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Differential effects of single-sex versus coed education on the mathematical reasoning ability, verbal reasoning ability, and self-concept of highschool girls

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FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

**DIFFERENTIAL EFFECTS OF SINGLE-SEX VERSUS
COED EDUCATION ON THE MATHEMATICAL REASONING
ABILITY, VERBAL REASONING ABILITY,
AND SELF-CONCEPT OF HIGH SCHOOL GIRLS**

**A dissertation submitted in partial satisfaction of the
requirements for the degree of
DOCTOR OF EDUCATION
IN
ADULT EDUCATION AND HUMAN RESOURCE DEVELOPMENT**

by

Kevin E. Conway

1996

To: L. Ira Goldenberg
College of Education

This dissertation, written by Kevin E. Conway, and entitled DIFFERENTIAL EFFECTS OF SINGLE-SEX VERSUS COED EDUCATION ON THE MATHEMATICAL REASONING ABILITY, VERBAL REASONING ABILITY, AND SELF-CONCEPT OF HIGH SCHOOL GIRLS, having been approved in respect to style and intellectual content, is referred to you for judgement.

We have read this dissertation and recommend that it be approved.

Carlos Alvarez

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Douglas Smith, Major Professor

Date of defense: October 1, 1996

The dissertation of Kevin E. Conway is approved.

Dean L. Ira Goldenberg
College of Education

Dr. Richard L. Campbell
Dean of Graduate Studies

Florida International University, 1996

ABSTRACT OF THE DISSERTATION
DIFFERENTIAL EFFECTS OF SINGLE-SEX VERSUS
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by

Kevin E. Conway

Florida International University, 1996

Professor Douglas Smith, Major Professor

This study explored the differential effects of single-sex versus coed education on the cognitive and affective development of young women in senior year of high school. The basic research question was: What are the differential effects of single-sex versus coed education on the development of mathematical reasoning ability, verbal reasoning ability, or self-concept of high school girls?

This study was composed of two parts. In the first part, the SAT verbal and mathematical ability scores were recorded for those subjects in the two schools from which the sample populations were drawn. The second part of the study required the application of the Piers-Harris Children's Self-Concept Scale to subjects in each of the two sample populations. The sample schools were deliberately selected to minimize between group differences in the populations. One was an all girls school, the other coeducational.

The research design employed in this study was the causal-comparative method, used to explore causal relationships between variables that already exist. Based on a comprehensive analysis of the data produced by this research, no significant difference was found to exist between the mean scores of the senior girls in the single-sex school and

the coed school on the SAT 1 verbal reasoning section. Nor was any significant difference found to exist between the mean scores of the senior girls in the single-sex school and the coed school on the SAT 1 mathematical reasoning section. Finally, no significant difference between the mean total scores of the senior girls in the single-sex school and the coed school on the Piers-Harris Children's Self-Concept Scale was found to exist.

Contrary to what many other studies have found in the past about single-sex schools and their advantages for girls, this study found no support for such advantages in the cognitive areas of verbal and mathematical reasoning as measured by the SAT or in the affective area of self-concept as measured by the Piers-Harris Children's Self-Concept Scale.

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CHAPTER 1

Introduction

Both the value of an education and the challenges to educate have never been greater. The United States is witnessing a rapid transition of its population and work force. If we are to continue to meet the challenges of educating an evolving populace, we must turn the research spotlight on those underrepresented in previous educational study: women and minorities.

This study examines the potential benefits of single-sex education for girls. This chapter presents the background of the problem, a statement of the problem and research questions, a conceptual framework, the significance of the study, a definition of terms, assumptions, and limitations.

Background of the Problem

The problem examined by this study concerns the potential benefits of single-sex education for girls. These benefits may be cognitive and expressed by enhanced development of verbal and mathematical reasoning abilities, or they may be affective and expressed by variables such as higher self-esteem or greater likelihood to pursue non-traditional study areas or careers. Each of these issues is unique, yet interrelated. The fundamental problem concerns single-sex schools and the question of their value. As Keller (cited in Sadker, 1994) stated, "although coeducation is taken for granted today, over the course of history it has been at the center of controversy" (p. 230).

Single-sex schools are rapidly disappearing in the United States. In the past 25 years, all girl high schools and colleges have experienced dramatic reductions in numbers. Sadker (1994) referred to them as endangered species and contrasted this recent development with the 1960's when about 62% of nonreligious, independent schools were single-sex. By 1994, that figure stood at 19%. Likewise, all Catholic secondary schools were at one time single-sex, but by 1993 almost 60% were coeducational (Sadker, 1994).

Schneider and Coutts (1982) commented that "strikingly little research, particularly in North America, has been conducted, a state of affairs that undoubtedly is related to the declining availability of single-sex schools" (p. 898).

While on the verge of extinction in the United States, in other countries single-sex schools are more common. Jarchow (1992) noted that in New Zealand, for example, there is a choice for secondary school students. They may choose single-sex or coed schools although she observed that "most young women believe that a single-sex school is academically best for them" (p. 395).

Ryan (1974) pointed out that for a long time educators have been very interested in addressing the differences among students. Much study has been invested in the search for the most effective grouping methods, and yet one of the most obvious differences of all, gender, has been largely ignored.

Stating the case for single-sex schools in even more emphatic terms than Ryan, Powell and Powell (1983) argued that the move toward elimination of single-sex schools for girls has resulted in the elimination of a powerful option. They contended that coeducation does not guarantee equity for girls. Americans have come to regard coeducation as "natural" and "normal" because outside forces have promoted the idea that teenage socialization is the important function of high school. In fact, this was noted as early as 1961 by Coleman who wrote, "our society has created an adolescent subculture in which the importance of physical attractiveness and heterosexual popularity takes primacy over academic achievement" (cited in Riordan, 1985, p. 521). One can only wonder what Coleman would say now, 33 years later.

Powell and Powell (1983) proposed that for some girls, girls schools were the best option. They recommended the consideration of single-sex schools in the national discussion on improvements in education, and even suggested the creation of magnet schools where gender itself is the magnet. As Riordan (1985) observed, "The decision to

close and/or merge single-sex schools may be one of the most underresearched policies in education" (p. 521).

The probable extinction of the single-sex school in this country seems to be closely related to declining enrollment in parochial schools and other private institutions. Astin and Hirsch observed that "it is generally agreed that the purpose of coeducation was not to raise the status of women but to assist the institutions economically" (cited in Riordan, 1990, p. 33). Hennessey (1985) also cited financial pressures as the driving force behind almost all decisions of single-sex schools to merge with a brother/sister school or to open their doors to the opposite sex. Ryan (1974) concurred and said "coeducation was not adopted as a consequence of any careful consideration of the inherent values such a system might have, and certainly not because of any research evidence pointing to its benefits" (p. 2).

Statement of the Problem

This study explored the effects of classroom sex mix on the cognitive and affective development of girls. Whether or not high school girls developed greater reasoning skills or achieved more in academic areas in single-sex classes as opposed to coed (mixed-sex) classes had been examined, but the results were inconclusive. The same was true for self-concept. Current educational practice apparently assumes that learning is the same for all regardless of the sex mix environment despite previous research findings to the contrary (e.g. Lockheed, 1976).

The research problem was stated in three parts:

- (1) to determine if development of verbal reasoning abilities as indicated by the SAT 1: Reasoning Test (SAT) verbal reasoning scores was the same for girls in single-sex and coed secondary schools;
- (2) to determine if development of mathematical reasoning abilities as indicated by the SAT mathematical reasoning scores was the same for girls in single-sex and coed

secondary schools;

- (3) to determine if self-concept as indicated by the Piers-Harris Children's Self-Concept Scale was the same for girls in single-sex and coed secondary schools.

Research Questions and Hypotheses

The basic research question was: What are the differential effects of single-sex versus coed education on the development of mathematical reasoning ability, verbal reasoning ability, or self-concept of high school girls?

The following specific research questions were answered by this study:

- (1) Did senior girls in single-sex secondary schools score higher on the SAT verbal reasoning sections than their counterparts in coed secondary schools?
- (2) Did senior girls in single-sex secondary schools score higher on the SAT mathematical reasoning sections than their counterparts in coed secondary schools?
- (3) Did senior girls in single-sex secondary schools score higher on measures of self-concept than senior girls in coed schools?

The following research hypotheses were stated as null hypotheses in order to facilitate statistical treatment of the data:

- H_1 There is no difference between the mean scores of the senior girls in the single-sex school and the coed school on the SAT 1 verbal reasoning section.
- H_2 There is no difference between the mean scores of the senior girls in the single-sex school and the coed school on the SAT 1 mathematical reasoning section.
- H_3 There is no difference between the mean scores of the senior girls in the single-sex school and the coed school on the Piers-Harris Children's Self-Concept Scale.

Conceptual Framework

The lack of interest in women's issues in educational reform discussions and research in recent years has been striking. A report published by the American Association of University Women based on more than 1300 studies contended that the current educational debate ignores "the links among sex, gender, and academic performance" (American Association, 1995, p. 3). In fact, this report concluded, "In the midst of national education-reform efforts earlier in this decade it became disturbingly apparent to members of the American Association of University Women (AAUW) that girls were not adequately represented or addressed in the wide-ranging discussions and debates taking place throughout the country. Girls, in fact, were nearly invisible" (American Association, 1995, p. x). While data on feminist issues outside education continued to accumulate, the question of how women learn best has not yet been resolved.

There has been much recent research on learning styles and teaching styles, but very little on the importance of sex mix as a factor in structuring schools or selecting curriculum. At least some of the research that has been done suggested that single-sex schools may have some beneficial effects for women in high school and college settings.

In their comprehensive treatment of the education of women in the United States, Sadker and Sadker (1994) devoted a chapter to the debate about coeducation verses single-sex education for women and girls. They offered some anecdotal and qualitative evidence to support the potential value of single-sex schools for girls. And while Sadker and Sadker admitted that at times the methodology of studies supporting single-sex schools for girls was open to criticism, they concluded that the evidence was persuasive, that girls in single-sex schools had higher self-esteem and were more willing to study non-traditional (for girls) subjects such as math and science than their peers in mixed-sex schools.

The same AAUW report (American Association, 1995) cited above which drew national attention to the problem of equity in education for girls cited no studies that specifically examined the question of single-sex schools and their value for girls.

Significance of the Study

Need for the Study

Need within practice.

The question of the single-sex school has not received the attention it deserves. A 1970 review of a UNESCO study of 105 countries noted that "true coeducation is introduced initially much more often as a result of particular circumstances than because of any clearly defined principle" (Greenough cited in Riordan, 1990, p. 3). The American school system has automatically assumed that the very "equality" provided by coeducational institutions guarantees "equity." The possibility of alternative approaches has barely been considered. In this era of the multicultural society, it is important for educators to know if single-sex classes offer any benefits to some students in some circumstances.

And what are the supposed benefits of the coeducational model that now enjoys preeminence in the American educational scheme? Riordan (1990) summarized the arguments in favor of coeducation as follows: coeducation insured economic efficiency; coeducation was "natural;" coeducation resulted in the reduction of gender stereotypes; coeducation prepared students for less differentiated gender roles; and coeducation provided quality of educational opportunity.

On the other hand, what possible rationale might be made for single-sex schools? Riordan (1990) continued his examination of the possible beneficial affects of single-sex schools by arguing the following: single-sex schools provided more role models of the same sex; single-sex schools allowed for the development of appropriate sex roles; single-sex schools provided all students with complete access to the full range of educational

opportunities within the curriculum; single-sex schools provided more teacher-student interaction along gender lines; single-sex schools reduced the influence of the adolescent subculture.

Need within the body of research and theory.

There was insufficient research dealing with this question. Riordan (1990) said that coeducation is one of the least studied topics. Numerous researchers have commented on the sparsity of research on single-sex schools in general. An even smaller amount existed on the benefits of single-sex schools for girls. Lockheed (1976) asked, "What is known about the relative merits of single-sex education verses coeducation?," then answered, "Very little, it appears" (p. 6). Ryan (1974) concurred and called for more study of school sex mix as a factor that influences learning. She concluded by saying that "reliable studies dealing with the strengths and weaknesses of coeducation as compared with single-sex schools are extremely rare" (Ryan, 1974, p. 13). Ten years later, Hennessey (1985) noted the continued absence of research on the differences between the coeducational and single-sex environment on secondary students.

Anticipated Consequences

Consequences for practice.

Prior to data collection and statistical analysis in this study, one could have anticipated several possible results. First, the possibility existed that sex mix had no effect on SAT scores or measures of self-concept. In this case, the null hypotheses of this study would be supported.

Secondly, the study could have found that sex mix had an effect on either SAT verbal reasoning or mathematical reasoning scores, or both, but not on self-concept. A third possibility was that sex mix only affected measures of self-concept. The second and third possibilities would indicate support for one or more of the study's alternate

hypotheses. The fourth possibility, and the one suggested by the intent of the study, was that sex mix would be found to affect both SAT scores and the measure of self-concept.

Consequences for research and theory.

The results of this study will contribute toward resolution of the educational issues already raised in this paper. If the hypotheses were supported, or supported in part, further research would be needed to determine the exact relationship between the variables of classroom sex mix, SAT verbal ability scores, SAT mathematical ability scores, and measures of self-concept in order to determine the presence of a cause and effect relationship. These consequences are discussed further in Chapter 5.

Definition of Terms

The following terms were defined in order to clarify their meaning and use in relation to this study.

Classroom sex mix. Classes are either homogeneous or heterogeneous with respect to gender. Classroom sex mix refers to whether a class is single-sex (homogeneous) or mixed-sex (heterogeneous or coeducational) in its composition.

Coed or Coeducational. A school environment in which members of both sexes are present in the same classroom. At one time it was possible to find schools with male and female students in the same building, but classrooms segregated by gender. This is known as co-institutional schooling.

Mixed-sex. This term is synonymous with coed and coeducational. It refers to educational settings in which members of both genders are present in the same classroom.

Self-concept. The term is used to describe a relatively stable set of self-attitudes that reflect both a description and evaluation of one's own behavior and attributes (Piers, 1984).

Single-sex. Class environments in which only boys or only girls are present are single-sex. Under ordinary circumstances single-sex classes are found in single-sex

schools, though they may also exist as part of coeducational schooling. In this study the single-sex school is also referred to as the girls school.

Assumptions

The following assumptions were made when conducting this study:

1. Because the subjects in the study attended private, Catholic schools, with similar tuitions,¹ it was assumed that they came from similar socio-economic backgrounds.
2. Because the schools in the study followed a curriculum determined by the Florida State Education Department, it was assumed that students in the two schools were exposed to the same basic curriculum.
3. It was assumed that academic differences between the subjects in the single-sex school and the coed school could be statistically controlled.
4. It was assumed that self-concept was a measurable component of personality and could be quantified using the appropriate instrument.

Limitations

The participants in this study were students in two different Catholic schools, a possible liability. While girls in these two Catholic schools may have differed from each other, the two schools did share many similar features: Catholic schools, located in Miami, Florida, similar tuition, similar entrance requirements, and similar ethnic composition. Similar schools were deliberately chosen in an attempt to reduce the influence of extraneous variables. Potential effects not related to school type but to extraneous factors had to be identified and taken into account in interpreting the results of the statistical analysis of the data.

Verbal and mathematical reasoning abilities in this study were measured by SAT scores. In order to control for ability, initial high school entrance exam scores were used

¹ Tuition for the 1995-96 school year was \$3,300 at the coed school and \$3,650 at the girls school.

for those seniors who took the entrance exam as eighth grade applicants. This information was not available for students who transferred into the school or did not take the entrance exam. Furthermore, since students take the SAT exam at different points in their high school careers, SAT 1 scores from the October, November, or December exams taken in the students' senior year were used. These SAT test dates were chosen for inclusion because they are the dates selected by a large number of high school students to take their SAT 1 exams. However, this further limited the number of girls used in the comparison to those who took the SAT 1 exam in the months specified above.

Another limitation was school population size. The schools in this study had female populations between 700 and 1000. This meant that the number of senior girls in each school would range from 175 -225. After eliminating students who did not take the October, November, or December SAT exam, the number of girls with SAT scores available for comparison would be reduced to approximately 125 - 150 in each school.

Further limitations were related to the nature of the instruments used to gather the data. The accuracy with which one can measure verbal and mathematical reasoning ability depends on the validity of the SAT. The same was true for the instrument used to measure self-concept, the Piers-Harris Children's Self-Concept Scale.

Because of the unique environment of Catholic schools, the cultural peculiarities of Miami, and the relatively small sample size that provided the data for this study, the results cannot be freely generalized to girls in other kinds of high schools or in other areas of the country.

Summary

In Chapter 1, the research problem was stated and the background was given. The objectives of the study, to explore the differential effects of single-sex versus coed education on specific cognitive and affective outcomes, were presented in the form of research questions and hypotheses. A conceptual framework for the research problem was

laid out. The need for such study was corroborated by citing researchers who pointed out both the scarcity of this type of research and the rapid disappearance of single-sex schools in the United States.

The potential consequences for practice and theory were delineated. Important terms used in the study were defined, and assumptions made in conducting the research were identified. Finally, limitations related to the sample, methodology, and measurement instruments were acknowledged.

In Chapter 2, studies related to the research problem are reviewed and discussed.

CHAPTER 2

Review of the Related Literature

Introduction

This chapter expands upon the introductory presentation in Chapter 1 and reviews research related to this study that examined the advantages of single-sex versus coed schools for girls. Chapter 2 includes a review of the theoretical and empirical literature germane to this study.

Theoretical Review

In their joint monograph, Gilligan, Ward, and Taylor (1985) presented a series of articles discussing theories and ongoing research about questions of gender and moral development. Much of it was their own work and theory. One of the first questions posed by Gilligan in the prologue was, "What has been missed by not studying girls?" (p. x). More specific to education, El Saffar (1989) contended that until recently, American women have faced an "alien world" in schools and that today's challenge was to "define at the curricular and structural level what it means for women to be truly represented" (p. 48). Granted neither raised the question specifically about studying girls in single-sex schools, but if research about girls in schools has value, one can assume the same about the research on girls in single-sex schools.

According to the description of cognitive development presented by Gilligan et al. (1985), thinking becomes conventional during adolescence. Indeed, they wrote, "adolescence, the time when thinking becomes self-consciously interpretive, is also the time when the interpretive schemes of culture, including the system of social norms, values, and roles, impinge more directly on perception and judgment, defining within the framework of a given society what is the 'right way' to see and to feel and to think, the way 'we' think" (p. xxiii).

If the above assertion was accurate, what did this mean for girls in male-dominated societies (and male-dominated schools)? If there were two different "voices" for understanding and making sense of reality, and if adolescence was a critical time for the proper cultural "formation" of these voices, did that not suggest that at least some girls would be better served by schools in which the "impinging culture" and "societal framework" modeled during these critical formative years were speaking to them in their own feminine voice?

Now the argument could be made that even if one answered yes to the above question, that did not necessarily imply an endorsement of single-sex schools. In a perfect world, it might be possible to create educational environments in which both the male and female voices were equally accessible to all students, regardless of gender, promoting the healthy development of the male and female voice inside all of us. However, even if such a balance were achievable, there may still be a place for single-sex schools at certain ages or stages in the developmental process or for certain populations.

Further evidence supporting the single-sex environment was presented by Gilligan et al. (1985) when they cited the fact that teachers have often observed (in anecdotal fashion) that girls became less outspoken and less likely to disagree in public, or even participate in class after reaching puberty. They noted that high school education "may be more readily accessible and comprehensible to those students (male) whose experience and background are most similar to that of the framers" (p. xxxv). This fact may have partially explained why Riordan (1985) noted no differences for boys in single-sex Catholic schools, mixed-sex Catholic schools, and mixed-sex public schools in cognitive achievement. Since one could suppose that all three types of schools followed some version of the basic model dominant in American education, based on male experience and the "male voice," there was no measurable difference in achievement. On the other hand,

Riordan did report differences for girls and boys from minority groups, both of whose backgrounds would have been different from that of the "framers."

In an interesting application of this "two voice" theory, Johnson (cited in Gilligan et al., 1985) studied the two moral orientations of justice/rights verses care/response using Aesop's fables with children between the ages of 11 and 15 to see how they tended to resolve moral dilemmas. The children were presented with one of two fables and asked what action they would have taken. Their responses were analyzed and classified according to the orientation that was used. Responses fell into three categories: a justice/rights orientation; a care/response orientation; or a combination of the two.

One of the unpredicted results was that the older girls used the moral orientation of justice/rights more often in solving the problem posed by the fable of "The Porcupine and the Moles" (see Appendix A). It had been assumed that this was a male orientation. All girls tended to favor the moral orientation of care/response in solving the problem posed by the other fable and the younger girls chose this orientation more frequently in tackling "The Porcupine and the Moles" fable as well. Why did the older girls show a greater likelihood to use the (assumed) male orientation? Was it possible that as they got older they were being affected by the "system"? Neither Johnson (cited in Gilligan et al., 1985) nor Gilligan et al. (1985) raised these questions directly. However, in this consideration of the single-sex question these were very important data. It was important to know if girls (or some girls, or some girls at certain ages) learned better in a single-sex environment (whether that be a single-sex class or a single-sex school). However, if something as intrinsic to a person as his/her moral stance can be affected by environment, as was suggested by the above study, that is even more important for educators and political leaders to know as they plan our schools of the future.

If two moral voices, that while not "gender specific" but "gender related," did exist, then a much stronger argument could be made for taking a closer look at single-sex

institutions, especially for girls. What educator would take a French-speaking child from Paris and put him/her in a German-speaking school in Berlin without realizing that the child would be disadvantaged? And if we left that child in Berlin for fifteen years, in an environment that was predominantly German-speaking and German thinking, would we be surprised if the child's ability to speak French diminished? Would we expect the child to grow up without being influenced by the German culture that surrounded him/her? Without more research into gender issues, moral issues, developmental issues and how all these variables relate to one another, is it not possible that we are doing something similar to our own children?

This section has been concerned with the issue of sex mix in schools or classrooms because it is the theoretical basis of this study's interest. In the section that follows, studies are presented related to single-sex schools and their value for women. The first part of the empirical review focuses on cognitive outcomes, the second part discusses affective outcomes.

Empirical Review

A review of the literature on single-sex schools provided mixed information. These kinds of schools have been studied sporadically in the past decade. Furthermore, where such research did exist, it was frequently for schools in other countries (Hennessey, 1985). The most common studies were done in schools in England, Australia, and Canada, and these often dealt with the pros and cons of coeducation from a social perspective (Ryan, 1974). As Riordan (1985) noted, "The issue of single-sex schooling has received very little research attention, particularly in the United States" (p. 521).

One notable study was done by Dale. Marsh identified Dale's work (1989, p. 70) as "Historically, the most important research on single-sex/coed differences." This extensive research program, conducted in England and Wales in British grammar schools during the period between 1947 and 1967, led Dale to conclude that coeducation was

definitely preferable to single-sex schooling. Dale was an "unabashed" supporter of coeducation and believed that "it has been demonstrated that the average coeducation grammar school is a happier community for both staff and pupils than the average single-sex school" (cited in Marsh et al., 1988, p. 239). However, even Marsh, whose own work favored coeducation, realized the limitation of Dale's work and agreed with Bone when he said "there are good reasons why his (Dale's) conclusions cannot be regarded as the last word on the issue as it stands today" (cited in Marsh et al., p. 2). Dale studied a particular type of school (British grammar schools) during a particular time period and his results cannot be generalized to other settings.

A study by Rowe (1988) specifically focused on the establishment of single-sex classes for girls within coeducational Australian high schools. These classes were established in an effort to boost participation and achievement for girls in science and math. The single-sex classes did not produce significant differences in math achievement when results were compared to girls in coed classes.

Marsh (1989) noted that data provided by recent studies such as *High School & Beyond* favored single-sex schools for academic achievement. However, the advantage was not significant once extraneous factors like social class, prior achievement, and intelligence were taken into account. In analyzing the *High School & Beyond* data, Marsh concluded that when results were controlled for background variables, there were no significant school type effects. This conclusion is further confirmed by his participation in a five year longitudinal study done in Australia (Marsh, Smith, Marsh, and Owens, 1988) in which data were collected on students who attended single-sex high schools that were transformed into coeducational institutions. School type was found to have little or no effect on school performance.

Various other studies (Bornholt, Goodnow, and Cooney, 1988; Harvey, 1985; Lordan, 1987; Willis & Kenway, 1986) performed in England, Australia, and the United

States also found no evidence that single-sex schools benefited girls more than mixed-sex schools. Each of these examined some field of academic achievement.

Cognitive Outcomes

As stated in the introductory paragraph to this section, a review of the literature on single-sex schools provided "mixed" results. While the studies cited above showed no difference between single-sex and coeducational education for girls, or indicated benefits for the coed environment, other researchers have found evidence of advantages for the single-sex environment for girls. Investigations into the effects of single-sex versus coed education on girls could be classified as either studies of academic achievement (cognitive outcomes) or studies of affective outcomes. Often, a particular researcher examined both kinds of outcomes. The group of studies cited in the next section all examined cognitive outcomes. If a study also included data on affective outcomes, it is reported separately in the subsequent section.

Levi (cited in Ryan, 1974) summarized the relevant studies of single-sex and mixed-sex environments for the years 1945 through 1957. Of 100 articles reviewed, he found nearly half concluded against coeducation at the secondary level for a variety of reasons. Levi found that "opinions on the matter clearly divide themselves, for the most part, into two channels: those which favor separate education are decidedly concerned with intellectual advancement and scholastic achievement; those which favor coeducation are looking to a community of interest in which both sexes must co-mingle to work out life's problems together" (p. 14).

Ryan (1974) herself reviewed 34 studies that dealt with coeducation verses single-sex questions for the years between 1957 and 1974. She found mixed results and concluded that because of the diversity of the findings the question remained open. In point of fact, only one of the 34 studies cited by Ryan for this time period reported specifically on achievement for girls in a single-sex school at the secondary level or higher,

and this study by King found evidence to suggest that achievement by girls and boys in mathematics was significantly higher for students in single-sex schools. She concluded, "At the present time the advocate of separate schools or classes cannot point to experimental studies that prove conclusively the advantage he (sic) might claim for the educational arrangement he (sic) recommends -- but neither can the proponent of coeducation. For too little substantial research on the problem has been done" (Ryan, 1974, p. 27).

At almost the same time, Lockheed (1976) reached the same conclusion about the need for further research on the potential benefits of single-sex schools for women and girls. She reported finding less than 20 articles published between 1968 and 1976 dealing directly with the question of coeducation and its implications for females. However, based on that work which did consider females in single-sex and coeducational environments at the secondary level, her research indicated that "the mixed-sex situation is detrimental to the academic achievement of girls" (p. 6). Summarizing her findings, she said "we may tentatively conclude that coeducation impacts negatively on boys in the early grades and negatively on girls in the later grades and in secondary school" (p. 9).

Perhaps the most extensive study that considered the academic affects of single-sex and coed schools was done by the International Association for the Evaluation of Educational Achievement (IEA). This massive study took 7 years to complete and collected information from 133,000 students at the secondary and elementary levels in 21 countries from 1966 to 1973. Achievement in seven curriculum areas was examined. Sex mix was not the central focus of the study, but an analysis of the data base revealed that the students in single-sex secondary schools scored higher in math and science than those in coed secondary schools (Riordan, 1990). In fact, Riordan concluded thusly, "Taken as a whole, these reports offer considerable support in favor of single-sex schools" (p. 48).

In 1976 Trickett, Pendry, and Trickett (cited in Powell & Powell, 1983) studied the experience of adolescent girls in single-sex and coeducational environments. They reported four advantages for girls who attended single-sex schools. One of these advantages was a better academic orientation. The other three advantages were affective outcomes and are discussed in the appropriate section of this report.

Finn (1980) analyzed 14-year olds in the United States, Sweden, and England for sex differences in achievement and attitudes in science and reading. Although it was difficult to generalize the results across nationalities, Finn discovered evidence that the English girls benefited from exposure to female instructors and role models in a way that may have resulted in higher achievement and more positive self-concept with regard to science skills for those in single-sex schools.

When Riordan (1985) studied single-sex Catholic schools, he found them to be twice as effective as coed Catholic schools when achievement was compared. In his analysis of data collected during the National Longitudinal Study of the High School Class of 1972, he discovered little or no improvement in achievement for boys on most cognitive tests in single-sex Catholic high schools when compared to boys in coed Catholic and public high schools. However, girls in single-sex Catholic high schools scored higher on nearly all cognitive tests than girls in coeducational Catholic and public high schools. Riordan concluded that, "In the final analysis, girls in single-sex schools score about one-third of a grade equivalent higher than girls in coed schools, on average. In science, this difference is almost one full year (0.9) of a grade equivalent advantage" (p. 112). There was little difference in the socioeconomic levels of the groups being compared.

Riordan (1985) further found that Black and Hispanic students of both sexes did better on tests in single-sex high schools than comparable minority students in mix-sexed high schools. Riordan concluded his comparison of single-sex Catholic high schools to

coed public and Catholic high schools by stating that "more should be known about single-sex schools before they become historical artifacts" (p.535).

Further support for this line of thinking came from a more recently published investigation into the problem of single-sex schools performed by Bauch. Bauch (1988) claimed that researchers were just beginning to understand the positive effects that single-sex education could have at the high school level. Girls especially benefited. The obvious irony was that this awakening was coming at a time when mergers and conversions were rapidly eliminating single-sex high schools and institutions of higher education in the United States. Bauch went on to report that the research accumulated since 1960 across a variety of cultures revealed that all students in single-sex schools consistently outperformed students in mix-sexed schools in math, science, and reading.

Harvey and Staples (1986) also examined achievement and found advantages for girls in single-sex schools for physical science. Likewise, did Lee and Bryk (1986) who used the same *High School & Beyond* data that had led Marsh (1989) to conclude that there were no significant school type effects when the results were controlled for background variables. These data were collected from 1980 sophomores and 1982 seniors to investigate school type effects. Lee and Bryk reported that the adjusted single-sex affects on academic achievement for girls were generally positive and that these effects increased in size from 10th to 12th grade in science and reading at a statistically significant level. Lee and Bryk stated "it is clear that the estimated single-sex school effects represented a very large portion of the total variability occurring between Catholic secondary schools" (p. 30).

Affective Outcomes

In addition to its effects on academic achievement, researchers have also been interested in questions related to the effect of school type for girls on such affective areas as self-concept, self-esteem, willingness to study non-traditional subject areas,

assertiveness, extra-curricular involvement, and attitudes toward feminist issues. Sadker and Sadker (1994) suggested that all girl classrooms provided an advantageous environment in which girls were "educational players rather than spectators" (p. 234). Supporting this contention was the work of Welch who compared verbal assertiveness in class discussions at four prestigious universities and discovered that the women in the single-sex schools were more assertive than their counterparts in coeducational institutions (cited in Sadker and Sadker, 1994).

The 1976 Trickett, Pendry, and Trickett (cited in Powell & Powell, 1983) study discussed in the previous section on cognitive outcomes reported four advantages for girls who attended single-sex schools. One of these advantages (better academic orientation) was of a cognitive nature. However, the other three advantages (higher self-esteem, more ambition and assertiveness, and more extracurricular involvement) were all affective outcomes. In a later study, Trickett, Trickett, Castro, and Schaffner (1982) looked at girls' attitudes in public and private high schools. They found support for the idea that girls in single-sex schools had greater interest in the women's movement than girls in coeducational schools.

In a five year longitudinal study done in Australia (Marsh, et al., 1988), data were collected on students who attended single-sex high schools that were transformed into coeducational institutions. Control students who remained in single-sex schools exhibited modestly higher self-concepts, although this was ascribed to the depressing influence of the disruption caused by the transition process.

Finn (1980), whose work is discussed in the section of this report dealing with cognitive outcomes, looked for sex differences in achievement in science and reading. He reported evidence linking cognitive gains in science for English girls with more positive self-concepts with regards to science skills resulting from exposure to female instructors and role models. A similar benefit for girls in single-sex schools was explained by Sarah,

Spendes, and Scott (cited in Pepper, 1985). They observed that all girl classes with female teachers provided greater opportunity to redefine sex-role stereotypes than coed classes.

Rowe (1988) found significant gains in girls' confidence in learning and using math independent of achievement. This study, also cited in the section on cognitive outcomes, supported the results reported by Finn (1980). Although Rowe reported improved confidence in learning math, and Finn found more positive self-concept with regards to science skills, both researchers correlated cognitive gains to affective ones for girls in a single-sex environment.

Lee and Bryk (1986), using the *High School & Beyond* data previously described in the section on cognitive outcomes, found that girls in single-sex schools showed consistent positive effects on attitudes towards academics. Lee and Bryk concluded that single-sex schools gave special advantages to girls, perhaps by making them more aware of the full range of potential occupations available to them and by freeing them from the pressures of the adolescent culture.

Harvey and Staples (1986) reached a different conclusion than Lee and Bryk about the affective benefits of school sex mix. Their interpretation of the *High School & Beyond* data indicated that girls in coed schools had more positive attitudes towards school. Other research done in Canada on the question of single-sex versus coed schools also found that coed students were generally more positive toward school and that the coed schools provided a more pleasant environment for the social and emotional needs of their students and reduced rigidity and discipline (Schneider, Coutts, and Starr, 1988; Schneider and Coutts, 1982). But even Schneider et al. (1988) whose report was entitled *In Favor of Coeducation* admitted that "it is quite likely that future research will demonstrate that there is a place for both single-sex and coeducational schools in the education of children" (p.492).

Further evidence of the effect of school sex mix on affective areas came from the work of Mixell (1989) who reviewed 43 studies dealing with the issue of single-sex schools. She found that girls received advantages in the areas of female educational success, diminishing sex-stereotyping and enhanced academic performance although her research did find an advantage for the coeducational setting in terms of school environment.

Many of the above mentioned studies have dealt with single-sex and coed Catholic schools. It should be noted that often the researchers were as much interested in the impact of the "Catholic" school environment as the issue of sex mix. Consequently, the results may be less useful than they would be if sex mix were the only focus of the investigation.

Summary

Most of the research and theory cited thus far come from those whose work supported the call for further investigation into the question of single-sex schools. As many of the above researchers (i.e. Levi, Ryan, Sadker) have noted, there are also studies whose results indicated either no difference between the coed and single-sex environment, or implied the superiority of coeducational schooling.

If anything can be gleaned from the review of the research presented in this paper, it is that while no consensus exists, there is clearly the suggestion that the single-sex environment may offer a variety of benefits to girls. Such benefits are thought to be both cognitive and affective in nature and may include enhanced achievement (especially in math, science, and reading), higher self-esteem, greater willingness to take science and math, and increased likelihood to pursue nontraditional majors or careers. The main advantage identified for the coeducational environment is the presence of a more positive attitude on the part of the students toward school or academics.

It is also clear from the research that the number of single-sex girls schools in the United States has declined significantly over the past 30 years. This near extinction can be traced to two factors. The first factor is a public policy that has wholeheartedly embraced coeducation. The second factor is the financial pressures that have driven single-sex private schools to close or merge. What has been noticeably absent in this wholesale shift to coeducation is a data-based educational justification. The one imperative that emerges from nearly all the cited research is the fact that more research is needed.

CHAPTER 3

Methodology

Introduction

This study was composed of two parts. Chapter 3 details the methodology used in each part of the study to collect the data. In the first part of the study, the SAT I: Reasoning Test (SAT) verbal and mathematical ability scores were recorded for those subjects in the two schools from which the sample populations were drawn. The High School Placement Test (HSPT) verbal and quantitative cognitive skill scores were also recorded.

The second part of the study required the use of an instrument to measure self-concept. This instrument was given to subjects in the 9th and 12th grades in each of the two schools.

Research Design and Rationale

The research design employed in this study was the causal-comparative method (also referred to as the *ex post facto* method). This method is used to explore causal relationships between variables that already exist. The causal-comparative method produces tentative cause-effect relationships. In this study, it was not possible to manipulate the independent variable, type of school attended; it had already occurred. This research started with a cause, e.g. attendance at a single-sex or coed high school, and investigated its effect on three other variables: verbal reasoning ability, mathematical reasoning ability, and self-concept.

Review of Methodological Literature

When groups are already formed and already different with respect to the independent variable, causal-comparative research is an appropriate methodology to use in attempting to identify cause and effect relationships. This is what differentiates this type of research from experimental research.

Causal-comparative studies examine the effects of independent variables that either **should not** or **can not** be manipulated (Gay, 1996). This is the major advantage of causal-comparative research, studying cause-and-effect relationships in situations where experimental manipulation is not possible. Gay described another use of this research methodology as the identification of relationships that may serve as the basis for future experimental study. Borg and Gall (1989) asserted that discovering such cause-and-effect relationships is an important component of theory building whose ultimate goal is educational improvement.

However, there are limitations in doing causal-comparative research concerning data analysis and drawing conclusions. One important limitation is connected to the very reason for using this method: the independent variable condition is pre-existent. This fact results in limited research control and precludes the kind of rigorous application of the scientific method available with experimental designs. A second important limitation is that even if a relationship is established, it is not necessarily a causal one (Gay, 1996) and it is difficult to support causality using the data collected (Borg and Gall, 1989).

Overview of Strategies

The intent of this study was to compare affective and cognitive measures for high school senior girls in two different schools, a single-sex girls high school and a coeducational, mixed-sex high school. The experimental question asked whether school sex mix, single-sex versus mixed-sex, affected the development of verbal or mathematical reasoning abilities or self-concept.

In order to answer this question, data were collected for subjects in the girls school. The same kind of data were collected for girls in the coeducational school. The specific data collected were SAT scores, High School Placement Test scores, and scores on the Piers-Harris Children's Self-Concept Scale. These data were then subjected to statistical analyses.

Population and Sample

The population for this study consisted of girls in two Miami Catholic high schools: St. Brendan's High School and Our Lady of Lourdes Academy. The former is a coeducational school with approximately 1000 girls and 250 boys in grades 9 through 12. The latter is an all girls high school with about 700 students. The two schools were deliberately selected to minimize between group differences in the populations.

The sample for part one of the study consisted of all senior girls who took the SAT exam between September and December of 1995. This yielded 130 students in Our Lady of Lourdes Academy and 140 students in St. Brendan's High School.

Part two of the study required the administration of an instrument to measure self-concept. The sample subjects included those freshman and senior girls present on the day selected for the exam in both St. Brendan's High School and Our Lady of Lourdes Academy.

The population of each school was multicultural. The majority of the girls in both schools came from Hispanic families. Nearly all of the other students in the sample were non-Hispanic, whites. The two populations shared several common characteristics. Both consisted of high school girls who were similar in age and educational level. Both schools were college preparatory, Catholic high schools. Both enrolled students in grades nine through twelve. The curricula in each school were similar, and each school was sponsored by the Archdiocese of Miami and accredited by the Southern Association of Colleges and Schools. The schools charged similar tuition and accepted students from similar socio-economic levels. The two schools were located in the southwestern section of Dade county, only a few miles apart.

Instrument Selection, Application, and Validity and Reliability

SAT I: Reasoning Test

The first part of this study attempted to examine the effect of school sex-mix on the cognitive areas of verbal and mathematical reasoning. The SAT I: Reasoning Test was the instrument that provided the data for this research. Prior to 1994, the test was called the College Board Scholastic Aptitude Test. The test is now called the SAT I: Reasoning Test and will be referred to as the SAT in this paper. Its purpose is to measure the "developed verbal and mathematical reasoning abilities related to successful performance in college" (Murphy, Conoley, and Impara, 1994, p. 186). The test yields two scores: one for verbal reasoning and another for mathematical reasoning.

The SAT was chosen for use in this study for several reasons. First, the SAT measures the extent of development of the cognitive abilities of verbal and mathematical reasoning that are related to successful achievement in college. One purpose of this study was to explore the effect that school sex-mix has on women and girls in such cognitive areas. Second, the SAT was taken by most of the senior girls in both of the sample schools between September and December of 1995. This provided a sample size of between 130 and 140 girls in each school. Because the subjects took the exam as part of the college application process, it was not necessary to select and administer a separate instrument.

A third reason for choosing the SAT was that it is one of the best-known and most-widely used standardized tests. The scores reported are scaled in such a way as to allow comparison across different test forms and different test-taking groups. This was important because the subjects in this study took the SAT on different dates and in different locations. The test has good internal reliability. An adaptation of the Kuder-Richardson 20 yielded reliability coefficients greater than .90 and test-retest correlations that averaged approximately .87 for both verbal and mathematical sections (Dressel cited in Cohn, 1985).

The question of the SAT's validity has been exhaustively researched since 1964 with more than 3,500 studies conducted at 750 colleges (Mitchell, 1985). The studies confirmed that SAT results were correlated with college performance, and Cohn (1985) claimed the SAT was the "best documented" instrument of its kind. Furthermore, Cronbach (1985) reported that research has not supported accusations that SAT results "underpredict" college grade averages for minority populations.

A final reason for using the SAT in this study was that, despite its widespread use, little or no research had been performed concerning differences in scores for high school girls related to attendance at single-sex or coed schools. A review of 167 SAT test references for the period 1983 to 1994 revealed that not one study explored the affect of the school sex mix on SAT scores in high school girls (Murphy et al., 1994). Several studies looked at gender differences comparing males to females, but none compared females in girls school environments to females in coeducational school environments.

High School Placement Test

The High School Placement Test (HSPT) was designed by Scholastic Testing Service (STS) for the purpose of selection and placement of students entering high school. The present format has been in use since 1958 and includes measures of broad cognitive skills and essential basic skills. A standard score, national percentile, and local percentile are provided in the following areas: verbal cognitive skills, quantitative cognitive skills, total cognitive skills, basic reading skills, basic mathematics skills, basic language skills, total basic skills, and battery composite. This study used the HSPT verbal ability score and the HSPT quantitative ability score.

The STS High School Placement Test was used by all Catholic secondary schools in the Archdiocese of Miami as the entrance examination. Because most of the sample subjects in the first part of this study had already taken this test as eighth grade students prior to their acceptance at our Lady of Lourdes Academy or St. Brendan's High School,

the verbal and quantitative cognitive skills data were recorded and used to establish baseline ability levels in later statistical comparisons of the SAT results.

The test publisher's own research estimated test reliability for a representative sample of 5000 students using both the Kuder-Richardson Formula 20 and the Kuder-Richardson Formula 21 ("High School Placement Test," 1994). The reliability coefficients for the verbal and quantitative cognitive skills scores ranged from .86 to .89 and for the battery composite scores were .95.

Scholastic Testing Services has also studied the relationship between HSPT scores and SAT scores. Their report pointed out that HSPT percentile-ranks are based on a population of eighth grade students who planned to attend high school, whereas the SAT percentile-ranks are based on populations of junior and senior high school students who planned to attend college. Consequently, there was a difference in the normative populations established for each of these instruments. The HSPT normative population "tends to be slightly more selective than eighth-grade students in general," but the SAT normative populations "represent very elite groups of individuals who clearly are not typical of eleventh- and twelfth-grade students in general" ("Using the STS-HSPT," 1987, p. 1).

Scholastic Testing Services drew the data for the table that appears in Appendix B from a project involving 46 high schools encompassing approximately 4000 students ("The STS Educational," 1987). The table provides an estimate of performance on the SAT based on the HSPT composite. The report indicated that "while the predicted value will not be obtained in every case, one could expect that a value meaningfully close to the prediction will be obtained in the majority of cases" ("Using the STS-HSPT," 1987, p. 1). Furthermore, as might be expected from the differences in the normative populations, the HSPT percentile scores are higher than the predicted SAT percentile scores.

Piers-Harris Children's Self-Concept Scale

The second part of this study explored the effect of school sex mix on the development of self-concept in high school girls. Previous research had suggested that attendance at all girls schools may result in important affective benefits for high school girls. Since the sample subjects did not take a measure of self-concept as part of their guidance testing program, an instrument had to be selected.

Five instruments that measure self-esteem and self-concept were considered. Two were eliminated because they were not appropriate for the high school level. Another test was rejected because it lacked widespread verification of its reliability and validity. The Coopersmith SEI-SF was reported to have good validity and reliability, and it could be used with children and adults. However, it existed in two versions: one for children up to the age of 15, and a second for subjects 16 years and older. This study's research design called for administration of the instrument to both freshman and senior girls. In order to avoid giving two different forms of the same test, use of the Coopersmith SEI-SF was rejected.

The instrument that was selected to measure self-concept in this study is the Piers-Harris Children's Self-Concept Scale. Like the Coopersmith SEI-SF it could be given to all secondary grade levels. Unlike the Coopersmith, there was only one test form. In addition, the Piers-Harris was first developed as a research instrument (Piers, 1984), and its use as a research instrument was recommended in the test manual (Epstein, 1985).

The Piers-Harris gives a total raw score of 80 and six cluster scores: happiness and satisfaction, popularity, intellectual and school status, physical appearance and attributes, anxiety, and behavior. These six cluster scales were empirically derived through factor analysis. Their presence reflects the test developers' assumption that self-concept is not a single concept. The cluster scores may be used to identify specific areas of high or low

self-evaluation in individuals test takers. The clusters were described by Piers (1984) as follows:

Behavior. This cluster is composed of 16 items. It is intended to measure the degree to which the subject admits or denies problematic behaviors. Low scores on this scale suggests that the subject recognizes problem areas. High scores may indicate a lack of behavioral problems or denial of the problems (Piers, 1984).

Intellectual and School Status. The cluster has 17 items. The focus is the subject's self-evaluation of his or her abilities in relation to academic and intellectual tasks. Included in this self-evaluation is one's general satisfaction with school and future expectations.

Physical Appearance and Attributes. The cluster is based on 13 items. The scale measures the subject's attitudes regarding his or her own physical characteristics. Included within this scale is an evaluation of leadership and ability to express ideas.

Anxiety. The fourth cluster is composed on 14 items. The scale examines a variety of emotions related to worry, nervousness, shyness, sadness, and a general feeling of being left out of things.

Popularity. A 12-item cluster that reflects the subject's evaluation of his or her popularity with classmates. This scale includes topics related to being included by peers and ability to make friends.

Happiness and Satisfaction. The last scale is composed of 10 items. It is concerned with one's perception of overall happiness and satisfaction in life.

Both the total score and the cluster scores are scaled in the direction of positive self-concept. Therefore, high scores suggest more positive self-concepts and low scores more negative self-evaluations.

The Piers-Harris is a self-report type inventory composed of 80 (see Appendix C), first-person, declarative statements such as, "I am shy." The test takers must answer either "Yes" or "No" in response to each statement indicating that the statement does, or does

not, describe the way they feel about themselves. The Piers-Harris requires less than 30 minutes to complete, can be administered by teachers, and taken in groups.

Scoring can be done by hand or mailed to the company for mechanical scoring. Raw scores can be converted to percentiles and stanines for each of the six clusters. However, in this study, scoring was done by the researcher and only raw scores were subjected to statistical treatment.

The Piers-Harris was given to the senior girls in both Our Lady of Lourdes Academy and St. Brendan's High School who were present on the day selected for testing. Students absent on the day the test was given were not included in the sample group.

In addition to giving the scale to senior girls, freshman girls in both schools also took the Piers-Harris on the same day. The reason for this was to allow for two-way comparisons. The scores of the senior girls in the single-sex school were compared with those of their counterparts in the coed school. If school sex mix had any effect on the scores, one might assume the affect would be most pronounced in the senior girls who had been subjected to the influence of the school sex mix for four years. The data from the freshman girls provided a baseline of sorts and allowed additional statistical comparisons.

The Piers-Harris Children's Self-Concept Scale appeared to be very reliable although Piers (1984) noted that the "single most reliable measure for the *Piers-Harris*, and the one with the best research support, is the total score" (1984, p.37). Epstein (1985) reported a mean of .73 for test-retest stability and coefficients ranging from .88 to .93 for internal consistency. He noted that recent reliability studies confirmed and expanded on the original studies.

Epstein (1985) also discussed recent validity studies cited in the manual that explore the relationships between this instrument and other measures of self-concept, personality, and behavior. The manual reported "moderate" relationships with other measures of self-concept and that relationships with personality and behavioral measures

were "generally in the direction expected" (Epstein, 1985, p.1169). It should be noted that the test's authors caution users to integrate test results with other information before making individual clinical interpretations. Epstein concluded by stating that for inventories of this type, the Piers-Harris Children's Self-Concept Scale is a psychometrically adequate instrument and its usefulness has been documented.

Procedures, Data Collection

This research began with the framing of the research questions and an in-depth review of the relevant literature. The nature of these research questions and the results of previous studies led to the selection of the causal-comparative research methodology. The next step in planning the study was to decide on measures of the dependent variables and select the appropriate instruments. Once the methodology and instruments were decided upon, the population and sample were identified.

In the Spring of 1995, the principals of St. Brendan's High School and Our Lady of Lourdes Academy were contacted to solicit their active participation. They agreed to meet at a future date with the researcher so that he might explain the research and seek permission to collect the necessary data, and administer the Piers-Harris Children's Self-Concept Scale. Face-to-face meetings and written communication followed. Each principal agreed to make the requested scores available and permit their students to be given an instrument to measure self-concept in the spring of 1996. They granted permission prior to the end of the school year in June, 1995.

In January, 1996, a formal letter was sent to each principal reviewing the purpose of the study, the data required, and the proposed method for collecting that data. The principals were asked to indicate their preferences for the dates and manner of data collection. An attempt was made to coordinate schedules so as to give the Piers-Harris Children's Self-Concept Scale on the same day in both schools. However, because of individual school calendars, this was not possible. The instrument was given to the girls in

Our Lady of Lourdes Academy on February 27, 1996, and to the girls in St. Brendan's High School on March 28, 1996.

The principals were told that all costs related to giving and scoring the Piers-Harris Children's Self-Concept Scale would be assumed by the researcher, and that the results would be available to both the school and the researcher. An attempt was made to establish with the principals, in advance, what help each school would provide for this testing and what role the classroom teacher would play.

In both schools, the self-concept instrument was given during a regular class period in a regularly scheduled class. On the day selected for the Piers-Harris, proctors were provided with the testing protocols as specified in the Piers-Harris Children's Self-Concept Scale Revised Manual (Piers, 1984). The Piers-Harris Children's Self-Concept scale was given to the girls present in all 9th and 12th grade classes in each school. The exam requires less than 30 minutes to complete. As already agreed upon with the principals, the proctors were the regular teachers of that class. Borg and Gall (1989) consider the regular class unit the most desirable grouping in which to test students because it is a familiar environment and the group is small.

The researcher had hoped that it would be possible for all subjects to take the Piers-Harris during their English class. Since the two comparison groups in the different schools were tested separately, it would have helped to equalize scheduling variables and insure that the exam was administered under as equivalent conditions as possible in both schools. However, it was not possible to do this; the instrument was given in religious studies classes or homeroom.

Upon completion of the exam, a research assistant collected the exam booklets and scantron answer sheets at the end of the school day in each school. The answer sheets were graded by scantron machine and yielded a total score and six cluster scores as previously described.

The collection of the SAT verbal and mathematical reasoning scores and the STS High School Placement Test verbal and quantitative ability scores took place during the same period of time that the Piers-Harris was given. These data were accessed from the permanent record cards of the girls in the study and recorded.

Treatment of Data

Gay (1996) reported that the most common descriptive statistics used in causal-comparative study were the mean and standard deviation, and the most common inferential statistics used were the t test, analysis of variance, and the chi square test. The data collected in this study were subjected to a number of statistical analyses which included use of the mean, standard deviation and t test, analysis of covariance, and two-way analysis of variance.

The mean and standard deviations of the two comparison groups were calculated for the variables: SAT verbal score, SAT mathematical score, HSPT verbal ability score, HSPT quantitative ability score, Piers-Harris total score, and each of the six Piers-Harris cluster scores. A t test was then applied to the mean differences to determine if there were any significant differences at the .05 level for any of the variables.

It was possible that the comparison groups were not identical in every respect despite the similarities of the schools and their student populations earlier described. If statistically significant differences in mean scores did exist, they could be related to such extraneous factors rather than the independent variables under study. In order to control for the possibility that any differences in mean SAT scores or Piers-Harris scores were attributable to pre-existing differences in the comparison groups with respect to academic ability or achievement, the results from the HSPT were recorded. These scores were used to perform an analysis of covariance on the data for the dependent variables. Therefore, it was possible to account statistically for possible initial differences in academic ability or

achievement that otherwise might have been responsible for any significance differences in the means of the comparison groups for any of the variables in this study.

Finally, the combined HSPT verbal and quantitative reasoning scores were used to form subgroups within each comparison group. Three subgroups were formed: a high ability subgroup with scores of 1150 or higher; a moderate ability subgroup with scores between 850 and 1149; and a low ability subgroup with scores less than 850. Using school attended as one independent variable and combined HSPT score as a second variable, a two-way analysis of variance was performed to determine the main effects and interaction effects on the dependent variable which were the Piers-Harris scores. This analysis examined the possible interaction of school and reasoning ability on self-concept.

The data needed, method of data collection, and statistical measures applied to the data in this study are summarized in Table 1. To test the first hypothesis, that there was no difference between the mean scores of the senior girls in the single-sex school and the coed school on the SAT 1 verbal reasoning section, SAT verbal reasoning scores and HSPT verbal ability scores were needed. The method of collection employed for this part of the study was a record check. Since these two exams had already been taken by the subjects, the results were available on the students' permanent record cards. The data were subjected to t tests and an analysis of covariance.

To test the second hypothesis, that there was no difference between the mean scores of the senior girls in the single-sex school and the coed school on the SAT 1 mathematical reasoning section, SAT mathematical reasoning scores and HSPT quantitative ability scores were needed. The same method of collection was employed, a record check. These data were subjected to the same statistical analyses used to treat the verbal ability data, t tests and an analysis of covariance.

To test the third hypothesis, that there was no difference between the mean scores of the senior girls in the single-sex school and the coed school on the Piers-Harris

Children's Self-Concept Scale, Piers-Harris total and cluster scores were needed. The instrument was administered to the sample subjects, the scales were graded, and the scores recorded. The statistical procedures used to analyze the Piers-Harris data included t tests, analysis of covariance, and two-way analysis of variance.

Summary

The data accumulated as a result of this study served as the basis upon which the research hypotheses were evaluated. The data enabled the researcher to compare the effects of the single-sex school environment and the coed school environment on the development of verbal or mathematical reasoning abilities and self-concept for high school girls. In Chapter 4, the data produced by this study is presented and the results of the statistical treatments are reported.

Table 1

Summary of Data Required, Methodology, and Statistical Measure Applied in Analysis

Hypothesis	Data	Methodology	Statistic
H ₁	SAT verbal reasoning scores and HSPT verbal ability scores for girls in the study.	Record check	t test for means, analysis of covariance
H ₂	SAT mathematical reasoning scores and HSPT quantitative ability scores for girls in the study.	Record check	t test for means, analysis of covariance
H ₃	Scores on self-concept instrument for 9th & 12th grade girls in both schools.	Administration of Piers-Harris Children's Self-Concept Scale	t test for means, analysis of covariance, two-way analysis of variance

CHAPTER 4

Analysis of Data

Introduction

The main objective of this study was to answer the basic research question: Did single-sex education affect the development of verbal reasoning abilities, mathematical reasoning abilities, or self-concept in high school girls? The purpose of this chapter is to present the analyses of the data that were performed and interpret them in light of the basic research questions and related specific research questions and hypotheses presented below.

The data analyses are presented in three main sections: an analysis of the difference between the SAT 1:Reasoning Test (SAT) verbal reasoning mean scores of the senior girls in a single-sex and coed secondary school; an analysis of the difference between the SAT mathematical reasoning mean scores of the senior girls in a single-sex and coed secondary school; and an analysis of the difference between the Piers-Harris Children's Self-Concept Scale mean scores of the senior girls in a single-sex and coed secondary school.

Additionally, data on freshman girls in each school are presented for exploratory purposes. Comparisons of the High School Placement Test (HSPT) verbal and quantitative scores of the freshman girls by school were made. Within school comparisons of 9th to 12th grade girls were also done. Similar types of comparisons were made for the Piers-Harris scores.

Treatments were selected to analyze the data in light of the hypotheses under study:

H_1 There was no difference between the mean scores of the senior girls in the single-sex school and the coed school on the SAT 1 verbal reasoning section.

- H₂ There was no difference between the mean scores of the senior girls in the single-sex school and the coed school on the SAT 1 mathematical reasoning section.
- H₃ There was no difference between the mean scores of the senior girls in the single-sex school and the coed school on the Piers-Harris Children's Self-Concept Scale.

Analysis of the Difference Between
the SAT Verbal Reasoning Mean Scores
of the Senior Girls
in a Single-sex and Coed Secondary School

To test the first hypothesis, that there was no difference between the mean scores of the senior girls in the single-sex school and the coed school on the SAT 1 verbal reasoning section, the means of the comparison groups, presented in Table 2, were analyzed. It was possible that if a significant difference in the mean scores of the SAT 1 verbal reasoning test was found, it could be attributable to differences in the populations admitted into the two schools. To examine this possibility, the means of the HSPT verbal ability scores for both senior and freshman girls in the two schools are presented in Table 3 and subjected to similar statistical analysis.

The results of the t test that compared the SAT verbal reasoning mean scores of the senior girls in the two schools are presented in Table 4. The mean difference in scores, in favor of the girls school, was 11.85. However, the p -value was .243 and the difference was not significant. Therefore, the null hypothesis, that there was no difference between the mean scores of the senior girls in the single-sex school and the coed school on the SAT 1 verbal reasoning section, was not rejected.

An examination of the data in Table 5 revealed that despite the fact that there was no significant difference between the mean SAT verbal scores of the comparison groups,

Table 2

Means and Standard Deviations of the SAT 1: Reasoning Test (SAT) Verbal and Mathematical Reasoning Scores for Senior Girls in Both Schools

Variable	<u>M</u>	<u>SD</u>	<u>n</u>
SAT Verbal			
Girls School	510.92	77.10	130
Coed School	499.07	88.39	140
SAT Mathematical			
Girls School	471.08	78.01	130
Coed School	460.59	82.48	140

the means of the two groups did differ significantly for their HSPT verbal scores. The girls school mean was 18.92 points higher than the coed school mean for seniors. This difference was significant at the .01 level with a p-value of .008. Furthermore, Table 5 also presents data for the freshman class. Their mean difference of 83.75 was much larger, again in favor of the girls school, and significant at the .01 level with a p-value < .001.

Table 6 presents the results of within school comparisons of HSPT verbal means. When the mean score of the freshman subjects in the girls school was compared to the mean of the seniors, the difference of 34.49 yielded a p-value < .001 significant at the .01 level. In the girls school, the freshman girls had a higher mean than the seniors. Examination of the data for the coed school revealed the converse, the senior mean was 30.34 points higher than the freshman mean, resulting in a significant difference at the .01 level and a p-value < .001.

Table 3

Means and Standard Deviations of the High School Placement Test (HSPT) Verbal and Quantitative Ability Scores for Freshman and Senior Girls in Both Schools

Variable	Freshmen			Seniors		
	M	SD	n	M	SD	n
HSPT Verbal						
Girls School	594.78	74.08	207	560.29	70.77	200
Coed School	511.03	88.08	248	541.37	69.36	187
HSPT Quantitative						
Girls School	582.83	76.98	207	563.72	65.83	200
Coed School	510.62	81.72	248	532.93	70.72	187

Table 4

T Test of Means Comparing the SAT Verbal and Mathematical Reasoning Mean Scores of Senior Girls in the Girls School and Coed School

Variable	M difference	t-value	df	p-value
Verbal reasoning	11.852	1.17	268	.243
Mathematical reasoning	10.491	1.07	268	.285

Table 5

T Test of Means Comparing the HSPT Verbal and Quantitative Ability Mean Scores
Between Schools for Freshman and Senior Girls

Variable	M difference	t-value	df	p-value
Seniors				
Verbal ability	18.921	2.65	385	.008 ***
Quantitative ability	30.791	4.44	385	.000 ***
Freshmen				
Verbal ability	83.754	10.85	453	.000 ***
Quantitative ability	72.209	9.69	446	.000 ***

*** $p < .01$.

Possible implications of the data presented in Tables 5 and 6 will be discussed in Chapter 5.

Table 6

T Test of Means Comparing the HSPT Verbal and Quantitative Ability Mean Scores
Between Freshman and Senior Girls By School

Variable	M difference	t-value	df	p-value
Girls School				
Verbal ability	34.493	4.80	405	.000 ***
Quantitative ability	19.106	2.69	405	.007 ***
Coed School				
Verbal ability	-30.341	4.02	432	.000 ***
Quantitative ability	-22.314	2.98	433	.003 ***

Note. Negative values signify that the mean difference was in favor of the senior girls.

*** $p < .01$.

Analysis of the Difference Between
the SAT Mathematical Reasoning Mean Scores
of the Senior Girls
in a Single-sex and Coed Secondary School

To test the second hypothesis, that there was no difference between the mean scores of the senior girls in the single-sex school and the coed school on the SAT 1 mathematical reasoning section, the means of the same comparison groups, presented in Table 2, were analyzed. Once again, it was possible that if a significant difference in the mean scores of the SAT 1 mathematical reasoning test was found, it could be attributable to differences in the populations admitted into the two schools. To examine this possibility, the means of the HSPT quantitative ability scores for both senior and freshman girls in the two schools that are presented in Table 3 were subjected to statistical analysis.

The results of the t test that compared the SAT mathematical reasoning mean scores of the senior girls in the two schools are presented in Table 4. The mean difference in scores, again in favor of the girls school, was 10.49. The p -value was .285 and the difference was not significant. Consequently, the null hypothesis that there was no difference between the mean scores of the senior girls in the single-sex school and the coed school on the SAT 1 mathematical reasoning section was not rejected.

Further examination of the data in Table 5 revealed that the means of the two senior groups also differed significantly in their HSPT quantitative scores. The girls school mean was 30.79 points higher than the coed school mean. This difference was significant at the .01 level with a p -value $< .001$. The data for the freshman class indicated a larger mean difference of 72.21 in favor of the girls school, significant at the .01 level with p -value $< .001$.

The results of the within school comparisons of HSPT quantitative means

found on Table 6 followed the same pattern as they did for the verbal means. The mean score of the freshman subjects in the girls school was higher than the mean score of the seniors. The difference of 19.11 was less than the verbal difference but still significant at the .01 level with a p-value of .007. Again, examination of the data for the coed school revealed the converse, the senior mean was 22.31 points higher than the freshman mean with a p-value of .003 significant at the .01 level.

The implications of these data will be discussed in Chapter 5.

Analysis of Covariance of the SAT Verbal and Mathematical Reasoning Scores

In order to further examine the first two hypotheses that there was no difference between the mean scores of the senior girls in the single-sex school and the coed school on the SAT verbal and mathematical reasoning sections, the data were subjected to an analysis of covariance. The results are presented in Table 7. The SAT scores were compared by school with an HSPT score (HSPT verbal for SAT verbal and HSPT quantitative for SAT mathematical) as the covariate.

The number of cases used for the analysis of covariance was 247. This number was less than the 270 cases used to run the t tests that produced the results in Table 4. The reason for this was that there were some students for whom SAT results were available but not HSPT scores and vice versa.

The analysis of covariance of the SAT verbal reasoning produced an f -value of 2.32 comparing the adjusted means. The corresponding p -value was .129. While this p -value was lower than the .243 produced by the t test reported in Table 4, it was still not significant and confirmed the decision not to reject null hypothesis H_1 .

An analysis of covariance of the SAT mathematical reasoning produced a much lower f -value of 0.03 and a corresponding p -value of .859 that was not significant. These results also confirmed the decision not to reject null hypothesis H_2 .

Table 7

Analysis of Covariance of the SAT Verbal and Mathematical Reasoning Scores of Senior Girls By School With Corresponding HSPT Score as Covariate (n = 247)

Variable	n	Observed M	Adjusted M	f-value	p-value
SAT Verbal Reasoning				2.32	.129
Girls School	123	513.17	515.25		
Coed School	124	505.40	503.33		
SAT Mathematical Reasoning				0.03	.859
Girls School	123	470.73	468.52		
Coed School	124	464.77	466.99		

The means, standard deviations, and t test results for the same 247 cases used to generate the ANCOVA data reported in this section are presented in Table 8. Although the mean differences for the SAT verbal and mathematical reasoning scores were different from those reported for the larger sample in Table 4, these t tests also yielded t -values (SAT verbal, $p = .443$; SAT mathematical, $p = .556$) that were not significant.

In summary, both the ANCOVA results reported in Table 7 as well as the t test results reported for the same cases used for the ANCOVA and presented in Table 8 confirmed the decision (based on the t test results generated by the larger sample and already reported in Table 4) not to reject null hypotheses H_1 and H_2 .

Table 8

T Test of Means Comparing the SAT Verbal and Mathematical Reasoning Scores for Senior Girls in Both Schools Restricted to Cases in ANCOVA Sample (n = 247)

Variable	<u>M</u>	<u>SD</u>	<u>n</u>	
SAT Verbal				
Girls School	513.17	78.13	123	
Coed School	505.40	80.65	124	
SAT <u>M</u>athematical				
Girls School	470.73	79.24	123	
Coed School	464.77	79.65	124	
Variable	<u>M</u> difference	t-value	df	p-value
SAT Verbal	7.77	0.77	245	.443
SAT <u>M</u> athematical	5.96	0.59	245	.556

Analysis of the Difference Between
the Piers-Harris Children's Self-Concept Scale Mean Scores
of the Senior Girls
in a Single-sex and Coed Secondary School

To test the third hypothesis, that there was no difference between the mean scores of the senior girls in the single-sex school and the coed school on the Piers-Harris Children's Self-Concept Scale, the means of the comparison groups were analyzed (see Table 9). Piers-Harris scores were recorded for 148 seniors from the girls school and 145 seniors from the coed school. Table 10 contains Piers-Harris mean scores and standard deviations for 201 freshmen from the girls school and 270 freshmen from the coed school. Although not included in this study's hypotheses, the data for the freshman girls were collected to be used for exploratory purposes in Chapter 5.

The results of the t tests that compared the Piers-Harris Children's Self-Concept Scale total and cluster mean scores of the senior girls in the two schools are presented in Table 11. For the Piers-Harris total score the mean difference was 0.544 in favor of the girls school. The resulting t -value of 0.51 had a p -value of .613 and was not significant. Of the six cluster scores, only the mean difference for the anxiety cluster was significant at the .05 level ($p = .022$) in favor of the girls school. The behavior cluster ($p = .127$), intellectual and school status cluster ($p = .711$), physical appearance and attributes cluster ($p = .740$), popularity cluster ($p = .340$), and happiness and satisfaction cluster ($p = .204$) mean differences were all found not to be significant at the .05 level.

When the Piers-Harris data for the freshman girls were compared by school, the results, as reported in Table 11, were rather different. For all seven Piers-Harris variables, the means for the girls school were higher. Three of the differences when subjected to

t tests were found to be significant at least at the .05 level including the total score mean ($p = .010$) as well as two of the cluster means: intellectual and school status ($p < .001$) and popularity ($p = .003$).

Likewise, within school comparisons of the freshman to senior girls reported in Table 12 yielded a number of significantly different means in both school. In the girls school, t tests of means revealed that four clusters were significantly different at least at the .05 level: physical appearance and attributes ($p = .009$), anxiety ($p = .013$), popularity ($p = .045$), and happiness and satisfaction ($p = .009$). In all cases but popularity, the senior girls had the higher means.

Table 12 presents the results of a similar comparison of freshman to senior girls using data from the coed school. T tests produced a significant t -value of 2.74 with a corresponding p -value of .007 for the total score. Four of the six cluster means were significantly different at least at the .05 level: behavior ($p < .001$), intellectual and school status ($p < .001$), physical appearance and attributes ($p = .001$), and happiness and satisfaction ($p = .030$). As was the case in the girls school, the seniors had the higher means for all variables except popularity.

In conclusion, based on the t test results already discussed and presented in Table 11, the null hypothesis (H_3) that there was no difference between the mean scores of the senior girls in the single-sex school and the coed school on the Piers-Harris Children's Self-Concept Scale could not be rejected although there was a significant difference in means for the anxiety cluster scores. The implications of the t test comparisons of freshman girls by school and the within school comparisons by grade will be commented on in Chapter 5.

Table 9

Means and Standard Deviations of the Raw Scores of the Piers-Harris Children's Self-Concept Scale for Senior Girls in the Girls School and Coed School

Variable	Items	Girls School			Coed School		
		M	SD	n	M	SD	n
Total score	80	59.37	9.05	148	58.83	9.35	145
Behavior cluster	16	13.30	2.70	148	13.75	2.37	145
Intellectual and school status	17	13.67	2.48	148	13.57	2.30	145
Physical appearance and attributes	13	9.79	2.29	148	9.70	2.20	145
Anxiety cluster	14	9.76	2.78	148	8.92	3.36	144
Popularity cluster	12	8.68	2.07	148	8.44	2.25	145
Happiness and satisfaction	10	8.59	1.73	148	8.31	1.99	145

Table 10

Means and Standard Deviations of the Raw Scores of the Piers-Harris Children's Self-Concept Scale for Freshman Girls in the Girls School and Coed School

Variable	Items	Girls School			Coed School		
		<u>M</u>	<u>SD</u>	<u>n</u>	<u>M</u>	<u>SD</u>	<u>n</u>
Total score	80	58.64	10.43	201	55.96	11.58	270
Behavior cluster	16	12.84	3.31	201	12.47	3.30	270
Intellectual and school status	17	13.58	2.91	201	12.33	3.12	270
Physical appearance and attributes	13	9.08	2.75	201	8.81	3.04	270
Anxiety cluster	14	8.96	3.05	201	8.55	3.29	269
Popularity cluster	12	9.14	2.16	201	8.50	2.43	270
Happiness and satisfaction	10	8.07	1.91	201	7.83	2.20	270

Table 11

T Test of Means Comparing the Piers-Harris Children's Self-Concept Scale Mean Scores of Girls in the Girls School to Mean Scores of Girls in the Coed School by Grade Level

Variable	Seniors				Freshmen			
	M difference	t-value	df	p-value	M difference	t-value	df	p-value
Total score	0.544	0.51	291	.613	2.678	2.59	469	.010 **
Behavior cluster	-0.454	1.53	291	.127	0.367	1.19	469	.234
Intellectual and school status	0.103	0.37	291	.711	1.248	4.42	469	.000 ***
Physical appearance and attributes	0.087	0.33	291	.740	0.270	0.99	469	.322
Anxiety cluster	0.833	2.31	277	.022 **	0.414	1.39	468	.164
Popularity cluster	0.241	0.96	291	.340	0.644	3.04	455	.003 ***
Happiness and satisfaction	0.278	1.27	284	.204	0.241	1.27	458	.204

Note. Negative values signify that the mean difference was in favor of the coed girls.

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

Table 12

T Test of Means Comparing the Piets-Harris Children's Self-Concept Scale Mean Scores of Freshman Girls to Mean Scores of Senior Girls by School

Variable	Girls School				Coed School			
	M difference	t-value	df	p-value	M difference	t-value	df	p-value
Total score	-0.735	0.70	338	.483	-2.868	2.74	351	.007 ***
Behavior cluster	-0.457	1.42	343	.157	-1.277	4.45	380	.000 ***
Intellectual and school status	-0.092	0.31	347	.757	-1.236	4.60	374	.000 ***
Physical appearance and attributes	-0.706	2.61	342	.009 ***	-0.889	3.42	378	.001 ***
Anxiety cluster	-0.797	2.50	347	.013 **	-0.377	1.10	411	.270
Popularity cluster	0.462	2.01	347	.045 **	0.059	0.24	413	.810
Happiness and satisfaction	-0.513	2.62	332	.009 ***	-0.477	2.18	413	.030 **

Note. Negative values signify that the mean difference was in favor of the senior girls.

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

Analysis of Covariance of the Piers-Harris
Children's Self-Concept Scale Scores

In order to further examine the third hypothesis, that there was no difference between the mean scores of the seniors in the girls school and the coed school on the Piers-Harris, the data were subjected to an analysis of covariance. The results are presented in Table 13. The Piers-Harris total and six cluster scores were compared by school with the HSPT verbal and quantitative scores as the covariates.

The number of cases used for the analysis of covariance was 232. This number was less than the 293 cases used to run the t tests that produced the results in Table 11. The reason for this was that there were some students for whom Piers-Harris results were available but not HSPT scores and vice versa.

An analysis of covariance of the Piers-Harris total scores produced an f -value of 0.06 when the adjusted means were compared. This was not significant ($p = .799$). The analyses of covariance for the six cluster scores failed to produce any adjusted mean differences that were significant at the .05 level. (The behavior cluster adjusted mean difference was significant at the .10 level.) These results confirmed the decision not to reject null hypothesis H_3 .

The means, standard deviations, and t test results for the same 232 cases used to generate the ANCOVA data reported in Table 13 are presented in Table 14. Because of the different sample size, the mean differences for the Piers-Harris scores were different from those reported for the larger sample in Table 11. However, these t tests failed to find any mean differences that were significant at the .05 level.

In summary, both the ANCOVA results reported in Table 13 as well as the t test results reported for the same cases used for the ANCOVA and presented in Table 14 confirmed the decision (based on the t test results generated by the larger sample and already reported in Table 11) not to reject null hypotheses H_3 .

Table 13

Analysis of Covariance of the Piers-Harris Children's Self-Concept Scale Scores of Senior Girls By School With HSPT Verbal and Quantitative Ability Scores as Covariates

(n = 232)

Variable	n	Observed M	Adjusted M	f-value	p-value
Piers-Harris Total Score				0.06	.799
Girls School	124	59.69	59.57		
Coed School	108	59.76	59.88		
Behavior cluster				2.85	.093 *
Girls School	124	13.31	13.32		
Coed School	108	13.90	13.89		
Intellectual and school status cluster				0.52	.472
Girls School	124	13.73	13.65		
Coed School	108	13.81	13.88		
Physical appearance and attributes cluster				0.32	.572
Girls School	124	9.78	9.77		
Coed School	108	9.94	9.95		
Anxiety cluster				2.63	.106
Girls School	124	9.76	9.74		
Coed School	108	9.01	9.03		

Table continued

Table 13, continued

Popularity cluster				0.46	.498
Girls School	124	8.79	8.80		
Coed School	108	8.61	8.60		
Happiness and satisfaction cluster				0.14	.713
Girls School	124	8.60	8.59		
Coed School	108	8.50	8.50		

* $p < .10$.

Table 14

T Test of Means Comparing the Piers-Harris Scores for Senior Girls in Both Schools
Restricted to Cases in ANCOVA Sample (n = 232)

Variable	<u>M</u>	<u>SD</u>	<u>n</u>
Piers-Harris Total			
Girls School	59.69	8.77	124
Coed School	59.76	8.99	108
Behavior cluster			
Girls School	13.31	2.69	124
Coed School	13.90	2.16	108
Intellectual and school status cluster			
Girls School	13.73	2.50	124
Coed School	13.81	2.26	108
Physical appearance and attributes cluster			
Girls School	9.78	2.22	124
Coed School	9.94	2.20	108
Anxiety cluster			
Girls School	9.76	2.84	124
Coed School	9.01	3.52	108

Table continued

Table 14, continued

Popularity cluster

Girls School	8.79	1.98	124
Coed School	8.61	2.25	108

Happiness and satisfaction cluster

Girls School	8.60	1.63	124
Coed School	8.50	1.87	108

Variable	<u>M</u> difference	<u>t</u> -value	<u>df</u>	<u>p</u> -value
Piers-Harris Total	-0.074	-0.06	230	.950
Behavior cluster	-0.592	-1.86	228	.065 *
Intellectual and school status	-0.080	-0.25	230	.800
Physical appearance and attributes	-0.153	-0.53	230	.291
Anxiety cluster	0.749	1.77	205	.079 *
Popularity cluster	0.179	0.65	230	.519
Happiness and satisfaction	0.97	0.42	214	.677

Note. Negative values signify that the mean difference was in favor of the coed girls.

* $p < .10$.

Two-way Analysis of Variance of the Piers-Harris
Children's Self-Concept Scale Scores
by School and Ability Group

The Piers-Harris Children's Self-Concept Scale data was subjected to one final analysis to investigate the possibility that while no overall significant school effect was found, there might be a differential effect for self-concept resulting from the interaction of school type and ability level. Perhaps self-esteem was significantly higher in one of the schools than the other for a specific ability group. In order to explore this possibility three ability groups were arbitrarily created by combining the HSPT verbal and quantitative ability scores to create an HSPT index. The three subgroups formed were as follows: a high ability subgroup with combined scores of 1150 or higher; a moderate ability subgroup with combined scores from 850 to 1149; and a low ability subgroup with combined scores less than 850.

Using school attended as one independent variable and HSPT ability subgroup as a second variable, a two-way analysis of variance was performed to determine the main effects and interaction effects on the Piers-Harris scores. The results for the Piers-Harris total score is reported in Table 15. Neither of the main effects were significant at the .05 level, nor was the interaction effect.

The two-way analysis of variance results for the six cluster scores are not reported in Table 15. However, none were significant at the .05 level for either the main effects or the interaction.

Summary

Based on a comprehensive analysis of the data produced by this research, none of the study's three null hypotheses were rejected. No significant difference was found to exist between the mean scores of the senior girls in the single-sex school and the coed

Table 15

Two-way Analysis of Variance of the Piers-Harris Total Mean Scores for Senior Girls by School and by Ability Group as Determined by Combined HSPT Scores

Source	df	MS	F	p-value
Between subjects				
Main Effects				
^a School (S)	1	10.71	0.136	.712
^b HSPT (H)	2	55.76	0.709	.493
Interactions				
S x H	2	74.67	0.950	.388
Within subjects				
Residual	226	78.64		
Total	331	78.36		

^aSchool refers to the school attended, either the girls school or the coed school. ^bHSPT groups are either low, moderate, or high ability and determined by the combined HSPT verbal and quantitative ability scores.

school on the SAT 1 verbal reasoning section. Nor was any significant difference found to exist between the mean scores of the senior girls in the single-sex school and the coed school on the SAT 1 mathematical reasoning section. Finally, no significant difference between the mean total scores of the senior girls in the single-sex school and the coed school on the Piers-Harris Children's Self-Concept Scale was found to exist.

CHAPTER 5

Findings, Conclusions, Discussion and Recommendations

Introduction

This study was conducted to examine the effect of single-sex education on the mathematical reasoning ability, verbal reasoning ability, and self-concept of high school girls. In this chapter, the researcher will restate the problem, describe the limitations of the sample, summarize the findings, present the conclusions, discuss the findings and conclusions, and offer recommendations.

Problem

Previous investigations into the effects of attending single-sex verses coed schools for girls had been inconclusive. However, a number of studies suggested that there were potential advantages in grouping girls by gender at the high school level. This study was designed to explore what those advantages for girls might be in two outcome areas: cognitive and affective. SAT verbal and mathematical reasoning scores were used as cognitive measures. Piers-Harris Children's Self-Concept Scale scores were used to assess the affective area of self-concept.

Specifically, this study examined the following questions:

- (1) Did senior girls in single-sex secondary schools score higher on the SAT verbal reasoning section than their counterparts in coed secondary schools?
- (2) Did senior girls in single-sex secondary schools score higher on the SAT mathematical reasoning section than their counterparts in coed secondary schools?
- (3) Did senior girls in single-sex secondary schools score higher on measures of self-concept than twelfth-grade girls in coed schools?

Limitations of the Sample

The study's participants attended two Catholic high schools in South Florida's Dade County. One school was single-sex, the other coed. The comparison schools were selected because of their many similarities. Senior girls were chosen as subjects because they had been subjected to the independent variable, single-sex or coed environment, for four years in most cases. Information was also collected for freshman girls from the two schools for two reasons: (a) to provide greater information about each school's student body, and (b) to provide data for exploratory purposes.

In conducting the research, two problems related to the senior subjects were encountered and require explanation. The first problem concerned the collection and recording of the Piers-Harris data. The instrument was administered in each school by a classroom teacher who acted as the test proctor. While every proctor was provided with the same complete set of instructions on the administration of the test, not all of them instructed the students to write their names on the scantron sheets used to record the responses. Consequently, it was not possible to match Piers-Harris scores and HSPT scores in every case. The data were present, but without names not all data sets could be matched.

Of the 198 seniors in the girls school, 75% (148 girls) took the Piers-Harris. Of those who took the test, 124 recorded their names. In the coed school, 66% of the senior girls (145 out of 219) took the Piers-Harris, and 108 of the test-takers recorded their names. The failure of some girls to record their names on the scantron did not seriously compromise the usefulness of the data collected or the statistical analyses that data were subjected to. The most important statistic used to analyze the differences between comparison groups was the t test. The group means for the test-takers were not affected by the absence of some students' names.

It was only in running an analysis of covariance that the missing names were limiting. Instead of doing an ANCOVA on all 293 seniors who took the Piers-Harris in the two schools, the ANCOVA results reported in Table 13 are based on the 232 cases for whom both Piers-Harris and HSPT scores were available. However, the fact that these ANCOVA results and the accompanying t tests in Table 14 corroborated the t test results based on the total sample indicate that the fact that some names were missing was of no consequence in the data analyses.

The second problem that requires explanation is the subjects' response rate for the dependent variables collected. As was just pointed out, 75% of the seniors in the girls school and 66% of the senior girls in the coed school took the Piers-Harris. The possibility that those who did not take the Piers-Harris in each school differ from one another in some important ways must be considered. The question of non-response always demands that we attempt to explain who the non-responders were.

Although in theory every senior girl in both schools should have taken the Piers-Harris, some did not for a variety of reasons, i.e. absence from school, early dismissal from school, or late arrival to school. Students may have been at the guidance office, the nurse's office, the principal's office, or involved with a club or activity meeting during the time the test was given. There are many reasons why a student might be out of class at any given time during the day. This is especially true for seniors. These reasons would be varied but similar in both schools. Interestingly, the freshman response rate for the Piers-Harris was 95% for the girls school and 97% for the coed school out of 211 and 279 ninth grade girls respectively. This is not surprising given the fact that freshman are more likely to be in school, and in class when they are in school. The point is that there is no reason to think that the group who did not take the Piers-Harris in the girls school is any different from those who failed to take the test in the coed school.

The SAT response rate in the two schools was nearly identical. SAT scores were recorded for 66% of the seniors in the girls school and 64% of the senior girls in the coed school. Once again, the possibility that those without recorded SAT scores in each school differ from one another in some important way must be considered. The first point to note is that the response rates cited above are only for SAT exams taken in October, November, or December of 1995. In order to provide SAT scores from the students' senior year, only scores from those three sets of exams were included in this study. Many students take the SAT exam in the spring of their junior year. Some, especially those who score high, do not take the exam again.

For a variety of reasons, other students did not take the SAT during the specified months of their senior year. Some students took the ACT instead of the SAT. Other students took the SAT later in their senior year. Still others did not take the SAT exams at all. As with the Piers-Harris, there is no reason to think that the group without SAT scores in the girls school is any different from those lacking SAT scores in the coed school.

The final set of data collected was the HSPT scores. In the girls school, 100% of these data were available. (This school does not take transfer students after ninth grade ordinarily.) For the coed school, HSPT scores were recorded for 85% of the 219 senior girls. Those for whom the scores were not available were admitted to the school after the initial placement testing process was concluded.

One other potential limitation must be noted. Although exact data on the ethnic makeup of the sample populations from the two schools were not available, diocesan officials estimated that at least 80% of the girls in each school were of Hispanic descent. The vast majority of the Hispanic students were Cuban-Americans. The normative sample for the Piers-Harris total score was drawn from 1,183 school children from a public school district in a small town in Pennsylvania (Piers, 1984). The fact that the normative population probably did not contain significant numbers of Hispanic or Cuban-American

students limits the usefulness of the Piers-Harris in drawing conclusions about the population in this study.

The same limitation applies to the SAT and HSPT. However, both of these instruments are well-known, widely used, and have been subjected to extensive validation.

Findings

The data reported in Chapter 4 did not support a rejection of this study's first hypothesis. No significant difference between the mean scores of the senior girls in the single-sex school and the coed school on the SAT 1 verbal reasoning section was found. Failure to reject the first null hypothesis indicates that there was no advantage for girls attending the single-sex school in the cognitive area of verbal reasoning.

The study's second hypothesis was also not rejected based on the analyses done. There was no significant difference between the mean scores of the senior girls in the single-sex school and the coed school on the SAT 1 mathematical reasoning section. This failure to reject the second null hypothesis indicates that there was no advantage for girls attending the single-sex school in the cognitive area of mathematical reasoning.

The data collected during this study also did not provide a foundation for rejecting the third hypothesis. No significant difference was found to exist between the mean total scores of the senior girls in the single-sex school and the coed school on the Piers-Harris Children's Self-Concept Scale. By not rejecting the third null hypothesis, the study suggests that there was no advantage for girls attending the single-sex school in the affective area of overall self-concept.

Contrary to what many of the studies cited in Chapter 2 have found in the past about single-sex schools and their advantages for girls, this study found no support for such advantages in the cognitive areas of verbal and mathematical reasoning as measured by the SAT or in the affective area of self-concept as measured by the Piers-Harris Children's Self-Concept scale.

Conclusions

The findings of this study, based on a careful and comprehensive analysis of data collected through rigorous methodological means, lead to the following conclusions about the research questions:

1. No significant difference exists between the mean scores of the senior girls in the single-sex school and the coed school on the SAT verbal reasoning section.
2. No significant difference exists between the mean scores of the senior girls in the single-sex school and the coed school on the SAT mathematical reasoning section.
3. No significant difference exists between the mean scores of the senior girls in the single-sex school and the coed school on the Piers-Harris Children's Self-Concept Scale total score.

Discussion

The findings and conclusions of this study, and the data upon which they were based, answered the original research question. However, they also give rise to many more questions that cannot be adequately answered from the data. In this section, the researcher will consider the implications of the study's findings and conclusions and explore possible reasons for them.

No significant difference was found to exist between the mean SAT verbal or mathematical reasoning scores for the senior girls in the comparison groups. Why were no significant differences in SAT means found? The most obvious explanation is because there were no significant differences in verbal and mathematical reasoning skills between the two schools. This implies that neither the single-sex school nor the coed school provided any greater cognitive benefits for the girls in attendance than the other.

A second possible explanation for the finding is that the girls in the single-sex school did receive advantages in cognitive areas, but the SAT did not adequately measure

the areas in which the benefits were received. Perhaps the girls improved in verbal and mathematical areas that were beyond the scope of the SAT, or the difference may have been in another cognitive area besides verbal or mathematical reasoning.

Still a third explanation for the finding of no significant difference in mean SAT scores between the girls school and coed school may be related to the nature of the schools. Because both schools select their students, charge tuition, and promote a religious philosophy and education, they undoubtedly deal with a much narrower population range than a typical public high school. The potential salutary effects of single-sex education for girls may have been masked by the fact that the girls attending the two schools came from a higher-achieving, more highly motivated population than secondary school students in general and were already performing at the upper range of their abilities.

If this third explanation is true, then what can be said about the fact that the HSPT mean scores in both verbal and quantitative abilities were significantly higher for the seniors in the single-sex school than those in the coed school whereas there was no significant difference in the SAT scores? It may be that the SAT is a better measure of such cognitive skills than the HSPT. Then again, perhaps the seniors who attended the girls school were significantly better in verbal and quantitative reasoning as eighth graders than their counterparts who were headed to the coed school. What happened to this initial difference in cognitive skills?

Assuming that the HSPT and SAT measure the same thing, which is an assumption partially warranted by the correlation studies performed on the HSPT and SAT and discussed in Chapter 3, there are two immediate explanations for the disappearance of this difference over the course of four years that come to mind. It may be that attendance at the coed school was the reason the girls remediated the difference by the time they

graduated. If this were the case, then contrary to much of the research already reviewed, the advantage would have been in favor of the coed school.

What is more likely, in this researcher's opinion, is that during the course of high school there is a leveling out effect that occurs for high-achieving students. It may simply have been that the single-sex girls reached the top of the learning curve faster than the girls who attended the coed school, but by senior year, when the SAT exams were taken, both groups had reached nearly the same level.

The information presented in Table 6 raises different questions. When the mean HSPT scores were compared within the same school by grade level, the results were significant but in different directions in the two schools. In the girls school, the freshman means for both verbal and quantitative abilities were significantly higher than the means for the seniors. In the coed school, there was also a significant difference in mean scores for both verbal and quantitative abilities, but in the opposite direction. The senior girls had the higher means.

What is suggested by these data? It may be that these results tell us nothing more than the fact that the freshman class in the girls school had a very high mean for both HSPT scores, and the means of each of the four groups were significantly different from each other with regard to HSPT verbal and quantitative mean scores. The data in Table 16 shows the results of an analysis of variance that compared HSPT verbal and quantitative means by one of four grade levels and school groups: girls 9th-grade, coed 9th-grade, girls 12-grade, coed 12-grade. All differences were significant at the .005 level. Fortunately, the greatest difference between group means was between the freshman girls in each school who were not part of the study's hypotheses.

No significant difference in the means of the Piers-Harris Children's Self-Concept total scores was found to exist for the senior girls. This was true for both the samples that included all senior test-takers as well as for the smaller sample restricted to those cases

used to run the ANCOVA. In fact, the mean differences were very small in both cases. Apparently, with respect to self-concept as measured by the Piers-Harris, neither school conveyed any more advantage than the other.

However, two of the cluster score means were borderline significant depending on which data set was used to make the comparison. When all 293 senior samples were analyzed, the anxiety cluster means were found to be significantly different at the .05 level in favor of the girls school. When only the 232 senior cases for which Piers-Harris scores could be matched with HSPT scores were subjected to a *t* test, the results as reported in Table 14 indicate significance at the .10 level ($p = .079$). The ANCOVA results for these same 232 cases yielded borderline significance at the .10 level ($p = .106$) once initial differences in HSPT scores were accounted for.

Two features of the Piers-Harris Children's Self-Concept Scale described in Chapter 3 must be reviewed. First, the six cluster scales were empirically derived through factor analysis. However, as Piers (1984) noted, the "single most reliable measure for the *Piers-Harris*, and the one with the best research support, is the total score" (1984, p. 37). Second, both the total score and the cluster scores are scaled in the direction of positive self-concept. Therefore, high scores suggest more positive self-concepts and low scores more negative self-evaluations.

The anxiety cluster is composed of 14 items. The scale examines a variety of emotions related to worry, nervousness, shyness, sadness, and a general feeling of being left out of things. Higher scores indicate better adjustment to these negative emotional states.

The data collected in this study strongly suggest that the senior girls in the single-sex school had better adjustment to anxiety in terms of their self-concept as measured by the Piers-Harris. However, the results do not establish cause and effect. It is possible that for some reason the girls who attended the single-sex school already had a better self-

Table 16

Analysis of Variance of the HSPT Verbal and Quantitative Mean Scores by Grade Level and School Group

Source	df	MS	F	p-value
HSPT Verbal				
Between groups	3	275,633.80	46.78	.000 ***
Within groups	838	5,892.43		
Total	841	6,854.65		
HSPT Quantitative				
Between groups	3	228,650.01	41.09	.000 ***
Within groups	838	5,564.52		
Total	841	6,360.30		

Note. There are four groups defined by grade level and school attended: girls 9th-grade, coed 9th-grade, girls 12-grade, coed 12-grade.

*** $p < .01$.

concept with respect to anxiety than the girls who attended the coed school before they began the ninth grade.

The other cluster that showed borderline significance was the behavior cluster composed of 16 items and intended to measure the degree to which the subject admits or denies problematic behaviors. Low scores on this scale suggests that the subject recognizes problem areas. High scores may indicate a lack of behavioral problems or denial of the problems (Piers, 1984).

The behavior cluster mean for the coed girls was higher than for the girls school sample using all 293 cases. The difference was not significant ($p = .127$). However, when the ANCOVA was run on the 232 senior girls, the resulting f -value was significant at the .10 level (.093) once initial differences in HSPT were accounted for. It is not possible to claim significance for the behavior cluster based on such equivocal data. Nevertheless, one cannot ignore the possibility that a significant difference in mean scores existed in favor of the coed school.

Where Piers-Harris means were clearly different in a significant way was when the freshman mean scores were compared. The Piers-Harris total mean scores for ninth grade girls were significantly different at the .01 level in favor of the girls school. In addition, the intellectual and school status cluster and the popularity cluster means also differed significantly at the .01 level. In a very significant way, the freshman girls who attended the single-sex school had more positive self-concepts overall and in two specific areas than their counterparts in the coed school. However, because they were ninth grade students who had only been in their respective schools for a few month at the time the Piers-Harris was administered, it is likely that these differences were preexisting.

There were also numerous differences in means that were significant when comparisons were made within each school of the freshman and senior means. In the girls school, four of the cluster score mean differences were found to be significant at the .05 level (see Table 12). In the coed school, the total score and four cluster means were significantly different (see Table 12). In both schools, as might be expected, the senior total score means were higher than the freshman means. Similarly, five out of the six cluster mean differences were in favor of the senior girls. The lone exception was the popularity cluster although the difference was not significant for the coed school girls.

It appears reasonable that 12th-grade students would have better self-concepts, in general, than younger adolescents. The fact that the freshman girls in this study scored

higher when they evaluated their own popularity with classmates, level of inclusion by their peers, and ability to make friends may be indicative of the fact that ninth grade girls place greater value on these things than seniors.

Recommendations

Based on the data collected during this study, the results of an analysis of the data, and the discussion of the findings, the following recommendations are made:

1. The study should be replicated with a larger sample drawn from more schools. The replication should include schools from a variety of geographic locations and include subjects from a wide range of socio-economic and ability levels. Ideally, subjects would not be drawn exclusively from Catholic schools, but would include representatives from public and non-religious private schools.
2. Very specific measures of achievement in cognitive areas should be used to measure this dependent variable. The cognitive areas studied should be expanded to include all major subject areas normally included in a secondary school curriculum.
3. Longitudinal studies are needed that compare students from single-sex and mixed-sex schools for longer periods of time. The progress of subjects from single-sex and coed secondary schools who continue on to similar types of universities should be followed and analyzed to determine if there is a cumulative component to school type exposure.
4. The Piers-Harris cluster areas of anxiety and behavior should be investigated more intensely using corroborating measures of self-concept and self-esteem to see if school type does affect the development of self-concept in these, or other, very specific areas.
5. Studies are needed to determine if girls who choose to attend single-sex schools have higher self-esteem than girls who elect coed schools.

6. Studies that focus specifically on cultural and ethnic background and their interaction with school type on cognitive and affective outcomes are needed to explore the possibility that single-sex schools benefit students from some cultural or ethnic backgrounds more than others.
7. Qualitative study of the experiences of girls in all girls schools and coed schools is needed to illuminate the complexity of the research question and suggest areas for future study.

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Appendix A

The Porcupine and the Moles

It was growing cold, and a porcupine was looking for a home. He found a most desirable cave but saw it was occupied by a family of moles. "Would you mind if I shared your home for the winter?" the porcupine asked the moles.

The generous moles consented and the porcupine moved in. But the cave was small and every time the moles moved around they were scratched by the porcupine's sharp quills. The moles endured this discomfort as long as they could. Then at last they gathered courage to approach their visitor. "Pray leave," they said, "and let us have our cave to ourselves once again."

"Oh no!" said the porcupine. "This place suits me very well."

Adapted from Aesop's Fables, retold by A. McGovern, which is published by Scholastic Book Company, 1963.

Appendix B

Using High School Placement Test (HSPT) Composite

Scores to Estimate SAT 1: Reasoning Ability (SAT) Scores

HSPT Composite	SAT Verbal	SAT Math
99	98	98
95	86	87
90	74	75
85	65	67
80	58	56
75	51	46
70	40	37
65	37	30
60	30	24
55	24	19
50	22	16
45	19	14
40	10	08
30	09	05
25	03	01
15	01	01

Note. Adapted from "Using the STS-HSPT to Estimate Student Performance on the PSAT, ACT, and SAT", Research Bulletin #134, 1987, p. 1. Copyright 1987 by the Scholastic Testing Service, Inc.

Appendix C

Piers-Harris Children's Self-Concept Scale

*Permission granted to include
sample copy only in proposal on file in
Office of Dean of Graduate Studies*

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