II

Teacher Interactions and Classroom Atmosphere

It has been theorized (e.g., American Association of University Women Educational Foundation, 1992; Campbell, 1991; Colley, Comber, & Hargreaves, 1994; Linn & Hyde, 1989; Rennie & Parker, 1987; Sadker & Sadker, 1994; Silverman & Pritchard, 1996) that one of the reasons women do not enroll in higher-level math and science courses and do not pursue careers in math, science, or technology is because of attitudes acquired in schooling. The American Association of University Women (AAUW) (1992) published a report on the experiences of girls in the classroom called, “How Schools Shortchange Girls”. One of the effects on girls’ achievement was the “subtle but powerful differences in the ways teachers interact with girls compared with boys” in the classroom sends “subtle messages concerning their lower expectations of girls in areas such as science and mathematics” (p. 173).

Silverman and Pritchard (1996) examined the impact of teaching methods, classroom organization and atmosphere, and teacher interaction on girls in technology education classes in middle schools. They conducted focus group interviews with high school boys and girls and asked why, or why not, they elected technology education in high school. The methodology included observation, a survey exploring the reasons students continue with technology education classes in high school, and finally, focus group interviews looking at the factors encouraging or discouraging all students from choosing technology education as an elective, and in particular to examine the differences between boys and girls that could account for the huge differences in participation. Silverman and Pritchard found that although girls in middle school enjoy technology

education and have confidence in their abilities, the “emerging sexism among peers begins to differentially affect participation on the basis of gender” (p. 5). For example, boys monopolized tools and sometimes made fun of girls trying to use equipment, and other sexist behavior (for example, using stereotypes about girls’ lack of technological skills to criticize), and teachers “sometimes let them get away with it” (p. 6). This example shows the importance of classroom interactions in influencing girls’ perceptions of technology as a male domain. Silverman and Pritchard also found that girls were “uninformed about economic realities and the world of work” (p. 6) which, combined with stereotypes about technology as a male domain, reinforced their lack of considering careers in math, science, and technology fields. From the interviews, Silverman and Pritchard found that girls’ encouragement by family and friends outside of school was particularly important for girls in pursuing their interest in technology education. They also found that girls taking technology education saw themselves as “pathbreakers” and rejected stereotypes, though the stereotypes are very powerful. Silverman and Pritchard also found that though many students of either sex received little advice about technology education from school counselors, this lack of information was particularly difficult for girls to overcome. Girls also reported that they were “discouraged from taking technology education” (p. 8). An important finding was that although most girls do not accept stereotypes about appropriate careers for women, other factors keep them out of technology classes: the small number of girls in the classes, lack of encouragement from family and friends, lack of confidence, and lack of knowledge about economic realities. The implications from this study are that a) teachers need to be aware of sexism in the classroom and monitor boys’ sexist behavior so that girls are not forced into stereotyped

roles, b) all students need to make a connection between what they do in classroom and what the economic realities are in their future careers, and c) schools need to “provide role models and positive programs to overcome stereotypes” (p. 9). The findings of this study play a vital role in improving girls’ enrollment in technology education and in challenging attitudes about careers for women in technological fields.

Rennie and Parker (1987) looked at gender differences in mixed-sex and single-sex groupings when the students were learning about electricity. The purpose of the study was to compare teachers of mixed-sex groupings with teachers of single-sex groupings. In particular, they investigated whether the interactions between teachers and student groupings were different in the experimental group of teachers who had been alerted to the possibilities of sexism in the physical sciences from those who had not. This was a field study in which two matched groups of ten teachers (five males and five females) and their classes were randomly assigned to either an experimental or control group. The experimental group received training in teaching electricity and in “awareness of reported differences in attitudes and achievements of boys and girls in science, the need for all children to develop some skills in, and positive attitudes towards, physical science, and techniques to help achieve this goal” (p. 66). The control group received training only in teaching electricity to control for science-teaching skills. After the in-service training, the teachers taught the electricity lessons and were observed for “organizational variables”, children’s participation in the science activities in small groups, and the nature of the teacher’s interactions with the children. Most importantly each child was observed and their activities recorded so that patterns of activity could be examined for children in same-sex and in mixed-sex groups.

What Rennie and Parker (1987) found was that boys spent the same amount of time on activities, especially “hands-on” activities whether in same-sex or mixed groups and whether they were in the control or experimental group. Girls’ time on activities differed in each combination of grouping. In short, girls spent less time manipulating equipment when they were in mixed-sex groupings regardless of whether they were in the control or experimental groups. The only situation in which girls spent the same amount of time manipulating equipment as the boys was in single-sex groupings in the experimental groups. Finally, what this study found was that “there is a danger that girls in mixed-sex groups may miss out on their share of the ‘hands-on’ experience” (p. 71). Most importantly, they found that teachers’ sensitivity to sexism in the classroom plays a vital role in girls’ opportunities to share in “hands-on” science activities and, in essence, the outcomes for girls’ future involvement with science. The results of this study play a vital role in the case for single-sex schooling for girls, whether in separate schools or in single-sex classes within a coeducational school.

Streitmatter (1998) studied high school female physics students in single-sex classes and compared them to female physics students in mixed-sex classes. The sample consisted of thirty-two girls who had enrolled in a girls-only physics class and fourteen girls who had registered for the mixed-sex class taught by the same teacher in one school. This was an ethnographic study that looked at women’s attitudes about participation in single-sex classes and identified variables and themes about this topic. The findings showed the difference in student-teacher interactions in single-sex and mixed sex classes, the difference in classroom atmosphere, and the types of interactions between students in either class. In the mixed-sex class the teacher interacted with the boys more and in

groups whereas the girls received individual attention after the boys' questions had been answered. In the single-sex class all the girls received equal teacher time though interactions with the girls were quite distinct from interactions with the boys. For example, "teacher's verbal interaction with the boys tended to be directly about their work, while he often gently joked and teased the girls in addition to asking them if they had any questions" (p. 5). The girls were also much quieter and approached the teacher in different ways than the boys. This example also addresses the atmosphere in the classroom—in a class not dominated by boys the girls optimized teacher time, group interactions, and question and answer sessions with the teacher. In the mixed-sex class there was more segregated interaction between the boys and girls. What these findings suggest is that the overall result for girls participating in single-sex classes is very beneficial to them in terms of feeling more comfortable in a physics class and receiving teacher attention. These findings play a vital role in supporting the need for single-sex classes to increase female success in technological fields.

Linn and Hyde (1989) used evidence from meta-analysis and process analysis from studies of gender differences to counter the argument that cognitive and psychosocial gender differences explain males' greater access to science and technical fields and greater earning power than females. What they found was that gender differences in overall cognitive abilities are negligible and that psychosocial gender differences interact with math and science performance "to influence both persistence and career success" (p. 24). However, the outcomes of psychosocial gender differences were situational, which means that other variables in the educational environment determined perceptions of mathematics and science disciplines as male domains. This

implies that the atmosphere in math and science classes, whether in single-sex or coeducational schools, plays a vital role in women's entry into the science and technology pipeline.

Roots of Gender Inequity

Campbell (1991) studied the "roots" of gender inequity in technical areas by looking at male and female Asian American and Caucasian students who won Westinghouse Awards in 1984 and 1985. The Self-Concept Attribute Attitude Scale (SaaS), an Attribution scale, and a Mathematics Attribution Scale were used to assess math and science self-concepts, along with general self-concept, and effort and ability attributions. The instrument was administered to 1,145 secondary students (667 gifted students and 478 nongifted students) who had received a Westinghouse Award for research study in science, math, or social science. A stepwise discriminant function analysis isolated 12 variables that separated the groups. After this analysis the variables that were extracted in each step were combined into multiple discriminant functions. What Campbell found was that the "groups of males had better math, science, and general self-concepts than the female groups" (p. 256). A combination of variables was used to label "confidence" and another combination of variables was used to label "technical orientation" in order to find the variables that might predict entry into technical careers. The most interesting finding was that Caucasian females' lack of "technical orientation" is what keeps them from pursuing technical college majors. So, if Caucasian females who have won a Westinghouse Award for technical research, which means that they've taken the advanced science and math courses, "have deficiencies that will divert them from technical careers, what about the larger numbers of bright

American females without such advantages?” (p. 260). These findings play a vital role in showing that psychological and sociological forces that produce self-concepts and attributions determine women’s and minority groups’ entry into technical areas.

Colley, Comber, and Hargreaves (1994) looked at the school subject preferences of students in single-sex and coeducational secondary schools. The purpose of the study was to examine what, if any, preferences for subjects exist in regard to single-sex and coeducational school environments. Investigators surveyed 321 male and 327 female pupils aged 11-12 years, and 245 male and 240 female pupils aged 15-16 years from three single-sex girls’ schools, four single-sex boys’ schools, and four coeducational schools. The respondents were asked to rank school subjects (e.g., English, math, science, history, woodshop) in order of preference. The method of analysis was Wilcoxon matched pairs signed-ranks tests as each school subject was compared to twelve others. Colley, et. al. found that in the “younger age group, girls from single-sex schools showed much stronger preferences for the male stereotyped subjects of mathematics and science than girls from co-educational schools. The female stereotyped subjects of music and art were higher in preference order of boys from single sex schools than in that of boys from co-educational schools, while the reverse was true for science” (p. 381). The older pupils showed gender stereotyped subject preferences regardless of school type. The results showed that for the younger respondents (eleven and twelve year-olds) there is less evidence of gender stereotyping in single sex schools than in coeducational schools. The evidence for the older students suggests that their awareness and exposure to gender stereotypes outside and inside of school determined their school

subject preferences. Again, this study shows the vital role that gender stereotyping plays in career aspirations of both men and women.

Single-sex Schools

Jimenez and Lockheed (1989) analyzed the performance of eighth grade students on standardized math tests from both single-sex and coeducational schools to gauge the relative effectiveness of single-sex education versus coeducation on student attitudinal and cognitive outcomes. Data were analyzed from the Second International Mathematics Study (SIMS) conducted by the International Association for the Evaluation of Educational Achievement (IEA) in Thailand during the 1981-82 academic year. Jimenez and Lockheed used a basic value added model derived from more complicated models of the level of achievement to measure the variables that could possibly affect achievement after controlling for intervening variables such as socioeconomic factors, innate ability, individual motivation, and school factors. What they found was that once past achievement and socioeconomic background were held constant, girls in eighth-grade single-sex schools had “an unconditional advantage in mathematics test performance of about four points” and boys an “unconditional disadvantage of about two points” (p. 130). This implied that an average single-sex school eighth-grade Thai girl chosen at random “would improve her achievement by about 40% by attending a single-sex school, whereas a boy would reduce his score by 20%” (pp.130-131). The statement implied a causal relationship. These results play a vital role in supporting single-sex education for girls in terms of math achievement. However, how can single-sex education be provided for girls while at the same time providing coeducation for boys’ achievement? The implications are that the process variables in female single-sex settings and male

coeducational settings need to be investigated in order to improve coeducation for both sexes. It is particularly important to continue with this line of investigation to see if similar results are found with American students.

LePore and Warren (1997) addressed this issue by studying if gender biases in coeducational settings impair girls' academic and emotional development, if so, will girls in single-sex schools not only score higher on achievement tests, but also on tests of psychological well-being. First they looked at the outcomes between students in single-sex Catholic schools and students in coeducational schools and if these outcomes were especially favorable to female students. The target population of this study was boys and girls in either single-sex Catholic secondary schools or coeducational Catholic secondary schools in grades ten and twelve using data from the National Educational Longitudinal Study of 1988 (NELS: 88). The sample from the NELS: 88 data was created to reduce risk to internal and external validity. For the tenth grade sample they selected cases "in which students were: (a) enrolled in either Catholic single-sex or Catholic coeducational secondary schools in 10th grade, (b) attending schools that reported that fewer than 25% of their students were in a vocational curricular program, and (c) in-school and in-grade in 1990 (their sophomore years)." For the twelfth grade sample they restricted it to "cases in which students (d) responded to the first three survey waves, (e) did not drop out between Grades 10 and 12, and (f) did not change schools between Grades 10 and 12" (pp. 494-495). So this was a cluster sampling design. The results found that there is "no evidence that the effect of attending a single-sex Catholic school differs for boys and girls." The results also showed that there are no "statistically significant positive effects of single-sex school enrollment for girls" (pp. 504-505). This means that attending a

single-sex Catholic school is no different, or better, than attending a coeducational Catholic school. The implications from LePore and Warren (1997) are that when factors such as family background, SES, differences in the characteristics of students, and ethnicity are controlled, there are no advantages for selecting a single-sex secondary school versus a coeducational secondary school in terms of looking for better outcomes such as higher academic achievement and socio-psychological factors like locus of control and self-esteem scores. These implications are significant to because it forces one to look closely at the different variables that need to be controlled for further studies. However, it is important to note that this study used only participants from private Catholic schools and none from public schools. Although in the United States there exist hardly any single-sex public schools, another study could compare single-sex and coeducational private schools.

Lee and Marks (1990) conducted a study to determine whether the effects of single-sex education are sustained for the students who experience it in high school, compared with the effects of coeducation for their counterparts. This was a longitudinal follow-up that used data from “High School & Beyond: 1980”. The sample consisted of 1533 college students who had attended Catholic high schools, 45 of which were single-sex. They looked at a variety of outcomes: academic achievement, gains in achievement, educational aspirations, locus of control, sex role stereotyping, and attitudes and behaviors related to academics. What they found was that there were no sustained effects on academic achievement and that “female college students who had attended girls’ schools held higher educational aspirations” (p. 584). Overall they found modest statistical significance for sustained effects after attending single-sex schools and that

“rarely did attending a coeducational secondary school prove advantageous” (p. 588).

The results suggest that coeducational schools need to address the variables that affect females’ overall success following secondary education by encouraging development of more sex-equitable and supportive environments. It suggests that contemporary research might be appropriate.

Self-efficacy

Of great interest to self-efficacy research is the application of theory to the career behavior of women, especially as it relates to math performance and math self-efficacy. Betz and Hackett (1983) investigated the relationship of math self-efficacy expectations to attitudinal, personality and career choice variables, in particular the selection of science-based majors. Subjects were 153 female and 109 male undergraduate students. Data was collected from a Mathematics Self-Efficacy Scale, the Fennema-Sherman scales, the Bem Sex Role Inventory, and a questionnaire concerning math background, college major, and occupational preferences. American College Test (ACT) Mathematics Usage scores were also obtained from university records. Using Pearson product-moment correlations relationships between math self-efficacy expectations and math anxiety, attitudes toward math, masculinity and femininity scores were examined. Subjects’ college major preferences were also classified on a 1 to 5 continuum with a high score indicating science emphasis. What they found was that self-efficacy expectations of males were consistently higher than those of females. Results also indicated “students with stronger mathematics self-efficacy expectations report lower levels of math anxiety, higher levels of overall confidence and effectance motivation, and a greater tendency to view math as useful (p. 341)”. In regards to science-based college

majors, subjects who reported strong math self-efficacy were more likely to select those majors. The findings support this study's investigation into the approach of single-sex education as a way to strengthen self-efficacy expectations.

Data collected for Betz and Hackett (1983) were used in a path analysis by Hackett (1985) to test the hypothesis that math-related self-efficacy mediates the effects of gender and math preparation and achievement on math relatedness of college major choice. Results indicated that of all the variables examined (gender, BSRI masculine score, years of high school math, ACT math scores, math self-efficacy, math anxiety score, and math relatedness of declared major), math self-efficacy was most highly correlated with math-related major choice. However, Hackett also found that "gender, years of high school math, and math self-efficacy have indirect as well as direct effects on major choice (p. 52)". Also stated was that "gender-related socialization influences in combination with amount of mathematics preparation predict level of mathematics achievement, which is, in turn, predictive of mathematics-related self-efficacy (p. 53)". As such, this suggests that the "gender-related socialization" of a single-sex school environment might predict strength of math self-efficacy.

Campbell and Hackett (1986) explored the effects of task performance on level and strength of task self-efficacy, task interest, and self-evaluations of performance. They found that changes in self-efficacy expectations in regard to task success or failure, were consistent with self-efficacy theory. Subjects (60 males and 60 females) were randomly assigned to either a success or failure condition where they were to solve incomplete number series. When subjects failed at a task they decreased their ratings of self-efficacy and interest. Conversely, when subjects succeeded, self-efficacy and task

interest increased. There was also a difference between males' and females' rates of dissatisfaction in the failure group with women rating significantly higher dissatisfaction. Since the purpose of this study was to test the hypothesis that "efficacy expectations relevant to vocational behaviors could be modified via behavioral performance (p. 161)" it supports the further exploration of situational factors, such as type of school environment, that influence career self-efficacy.

Four-hundred and fifteen eleventh-grade students were surveyed to assess their math self-efficacy, ethnic identity, gender, and career interests in math and science (O'Brien, Martinez-Pons, & Kopala, 1999). The Mathematics Self-Efficacy Scale adapted from Betz and Hackett (1983) was used to assess math self-efficacy. Ethnic identity was assessed using the Multigroup Ethnic Identity Measure. Career interest in science and engineering was assessed with the Jackson Vocation Interest Survey. Pearson product moment correlation coefficients and path analysis were used to see how math self-efficacy, ethnic identity, and gender related to career interests in math and science. The findings showed that "a) career interest in science is predicted solely by science-mathematics self-efficacy [and gender directly predicted students' career interest], b) self-efficacy is predicted by academic performance and ethnic identity, and c) academic performance is predicted by income level (p. 235)". Suggested in the discussion is further exploration of the intervening processes of past academic achievement and math self-efficacy in adolescent female students as a way to address the problem of low representation of women and minorities in science and engineering fields. This study seeks to do just that with the idea that a single-sex environment, compared to a co-educational environment, fosters high levels of math self-efficacy among girls.

Lopez and Lent (1992) examined relations between the four primary sources of efficacy information and math self-efficacy within a high school sample to determine the relation between math self-efficacy and perceived career options. Survey measures such as the “Personal Background Questionnaire,” the “Sources of Math Efficacy Scale,” the “Math Self-Efficacy Scale”, and the “Academic Self-Concept Scale” were administered. What they found was that, given the zero-order correlations among the measured variables, the “findings support a model in which the effect of self-efficacy (SE) on perceived math usefulness is largely mediated by math/science interests” (p. 10). What this means is that past performance accomplishments, vicarious learning, verbal persuasion, and emotional arousal in regards to math had a high correlation in terms of math/science interests, and the perceived usefulness of math/science interests. The findings suggest that all students should be provided with mastery experiences in math/science courses. Also, vicarious learning should occur from a variety of non-sexist models. In other words, there should be many non gender-stereotyped models in school settings. Finally, since verbal persuasion plays a vital role in math self-efficacy, then more attention needs to be paid to what we say to girls regarding their math abilities. This study suggests that when girls are provided mastery experiences in science, math, and technology and are provided with non gender-stereotyped models in school, then scores of math self-efficacy should be high.

Chapter III

Methodology

Design

This study examined the relationship between type of school, single-sex and coed, a two-level independent variable (IV), and three dependent variables (DV), consisting of female student scores on three separate scales: the Importance of Mathematics Scale (IOM), the Sources of Math Self-Efficacy Scale (SMSE), and the Math Self Efficacy Scale (MSE). Beliefs about the importance of mathematics (DV) were also compared to see whether there was a difference between schools (IV). The possible interaction between type of school, single-sex or co-educational (IV), grade levels (IV), and student confidence scores on the MSE (DV) were also investigated.

Participants

The participants included 58 girls in sixth ($n = 19$), seventh ($n = 19$), and eighth grade ($n = 20$) from a private single-sex school, the Louise S. McGehee School in New Orleans, Louisiana which has operated as a single-sex school for over ninety years. The ethnicity of the single-sex school participants included three African Americans, one Asian American, two Latinas, six Other, and 43 Anglo Americans.

Co-educational participants included 51 girls in the sixth ($n = 20$), seventh ($n = 18$), and eighth grades ($n = 13$) from a private school, St. Francis DeSales Central Catholic School in Morgantown, West Virginia that has operated since 1915. The ethnicity of the co-educational school participants included one Asian American, two Latinas, and 48 Anglo Americans. For both groups the age range was from 10-14 years old. This range is based on a variation in birth date and entrance into school.

Data Sources

The participants responded to four survey measures, which included a Personal Background Questionnaire (Appendix A), the Importance of Mathematics Scale (Appendix B), the Sources of Mathematics Self-Efficacy (Appendix C), and the Math Self-Efficacy Scale (Appendix D).

Personal background questionnaire. This is a self-report form that was used to gather demographic information including students' age, sex, ethnicity, grade level, career interests, role models, family members in science or technology related jobs, number of siblings, and birth order.

Importance of mathematics scale (IOM). Developed by Shell, Murphy, and Bruning (1989), The IOM was used to investigate whether there is a difference of perception about the importance of mathematics between girls in single-sex middle school and those in a coeducational middle school. The IOM is a 10-item Likert-type scale that asks students to rate on a scale from one (*not important at all*) to eight (*extremely important*) how skills in mathematics are important to life in general. Higher total scores indicate strong perceptions in the usefulness and value of mathematics.

Sources of mathematics self-efficacy scale (SMSE). This instrument was used to investigate the difference in self-efficacy between girls in a single-sex middle school and girls in a coeducational middle school. This is a modified scale of Lopez and Lent's (1992) 44-item instrument that was developed for high school students. The instrument used in this study was modified for middle school students and hence includes only 38 of the questions. The questions correspond to the four primary sources of efficacy described by Bandura (1986): vicarious learning, past performance, social persuasion, and

emotional arousal. Using a Likert scale from 1 (Strongly disagree) to 5 (Strongly agree) students were asked to rate their level of agreement with each of the 38 statements. For example, *I got a high grade in my last math class* (past performance), *Many of the adults I know are in occupations that require a good understanding of math* (vicarious learning), *I am often encouraged to participate in school activities that require math ability* (social persuasion), and *I get a sinking feeling when I think of trying hard math problems* (emotional arousal). Six of the 38 statements were fillers (e.g., *My relatives believe I can do well in math subjects*).

Math self-efficacy scale (MSE). The MSE instrument was used to investigate whether there is a difference in mathematics self-efficacy between girls in a single-sex middle school and those in a coeducational middle school. It was developed by a mathematics expert, Nisan-Nelson (2002), using the sixth, seventh, and eighth grade Mathematics Instructional Goals and Objectives for the state of West Virginia and validated for content by math teachers in the Atlanta Girls' School and math teachers from the St. Francis and the Louise S. McGehee schools. The 20-item scale asks students to rate their confidence in being able to solve math problems that they have had previous experience with, such as decimals, square roots, algebraic equations, and fractions. An example of a typical math problem is, "Solve for X if $X+2=8$." Students were instructed to look at each item and rate their confidence in solving each problem. They did not have to solve the problems or give answers. A 10-point Likert-type scale was used where zero indicated *no confidence at all* and nine indicated *complete confidence*. A high total score indicates strong math self-efficacy.

Procedure

The administrators at the Louise S. McGehee School were contacted by phone. School administrators gave permission to survey the sixth, seventh, and eighth grade math classes. Survey instruments were mailed to the school once the Institutional Review Board (IRB) at West Virginia University approved this research study. Included with the surveys was a one page written protocol (Appendix E) for each classroom teacher to administer the surveys. The protocol included a four-day schedule and a procedure for administering the surveys on day four. On the schedule Day One was the day Parental Consent (Appendix F) forms were sent home. Days two and three were a waiting period for students to bring in their forms. On the fourth day all consent forms should have been turned in and the surveys were administered. A math worksheet (Appendix G) was included for students who did not have signed parental consent forms or who chose not to participate. Classroom teachers administered the surveys during regular math class time.

An administrator at St. Francis DeSales Catholic School was also contacted by phone. Once school administrators gave permission to survey the sixth, seventh, and eighth grade math classes survey instruments were delivered to the school along with the same protocol for administering the surveys.

The survey instruments included consent forms for parents/guardians to give permission for their children to participate in this study. The consent form provided the parents/guardians with information regarding the purpose of the study, procedures, contact information, and confidentiality concerns. The assent form (Appendix H) for the participating students to sign was attached to each set of survey instruments. This form

provided information regarding the purpose of the study, procedures, and confidentiality concerns. The form also addressed students' possible concerns regarding grades and class standing and that they would not be affected through participation in this study. Both forms assured the fact that participation was completely voluntary. No compensation was offered to students for their participation.

Data Analysis

Data were collected from 58 of the 60 returned questionnaires from the Louise S. McGehee School. Only 51 out of the 99 returned from St. Francis were used because the data of interest at the time was only from the female respondents. Surveys were coded using student numbers provided by the schools. A data file was created in SPSS 8.0 student version for analysis. Demographic data were entered first and then all the instruments were scored.

For the Importance of Math Scale (IOM) all the responses for the 10 items were added for each student. As the scale ranged from zero to eight, the highest possible score on this instrument was 80, which would indicate that students believed skills in mathematics to be extremely important to life in general. The lowest possible score was 10, which indicated that students believed skills in mathematics were not important at all.

The Sources of Mathematics Self-Efficacy (SMSE) was scored by adding the responses to the 32 questions that categorized the four different scales of efficacy. Following the coding key from Lopez & Lent (1992) each item was read and color-coded for each scale (e.g., yellow for past performance accomplishments, pink for vicarious learning, green for social persuasion, orange for emotional arousal). Negatively worded items on a five-point Likert scale were reversed (e.g., if a subject marked a two on a

negatively worded question then their score on that question is actually four). The scale for vicarious learning was composed of nine items. The scale for past performance accomplishments was composed of nine items. The scale for social persuasion was composed of five items. The scale for emotional arousal was composed of nine items. Each scale was scored separately for each respondent then totaled for a combined score on the SMSE. The combined score of the 32 items was used for statistical tests. The maximum score was 160 and the minimum score was 32.

Adding responses to the Mathematics Self-Efficacy Scale (MSE) provided a score for each student. The highest possible score was 180 and the lowest possible score was 20. The higher the score, the more confident the student is in solving the math problems—indicating high mathematics self-efficacy.

Scores were entered into SPSS so that data could be analyzed. The research questions and hypothesis in this study were based on the self-efficacy literature recommendations of exploring the situational conditions that affect math self-efficacy (Campbell & Hackett, 1986).

1. Research question one asked whether a significant *relationship* exists between type of middle school, single-sex or co-educational, and sources of math self-efficacy (SMSE), math self-efficacy (MSE), and beliefs about the importance of mathematics (IOM). A point-biserial correlational analysis was conducted set at alpha .01 to limit making Type I errors to test whether there was a statistically significant correlation between type of school and student scores on the IOM, SMSE, and MSE Scales.

2. Research question two asked whether the scores on the SMSE were *different* for girls in single-sex middle schools than for girls in co-educational schools. An independent samples t-test was conducted to test for a significant difference.
3. Research question three asked if there was a *difference* in the scores on the MSE of girls in single-sex middle schools and those in co-educational schools. An independent samples t-test was conducted to test for a significant difference.
4. Research question four asked if there was a *difference* in perception of the importance of mathematics (scores on the IOM scale) between girls in single-sex schools and girls in co-educational schools. An independent samples t-test was conducted to test for a significant difference.
5. Research question five asked whether there was an *interaction* between type of school (single-sex or co-educational) and grade levels (sixth, seventh, and eighth) on student confidence scores on the MSE. A two by three factorial analysis of variance (2X3 ANOVA) was conducted to test for a statistically significant interaction between type of school (single-sex or co-educational) and grade levels (sixth, seventh, and eighth) on student confidence scores on the MSE.

Chapter IV

Results

The results from the first hypothesis are reported in Table 1.

Table 1

Correlations between type of school and scores on the SMSE, MSE, and IOM.

	SCHOOL	SMSE	MSE	IOM
SCHOOL		.191	.121	.245**
SMSE			.333**	.197
MSE				.147
IOM				

$N = 109$

** $p < .01$ (2-tailed).

The correlation revealed a statistically significant relationship ($\alpha = .01$) between the independent variable (IV) type of middle school, single-sex or co-educational, and the dependent variable (DV) of female students' scores on the Importance of Mathematics Scale (IOM). The correlation did not show a statistically significant relationship between the independent variable and female students' scores on the Sources of Math Self Efficacy Scale (SMSE) or the Math Self Efficacy Scale (MSE). As would be expected, the correlation matrix revealed that scores on the SMSE and MSE were significantly related, $r = .311$, $n = 109$, $p = .001$.

To answer Research Question 2 a t statistic ($t = -2.012$, $df = 107$) was obtained.

The researcher rejected the hypothesis at the .05 level of significance. There was a small, but statistically significant difference in scores between the two schools (IV) on the

SMSE (DV). The means and standard deviations for the dependent variable partitioned by the two levels of the independent variable are reported in Table 2.

Table 2

Means and standard deviations for type of school and scores on the SMSE

	<i>n</i>	<i>M</i>	<i>SD</i>
single-sex	58	103.93	8.35
coed	51	107.10	8.03
<i>p</i> = .047			

To answer Research Question 3 a *t* statistic ($t = -1.264$, $df = 107$) was obtained. The researcher failed to reject the hypothesis at the .05 level of significance. The difference in scores between the two schools (IV) on the MSE (DV) was not statistically significant. The means and standard deviations for the dependent variable partitioned by the two levels of the independent variable are reported in Table 3.

Table 3

Means and standard deviations for type of school and scores on the MSE

	<i>n</i>	<i>M</i>	<i>SD</i>
single-sex	58	137.02	26.31
coed	51	143.41	26.39
<i>p</i> = .209			

To answer Research Question 4 a t statistic ($t = -2.615$, $df = 107$) was obtained. The researcher rejected the hypothesis at the .05 level of significance. The difference in scores between the two schools (IV) on the IOM (DV) was statistically significant. The means and standard deviations for the dependent variable partitioned by the two levels of the independent variable are reported in Table 4.

Table 4

Means and standard deviations for type of school and scores on the IOM

	n	M	SD
single-sex	58	56.24	16.35
coed	51	63.47	11.79

$p = .01$

To answer Research Question 5 a 2 x 3 Univariate Analysis of Variance was conducted to see if there was a significant interaction between type of school (IV), grade level (IV), and scores on the MSE (DV). Table 5 shows the results of the ANOVA. However, there was a main effect for grade level. Table 6 shows how scores on the MSE increased as grade increased. A Dunnett's T3 post hoc test revealed that the only statistically significant difference was between the sixth and eighth grades ($p = .001$).

Table 5

ANOVA Summary Table

Source	<i>df</i>	<i>F</i>	<i>p</i>
School	1	3.414	.067
Grade	2	11.756	.000
SchoolXGrade	2	0.076	.927
Error	103	585941	

Table 6

Chapter V

Discussion

There have been no studies in the math self-efficacy or single-sex schools literature that have looked at the possible relationship between self-efficacy expectations and type of school. However, the self-efficacy literature recommends exploration of the situational conditions that affect math self-efficacy (Campbell & Hackett, 1986). This research sought to fill that void by investigating whether single-sex schools foster math efficacy levels among female students different from female students at coeducational schools. Based on a review of the research the results for all of the hypotheses tests were unexpected.

Research Question 1

Does a significant relationship exist between type of middle school, single-sex or co-educational, and sources of math self-efficacy (SMSE), math self-efficacy (MSE), and beliefs about the importance of mathematics (IOM)? The results of the hypothesis test indicated a statistically significant correlation between type of middle school and female students' scores on the IOM at alpha .01. There was no statistically significant correlation between type of middle school and female students' scores on the SMSE or the MSE. The mean scores for the coeducational school on the IOM ($M = 63.47$, $SD = 11.79$) are consistently higher than the mean scores of the girls in the single-sex school ($M = 56.34$, $SD = 16.35$). The average mean scores on the SMSE for the girls in the co-educational school were also higher with an average mean score of 107.10 ($SD = 8.03$) compared to an average mean score of 103.93 ($SD = 8.35$). Contrary to the assumptions

made by the researcher, the results showed that the coeducational school subjects' scores were higher overall.

The research would point to girls in single-sex schools as having higher self-efficacy because they do not have to compete with boys for grades or attention from the teachers, sexist language and behavior is at a minimum, and gender stereotypes are challenged (Colley, Comber, & Hargreaves, 1994; Silverman & Pritchard, 1996; Whelan, 1998). Research has shown that in co-educational classrooms (from elementary to graduate school) males receive a disproportionate amount of teachers' time, energy, and both positive and negative attention. "Teachers interact with males more frequently, ask them better questions, and give them more precise and helpful feedback (Sadker & Sadker, 1994, p.1)." The researcher assumed, and because the single-sex research asserts that "girls in single-sex schools have higher self-esteem, are more interested in nontraditional subjects such as science and math, and are less likely to stereotype jobs and careers (Sadker & Sadker, 1994, p.233)", that the single-sex school subjects would score higher than they did on the survey measures.

Research Question 2

Are the sources of math self-efficacy (SMSE) different for girls in single-sex middle schools than for girls in co-educational schools? The results of the hypothesis test were such that the researcher rejected the null hypotheses, with a *p-value* of .047. There was a statistically significant difference between type of school and scores of the SMSE. However, the girls in the coeducational school had a higher average mean score than the girls in the single-sex school. The girls in the coeducational school seem to have some situational variables that affected their scores on this measure. One of the variables was

that the coeducational girls seem to have more models that affect their vicarious learning. A look at the occupations of the parents and relatives of the coeducational school subjects revealed that many more of them were in occupations that required mathematical skills than the parents and relatives of the subjects from the single-sex school. Compared to the single-sex school there was a high representation of doctors, nurses, and engineers in the coeducational sample, which numbered 67 relatives in technology, math, or science occupations, whereas the single-sex sample only included 27 relatives that were in those same occupations. This may be due to the contextual variables of where the schools are located and the regional opportunities available to be employed in those fields.

The coeducational school is located in a small town with a population of 30,000 permanent residents and 22,000 graduate and undergraduate university students. There are only four private schools in the area, none of them single-sex. The largest employers are the university, which includes a teaching hospital, a large pharmaceuticals company, and the National Institute for Occupational Safety and Health (NIOSH). The single-sex school is located in a large metropolitan area with a population of 485,000 residents. Although there are nine universities, two with teaching hospitals, the traditional businesses in the area are oil and gas exploration, shipping, and tourism (service industry). There are 49 private schools, 14 of which are gender-specific. In effect, the single-sex school in this study is located where there is a larger distribution of students among all the schools; whereas the co-educational school has a larger concentration of students whose relatives work in technology, math, and science related jobs because of regional opportunities.

Research Question 3

Is there a difference in the math self-efficacy (MSE) of girls in single-sex middle schools and those in co-educational schools? The results of this hypothesis test prompted the researcher to fail to reject the null hypothesis. There was no statistically significant difference between scores on the MSE and type of school. The result may be due to students' experience and familiarity with the types of math problems on this instrument. The questions were developed to be typical math problems that students in the sixth, seventh, and eighth grades would encounter no matter which school is attended since most schools follow the national math standards.

Research Question 4

Is there a difference in perception of the importance of mathematics between girls in single-sex schools and girls in co-educational schools? The difference in scores between the two schools on the IOM was statistically significant. Again, the coed girls had a higher mean ($M = 63.47$, $SD = 11.79$) than the girls from the single-sex school ($M = 56.24$, $SD = 16.35$). Considering the types of jobs the relatives of the girls in the coeducational school held, the girls have the perception that math is important to life in general—highlighting the importance of role models.

Research Question 5

Is there an interaction between type of school environment (single-sex or co-educational) and grade levels (sixth, seventh, and eighth) on student confidence scores on the MSE? The results showed no statistically significant interaction. However, there was a statistically significant main effect for grade level. As grade went up, so did scores on the MSE. This may be due to past performance accomplishment and experience with the

types of math problems that were on the instrument, which was composed of items typical for sixth, seventh, and eighth grade math classes.

So why did the girls in this coeducational school do better than their single-sex counterparts? Research studies would suggest that when girls do not have to compete with boys for teacher attention then their attitudes about math, science, or technology are not as adversely affected (e.g., American Association of University Women Foundation, 1992; Rennie & Parker, 1987; Streitmatter, 1998). Also, the single-sex environment is assumed to be free of sexist language and behavior that would make girls believe that girls are not supposed to be good in math or science (Sadker & Sadker, 1994; Silverman & Pritchard, 1996). In this research the assumption was made that these factors in themselves would contribute to higher math self-efficacy. However, what was not taken into consideration was how influential the role of vicarious learning may be in mathematics self-efficacy. Vicarious learning may play a role in affecting emotional arousal, social persuasion, and past performance accomplishment. For example, the girls in the coeducational school not only had more role models overall, but they also had more mothers and aunts who were in math or science fields, so it is possible that they have higher social persuasion from same gender models that they are or can be good at math. This may also affect emotional arousal if the models demonstrate confidence in mathematics. And, if the subjects have a model that can help them with math, then they may be more likely to have successful past performance accomplishments.

Self-efficacy beliefs are acquired and modified through four primary sources: vicarious learning, social persuasion, past performance accomplishments, and emotional arousal (physiological states and reactions) (Lent, Lopez, Brown, & Gore, Jr., 1996). If

single-sex schools are serious about raising the numbers of girls who go into math and technology fields, they need to concentrate consciously on the four sources of self-efficacy, in particular, they need to provide more role models. Sometimes it is only through exposure to real-life models that people believe they can do something they previously thought impossible (Sadker & Sadker, 1994). However, which role models could be more influential than family members?

Finally, since this research looks at identifying factors that might underlie self-efficacy development and maintenance, this study may aid in the design of efficient career and educational interventions in regard to women in math and technology fields (Lent, Lopez, Brown, & Gore, Jr., 1996). Again, what could be more influential than role models, people the girls look up to and might think about emulating? A practical solution would be to provide career counseling at this young age; at least so that girls know that other options exist besides historically traditional female careers, like secretarial work.

Even though the girls were positive about what they could become when they “grew up”, their ideas were pretty diverse. For example, several girls, from both schools, said that they wanted to be actresses, veterinarians, teachers, or lawyers. Those careers require different kinds of training and if they were exposed to those realities and salary opportunities, they would have a better idea of what they might want to do. For example, counseling for technology jobs alerts students to how much more money they can make in technology fields, than in more gender-traditional occupations (Silverman & Pritchard, 1996).

Conclusion

The reviews of the research studies have concluded that attitudes about math, science, and technology acquired in schooling are responsible for career choice. These attitudes are acquired as a result of several factors, including a) the way in which teachers interact with girls compared with boys—particularly in math, science, or technology classes (American Association of University Women Educational Foundation, 1992; Rennie & Parker, 1987; Streitmatter, 1998), b) sexist language and behavior (Silverman & Pritchard, 1996), c) gender stereotypes (Colley, Comber, & Hargreaves, 1994), and d) familial expectations (Silverman & Pritchard, 1996). When the findings of the above studies were published, the public began to look at single-sex schools as a way to ameliorate girls' attitudes of math and science. However, all single-sex girls' (or boys', for that matter) schools do not follow the same philosophy or curriculum. Some schools can be “throwbacks, 19th century finishing schools to prepare little ladies (Sadker & Sadker, 1994, p. 249)” while other schools strive to provide girls with opportunities and real-life experiences in math, science, and technology. The results of this research would suggest that it would take more than single-sex schooling to improve girls' attitudes about math and their participation in technological careers.

The goals of this research were to 1) look at the possible relationship between type of school and sources of mathematics self-efficacy beliefs, 2) identify any differences in the beliefs about the importance of mathematics in middle school girls from both single-sex and co-educational schools, and 3) to investigate the sources of math self-efficacy of girls from single-sex and co-educational middle schools. Although

these goals were accomplished, the nature of research is that more questions emerge from our results. For example, what would the results look like if different schools were used?

Limitations and Suggestions for Further Study

One of the limitations in this study was the schools used. The researcher used research groups that were accessible at the time. It is believed that the occupations of the parents in the coeducational school had an impact on the results. Since 49 % of the coeducation subjects had parents with careers in the math and science fields and 55% of them had relatives in math and science fields, the girls had many more role models from which they acquired a lot of vicarious learning. In another study, it would be beneficial to control for educational level of the parents, which is related to type of chosen career.

Another study might use one (or more) of the newer single-sex girls' schools that were founded to expressly increase girls' participation in math, science, and technology fields. How might a less "traditional" single-sex school compare to another co-educational school or another "traditional" single-sex school? If one of the new schools is consciously addressing the concerns about women in those fields, will subjects' scores show higher mathematics self-efficacy?

This study only had subjects of high socio-economic status (SES) due to the nature of private schools. Although SES was consistent for both schools, it would be good to look across SES levels and find out what the results would look like.

The small sample size ($n = 58, 51$) may be a limitation in this study. A larger sample size might result in showing a bigger difference between groups. A larger sample

might also control for the confounding variables and give a clearer picture of the impact of type of school on mathematics self-efficacy.

Many studies have found support for the involvement of mathematics self-efficacy in the development of math-related careers (e. g., Betz & Hackett, 1983; Hackett, 1985; Multon, Brown, & Lent, 1991). These studies have also found that self-efficacy expectations are consistently higher for males than females. A suggestion for a future study would be to compare girls and boys from the same school and see how they score on the same measurements.

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Appendix A

BACKGROUND QUESTIONNAIRE

Directions: Please circle a response.

1. Gender: *Male* *Female*

2. Ethnicity: *African American* *Asian American* *Anglo American*
 Latino/a *Native American* *Other* _____

3. Are you the: Oldest Middle Youngest Only child

Directions: Please write in a response.

4. Grade: _____ 5. Age: _____

6. What are your career interests? _____

7. Who are your role models? _____

8. Family members in science or technology related jobs:

Please name the people in your family who:
 use computers to do their job;
 teach math, biology, science, or computer science;
 are doctors, engineers, or webpage designers.

Mother _____ Brothers _____

Father _____ Sisters _____

Aunts _____ Uncles _____

Other relatives _____

9. How many sisters do you have? _____

10. How many brothers do you have? _____

Appendix B

IMPORTANCE OF MATHEMATICS

Directions:

People differ in their feelings about the importance of mathematics. On a scale from **1** (*not important at all*) to **8** (*extremely important*), rate how important you think skill in math is for achieving the following.

	1	2	3	4	5	6	7	8
	<hr/>							
	Not important at all	A little important		Moderately important	Very important		Extremely important	
1. Making new friends.	1	2	3	4	5	6	7	8
2. Raising children properly.	1	2	3	4	5	6	7	8
3. Having a good family life.	1	2	3	4	5	6	7	8
4. Being happy in life.	1	2	3	4	5	6	7	8
5. Being able to help other people.	1	2	3	4	5	6	7	8
6. Being a good citizen.	1	2	3	4	5	6	7	8
7. Solving life's problems.	1	2	3	4	5	6	7	8
8. Getting a job.	1	2	3	4	5	6	7	8
9. Graduating from college.	1	2	3	4	5	6	7	8
10. Learning new things.	1	2	3	4	5	6	7	8

Appendix C

SE SOURCES SCALE

Directions: Using the scale below, circle the number that represents your level of agreement with each of the items listed below.

	Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree
1. I got a high grade in my last math class.	1	2	3	4	5
2. My favorite teachers are usually math teachers	1	2	3	4	5
3. I get a sinking feeling when I think of trying hard math problems.	1	2	3	4	5
4. My parents believe I have high math ability.	1	2	3	4	5
5. I received a good grade last year in math class.	1	2	3	4	5
6. Many of the adults I most admire are good at math.	1	2	3	4	5
7. Other people generally see me as good at math.	1	2	3	4	5
8. I look forward to more advanced math classes.	1	2	3	4	5
9. In math classes, I rarely get the answer before my classmates do.	1	2	3	4	5

Directions: Using the scale below, circle the number that represents your level of agreement with each of the items listed below.

	Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree
10. Most of my friends do poorly in math.	1	2	3	4	5
11. I really get uptight while taking math tests.	1	2	3	4	5
12. My teachers believe I can do well in difficult math courses.	1	2	3	4	5
13. Among my friends I'm usually the one who figures out math problems.	1	2	3	4	5
14. My parents have encouraged me to be proud of my math ability.	1	2	3	4	5
15. My mind goes blank and I am unable to think clearly when working mathematics.	1	2	3	4	5
16. I have received special awards for my math ability.	1	2	3	4	5
17. My career role models (i.e., those people I'd like to be like) are mostly in fields that do not involve math.	1	2	3	4	5
18. Math has always been a very difficult subject for me.	1	2	3	4	5
19. I almost never get uptight while taking math tests.	1	2	3	4	5

Directions: Using the scale below, circle the number that represents your level of agreement with each of the items listed below.

	Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree
20. My close friends believe I have poor math skills.	1	2	3	4	5
21. My parents are not very good at math.	1	2	3	4	5
22. Teachers have discouraged me from pursuing occupations that require a strong math background.	1	2	3	4	5
23. I am rarely able to help my classmates with difficult math problems.	1	2	3	4	5
24. People I look up to, like parents, friends, or teachers, are good at math.	1	2	3	4	5
25. I usually don't worry about my ability to solve math problems.	1	2	3	4	5
26. I am often encouraged to participate in school activities that require math ability.	1	2	3	4	5
27. Some of my closest friends do very well on the math exams they take.	1	2	3	4	5
28. Mathematics makes me feel uneasy and confused.	1	2	3	4	5
29. People I look up to have told me not to consider a math-related career.	1	2	3	4	5

Directions: Using the scale below, circle the number that represents your level of agreement with each of the items listed below.

	Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree
30. When I come across a tough math problem I work at it until I solve it.	1	2	3	4	5
31. Many of the adults I know are in occupations that require a good understanding of math.	1	2	3	4	5
32. I have usually been at ease during math tests.	1	2	3	4	5
33. I have always had a natural talent for math.	1	2	3	4	5
34. My relatives believe I can do well in math subjects.	1	2	3	4	5
35. Math makes me feel uncomfortable and nervous.	1	2	3	4	5
36. Many of my friends intend to enter fields that do not require strong math skills.	1	2	3	4	5
37. My parents have encouraged me to do well in math.	1	2	3	4	5
38. I have usually been at ease in math classes.	1	2	3	4	5

Appendix D

Math SE Scale

Directions: Using the rating scale described below, circle the number on the scale next to each problem that shows **how confident you are in your ability to solve** the following problems without using a calculator. You **do not** have to solve the problems.

Scale:

1. $2\frac{1}{3} + \frac{2}{9} = \boxed{}$	0	1	2	3	4	5	6	7	8	9
--	---	---	---	---	---	---	---	---	---	---

2. What is 25% of 120?	0	1	2	3	4	5	6	7	8	9
------------------------	---	---	---	---	---	---	---	---	---	---

3. 20 is what percent of 37?	0	1	2	3	4	5	6	7	8	9
------------------------------	---	---	---	---	---	---	---	---	---	---

4. Convert $\frac{3}{8}$ into a decimal number.	0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---	---

5. Convert 20% into a decimal number.	0	1	2	3	4	5	6	7	8	9
---------------------------------------	---	---	---	---	---	---	---	---	---	---

6. Solve for x if $x+2=6$	0	1	2	3	4	5	6	7	8	9
---------------------------	---	---	---	---	---	---	---	---	---	---

7. Which angle is an obtuse angle?	0	1	2	3	4	5	6	7	8	9
------------------------------------	---	---	---	---	---	---	---	---	---	---

Directions: Using the rating scale described below, circle the number on the scale next to each problem that shows **how confident you are in your ability to solve** the following problems without using a calculator. You **do not** have to solve the problems.

Scale:

8. What is the area of the rectangle?

0 1 2 3 4 5 6 7 8 9

9. Solve $\sqrt{169}$

0 1 2 3 4 5 6 7 8 9

10. Solve $\frac{x}{2} = \frac{18}{3}$

0 1 2 3 4 5 6 7 8 9

11. You have a rope 15 inches long. Cut it so that you have 3 pieces where 2 of the pieces are 2 times as long as the smaller piece.

0 1 2 3 4 5 6 7 8 9

12. How can Rita divide 3 dozen cookies between 9 friends?

0 1 2 3 4 5 6 7 8 9

13. Add: $13,574 + 839 + 5,011$

0 1 2 3 4 5 6 7 8 9

14. Divide $.07 \overline{)4.907}$

0 1 2 3 4 5 6 7 8 9

15. Multiply $.05 \times 13.9$

0 1 2 3 4 5 6 7 8 9

16. Solve $\frac{3}{4} \div \frac{7}{12} = \boxed{}$

0 1 2 3 4 5 6 7 8 9

Directions: Using the rating scale described below, circle the number on the scale next to each problem that shows **how confident you are in your ability to solve** the following problems without using a calculator. You **do not** have to solve the problems.

Scale:

17. If Dora makes a 6% commission on all her sales and her total sales were \$3,780. What was her commission?

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

18. Which is the better rate? 2lbs. For \$1.98 or 20oz. for \$1.10?

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

19. Solve $\frac{x}{3} + 7 = 41$

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

20. Measure the angle.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

Appendix E

PROTOCOL

Please follow and check off each section to ensure that everyone is following the same procedure.

_____ DAY ONE: Pass out Parent Consent forms. Ask students (parents) to return them within three days.

_____ DAY TWO: Ask students for returned and signed forms. Ask students who did not bring in forms to remind parents to send them in.

_____ DAY THREE: Same as above.

_____ DAY OF SURVEY: If there are students whose parents did not sign a consent form, these options exist; *please mark which one you chose.*

___ 1. Send students to another room.

___ 2. Make copies of the attached worksheet and allow students to work on this while the other students complete the survey.

___ 3. Another assignment from you.

Procedure for surveys:

___ A. Pass out surveys to students who have returned Parent Consent forms.

___ B. Read Assent form (top two pages of survey) aloud with the students.

___ C. Tell them to sign both forms, tear off the top copy and keep. This way, the whole package is turned in with the Assent form attached.

___ D. Tell the students to proceed with the survey.

___ E. Collect the completed surveys.

___ F. Make a list of student names and ID codes so that “nine-week” grades can be matched later on.

___ G. Send surveys back to AnaGloria Rodriguez.

___ H. Send nine-week grades when in.

Thank you very much for all your help.

Appendix F

Parental/Guardian Consent Form

Sources of Mathematics Self Efficacy

Introduction: I, _____ have been asked to allow my child _____ to participate in this study. Ana Gloria Rodriguez, B.A., who is conducting this research, under supervision of Anne H. Nardi, Ph.D., to fulfill the requirements for a Master's Thesis in Educational Psychology at West Virginia University, has explained this to me.

Purpose of the Study: The purpose of the study is to learn more about the sources of mathematics self-efficacy—how students feel about math; how good students think they are in math; how important students think math is.

Description of Procedures: This study will be conducted during class. My child will be asked to complete a set of questionnaires that will take about 10 minutes to complete. The first questionnaire asks for background information: gender, ethnicity, grade level, age, career interests, role models, family members in science or technology related jobs, number of siblings, birth order, and parents' educational level. The second questionnaire asks students to rate on a scale from 1 to 8 how important they think skill in mathematics is for achieving things in life. The following example identifies a typical statement in the questionnaire, "Being able to help other people." The third questionnaire is the Sources of Math Self-Efficacy that asks students to circle the number that represents their level of agreement with the items. The following example identifies a typical statement in the questionnaire, "Many of the adults I most admire are good at math." The fourth questionnaire (Math Self-Efficacy) asks students to rate their confidence in being able to solve math problems that they've had previous experience with, such as decimals, square roots, algebraic equations, and fractions. An example of a typical math problem is, "Solve for X if $X+2=8$." I have been given the opportunity to examine these questionnaires. Approximately 300 subjects will be entered in this study.

Risks or Discomforts: There are no known or expected risks from participating in this study.

Alternative: I understand that my child does not have to participate in this study.

Benefits: I understand that this study is not expected to be in direct benefit to my child, but the knowledge gained may be of benefit to others.

Sources of Mathematics Self-Efficacy

Contact Persons: For more information about this research I can contact AnaGloria Rodriguez at 304-293-4316 or arodrig3@mix.wvu.edu or her supervisor, Dr. Anne Nardi at 304-293-5703 ext. 1811 or Anne.Nardi@mail.wvu.edu. For information regarding my child's rights as a research subject, I may contact the Executive Secretary of the Institutional Review Board at 304-293-7073.

Confidentiality: I understand that any information obtained as a result of my child's participation in this research will be kept as confidential as legally possible. I understand that these research records, just like hospital records, may be subpoenaed by court order or may be inspected by federal regulatory authorities. In any publications that result from this research, neither my name nor that of my child, nor any information from which we might be identified will be published without my consent. In order to insure confidentiality four-digit codes will be used to keep track of students.

Voluntary Participation: Participation in this study is voluntary. I understand that I may withdraw my child from this study at any time. Refusal to participate or withdrawal will involve no penalty or loss of benefits for me, or my child and will not affect my child's class standing or grades. I have been given the opportunity to ask questions about the research and I have received answers concerning areas I did not understand. Upon signing this form I will receive a copy.

I willingly consent to my child's participation in this study.

Signature of Parent or Guardian

Date

Signature of Investigator or Investigator's

Date
Representative

Sources of Mathematics Self-Efficacy

Could you please answer the following questions?

1. Ethnicity: *African American* *Asian American* *Anglo American*
Latino *Native American* *Other* _____
2. Number of sons _____ Number of daughters _____
3. Your child is the (please circle) Oldest Middle Youngest Only child
4. Family members in science or technology related jobs.

Please name the people in your family who
use computers to do their job;
teach math, biology, science, or computer science;
are doctors, engineers, or webpage designers.

Yourself _____ Spouse _____

Sons _____ Daughters _____

Other relatives _____

Appendix G

Directions: Complete the crossnumber puzzle by finding the value of n.

Across:

1. $\frac{1}{4} = \frac{n}{16}$

2. $\frac{n}{3} = \frac{5}{15}$

4. $\frac{3}{6} = \frac{n}{18}$

3. $\frac{5}{15} = \frac{n}{45}$

7. $\frac{6}{12} = \frac{n}{24}$

5. $\frac{8}{10} = \frac{n}{30}$

8. $\frac{3}{8} = \frac{15}{n}$

6. $\frac{2}{7} = \frac{14}{n}$

9. $\frac{3}{10} = \frac{n}{20}$

7. $\frac{n}{5} = \frac{10}{25}$

10. $\frac{1}{n} = \frac{10}{50}$

9. $\frac{1}{7} = \frac{n}{49}$

11. $\frac{4}{9} = \frac{n}{72}$

12. $\frac{5}{7} = \frac{n}{42}$

13. $\frac{n}{6} = \frac{9}{18}$

Down:

Appendix H

Assent Form

Sources of Mathematics Self Efficacy

Introduction. I, _____ have been asked to be in this research study, which has been explained to me by my AnaGloria Rodriguez, B.A., a student at West Virginia University.

Purpose of the Study: I have been told that the purpose of the study is to learn more about the sources of mathematics self-efficacy—how I feel about math; how good I think I am in math; how important I think math is in my life.

Procedure: This study will be performed during class. I will be given 4 lists of written questions to answer. It will take about ten minutes to answer the questions. I may see the questions before signing this page. There are no right or wrong answers to the questions I will be asked to respond to. I do not have to answer all of the questions.

Discomforts: There are no known discomforts that are associated with participating in this study.

Benefits: I understand that this study is not expected to help me, but what they learn from the study may help other people.

Confidentiality: I have been promised that anything they learn about me in this study will be kept as secret as possible.

Voluntary Participation: I have been told that I do not have to do this. No one will be mad at me if I refuse to do this, or if I decide to quit or if I do not want to do this. This will not affect my grades or my class standing. I have been allowed to ask questions about the research and all of my questions have been answered. I will receive a copy of this form after I sign it.

I willingly agree to be in this study.

Signature of Subject

Date

Signature of Investigator or Investigator's
Representative

Date