



A comparison of academic achievement of students taught by the Montessori method and by traditional methods of instruction in the elementary grades
by John Robert Fero

A thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Education
Montana State University
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Abstract:

The problem of this study was to determine if there is a significant difference between the academic achievement scores of students in grades 2 through 5 who are taught with the Montessori method of instruction and those students who are taught with traditional methods of instruction in the Helena Public Schools. Analyses used a two-way ANOVA; method and gender as well as method and aptitude were examined. The level of significance was set at $\alpha = .05$. A matching technique was used to match Montessori students with students from traditional classrooms by the independent variables of grade, aptitude, gender, socioeconomic conditions, and handicapping conditions. The study also examined if there was a significant difference between the aptitude of all students in Montessori classrooms and all students in traditional classrooms.

The population studied was second, third, fourth, and fifth grade students during the spring of 1996. A total of 120 students was used in the study of academic achievement.

There were 145 F-tests conducted in this study. At the second grade level, students from traditional classrooms scored significantly higher than students in Montessori classrooms in mathematics computation and mathematics concepts and applications. Also at the second grade, when aptitude was taken into consideration, Montessori low aptitude students scored significantly higher in vocabulary than low aptitude students in traditional classrooms. There were no significant findings in any of the subtests at the third and fourth grade levels. At the fifth grade level, Montessori students scored significantly higher in language expression and social studies. Interaction was found with aptitude in language expression and with gender in science. A comparison of the aptitude of all Montessori students to all students from traditional classrooms revealed that Montessori students scored significantly higher.

The overall results of this study show that the Montessori method of instruction and the traditional method of instruction provide students with comparable achievement test scores. A longitudinal study is recommended to examine the long-term effects of academic achievement of those students taught by the Montessori method of instruction.

A COMPARISON OF ACADEMIC ACHIEVEMENT OF STUDENTS TAUGHT
BY THE MONTESSORI METHOD AND BY TRADITIONAL METHODS
OF INSTRUCTION IN THE ELEMENTARY GRADES

by

John Robert Fero

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This thesis has been read by each member of the graduate committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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ABSTRACT

The problem of this study was to determine if there is a significant difference between the academic achievement scores of students in grades 2 through 5 who are taught with the Montessori method of instruction and those students who are taught with traditional methods of instruction in the Helena Public Schools. Analyses used a two-way ANOVA; method and gender as well as method and aptitude were examined. The level of significance was set at $\alpha = .05$. A matching technique was used to match Montessori students with students from traditional classrooms by the independent variables of grade, aptitude, gender, socioeconomic conditions, and handicapping conditions. The study also examined if there was a significant difference between the aptitude of all students in Montessori classrooms and all students in traditional classrooms.

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There were 145 F-tests conducted in this study. At the second grade level, students from traditional classrooms scored significantly higher than students in Montessori classrooms in mathematics computation and mathematics concepts and applications. Also at the second grade, when aptitude was taken into consideration, Montessori low aptitude students scored significantly higher in vocabulary than low aptitude students in traditional classrooms. There were no significant findings in any of the subtests at the third and fourth grade levels. At the fifth grade level, Montessori students scored significantly higher in language expression and social studies. Interaction was found with aptitude in language expression and with gender in science. A comparison of the aptitude of all Montessori students to all students from traditional classrooms revealed that Montessori students scored significantly higher.

The overall results of this study show that the Montessori method of instruction and the traditional method of instruction provide students with comparable achievement test scores. A longitudinal study is recommended to examine the long-term effects of academic achievement of those students taught by the Montessori method of instruction.

CHAPTER 1

INTRODUCTION

Two paradigms have dominated the general philosophy in public schools in the United States over the past 40 years. In the 1960s and 70s, the predominate philosophy used for instruction was heavily reliant on behaviorist theory. In the 1980s and 90s, there has been an emergence of the constructivist theory, the foundations of which are rooted in the writings of Jean-Jacques Rousseau, Friedrich Froebel, Johann Pestalozzi, and John Dewey, and in Jean Piaget's research and writings. Carson (1994) noted that

at present, education worldwide is witnessing a sea of change, adapting the constructivist paradigm with its emphasis on the learner, the uniqueness of each learner, on discovering learning, on hands-on experience, on gentler and more subtle forms of discipline, and on the increasing use of cooperative learning as a means of facilitating the social construction of knowledge. (p. 1)

Another person whose philosophy coincides very closely with Carson's description of constructivism was an Italian medical doctor named Maria Montessori. She was one of the pioneers in research on early childhood development and related instructional practice. Dr. Montessori felt that the early years of child development were extremely important to a child's learning. Dr. Montessori and

several other leading early childhood advocates put their teaching theories into practice in the 1800s and early 1900s.

Dr. Montessori's observations of children, which took place between 1896 and 1906, led her to conclude that children could learn at a much younger age than previously thought. Her methods are supported by an environment that is favorable to children and conducive to the way they learn. Today, as a result of her teaching, there are thousands of "Montessori Schools" in existence worldwide.

"Montessori" is a very common word in America today. In order to understand Montessori education, it is necessary to understand that it represents many things to many people. According to Joy Turner (1992), Montessori is "a person, but also a social movement, a philosophy, a theory of development, a curriculum model, and a set of methodological strategies. Montessori called her approach either a 'method' or a 'system' of education" (p. 19).

Dr. Montessori believed that there are four stages of child development between birth and adulthood. These stages are similar to those described by Rousseau and more recently by Piaget. The development of these four stages centers around motor education, sensory education, and language. Consequently, her instructional methods centered around the development of these three areas. Dr. Montessori (1964) stated the following in her own handbook:

The technique of my method as it follows the guidance of the natural physiological and psychical development of the child may be divided into three parts: motor education, sensory education, and language. The care and management of the environment itself afford the principal means of motor education, while sensory education and the education of language are provided for by my didactic material. (p. 17)

This underlying philosophy coupled with the importance of an internal reward system and the use of manipulative materials formed the foundation for her methods of instruction.

Montessori schools emerged from Dr. Montessori's research and writings in the early 1900s. The current reemergence of Montessori schools in the United States began in the late 1950s and early 1960s. The Montessori method of instruction grew in popularity in what Kornegay (1981) called the "wake of Sputnik" (p. 38). At that time, parents began looking for a different way to have their children educated. The movement has been growing steadily in both the private and public sectors ever since.

Today public schools are faced with increasing pressure to provide alternative methods of instruction. In over 100 communities across the United States, parents have successfully lobbied to get the Montessori method of instruction incorporated into their public schools (Schapiro, 1995). Through articles, word of mouth, and preschool Montessori programs, Montessori is discussed as an alternative method of instruction. Many parents are

convinced that their children will achieve at a higher level if they are taught by the Montessori method. One study shows that students who attend a Montessori preschool do better in the early elementary years than those who have had a traditional preschool experience (Jones & Miller, 1979). Some parents believe that continued Montessori education in the elementary grades will give their children a better education. The question arises: Is setting up a Montessori classroom and training Montessori teachers worth the expense? This question and many like it are asked each time a school board considers instituting a Montessori program into its public schools. State legislatures and local school boards are demanding that schools be more accountable and demonstrate success through increasing academic achievement test scores. It is only reasonable that each program, including Montessori, be accountable to the standards set by these legislatures and school boards.

Statement of the Problem

The problem of this study was to determine if there is a significant difference between the academic achievement scores of students in grades 2 through 5 who are taught with the Montessori method of instruction and those students who are taught with traditional methods of instruction in the Helena, Montana public schools.

Significance of the Study

The purpose of this study was to determine whether students taught by the Montessori method of instruction achieve at an equal or significantly higher level than those students taught with traditional methods. In addition, this study has added to the research base on academic achievement of students taught by the Montessori method of instruction in a public school setting. It is considered possible by some that students taught in a Montessori environment may achieve at a higher level than those taught with traditional methods. If this is true, the Montessori method of instruction would be a feasible alternative method of instruction in any public school setting to assist students to achieve at a higher level than if taught by a traditional method of instruction.

Today many public school districts are examining alternative instructional methods. This movement for change has been brought about by increased public awareness of accountability through the publication of A Nation at Risk (National Commission on Excellence, 1983) in the early 1980s and the more recent attention on the national education goals. Though none of these have any direct connection to the Montessori movement in this country, they did bring an increased awareness of the need for change. Prior to the emergence of the magnet school concept, there

were very few alternatives available to parents other than to send their children to private or parochial schools.

The number of Montessori schools has been increasing in the private sector since 1958. Beginning in 1965 with the first public Montessori school, there has been slow but continued interest in making this an alternative for parents selecting an instructional program for their children. This slow development has been due to four major factors: lack of understanding of Montessori programs, the specialized training needed for Montessori teachers resulting in a lack of qualified Montessori teachers, the initial expense of setting up a Montessori classroom, and a lack of research in the area of academic achievement by students taught by the Montessori method.

The lack of understanding of the Montessori method of instruction is the same today as it was during the early 1900s and during its reemergence in the late 1950s. Applebaum (1971) said, "Lay interpretations of the Montessori system are that there is not enough stress on imagination, too little music, not enough discipline, and other such similar arguments to those used fifty years ago" (p. 209). Today, the complaints are very similar. In a chapter written by Katz (1992) in Loeffler's book, Montessori in Contemporary American Culture, the main concerns listed are little emphasis on children's social development, teaching that is too controlling, distant

teachers, the use of the same materials all year long, and little value placed on imagination.

In order to teach in a Montessori classroom in a public school, a teacher must be both certified by the state and Montessori trained. In most cases it takes an additional year of schooling beyond a bachelor's degree to become Montessori certified. For the majority of teachers, being trained in Montessori also means leaving home and attending one of the 115 training centers across the United States (Schapiro, 1995). Currently the American Montessori Society (AMS) requires 300 academic contact hours plus a year's internship for certification at any one of three levels recognized by AMS (Barron, 1992). In addition, teachers need to be trained at different levels in order to be certified by the AMS to teach more than one level. Currently AMS certifies in preschool (3-6 years of age), elementary (6-9 years of age), and intermediate (9-12 years of age).

Purchasing specific instructional materials makes starting a Montessori classroom relatively expensive. According to Chattin-McNichols (1992b), one of the most commonly asked questions is, "Is this Montessori education basically a traditional nursery school with hideously expensive Dutch toys, or is it really different?" (p. 16). Because the startup costs for these "hideously expensive Dutch toys" (estimated at \$11,000 per classroom) is a

concern for school boards, implementing the Montessori method often does not get full consideration as an alternative to the traditional methods normally used in schools. However, it should be noted that once a classroom is equipped for use, the cost of maintaining a Montessori classroom is no more than for a traditional classroom.

Montessori education in the public schools is relatively new in this country, and very few studies have focused on student academic achievement. A dissertation search found that since 1958 there have been 121 dissertations written on some aspect of Montessori in the world. Only three of these focused on academic achievement of Montessori students within the public schools. In addition to the dissertations, several studies have been conducted by school districts or individuals examining academic achievement by Montessori students in private, parochial, and public schools. Most of the studies are concerned with academic achievement of students in schools that have been started as a result of desegregation or the creation of a magnet alternative. Most research has dealt with preschools or the primary grades. There has been very little research conducted on public school Montessori programs to justify claims by Montessori advocates that students taught by Montessori methods achieve at levels equal to or higher than students taught by traditional methods. Chattin-McNichols (1992b), who is a member of the

American Montessori Society Board, said, "We need to make more research on Montessori a priority in our schools and through our associations" (p. 17).

The Helena Public School District has added five classrooms of Montessori instruction since 1990. Each year the Helena parent group interested in Montessori education has requested additional classrooms. The Helena Board of Trustees has debated the advantages and disadvantages each year. The startup cost for classroom supplies and the expense of training Montessori teachers are considerations in adding classrooms and maintaining the current classrooms. There is a need for research on whether the Montessori program is better than or equal to traditional classrooms in the area of student academic achievement. In addition, taking classroom space for a Montessori classroom in an already crowded school system has been met with mixed acceptance. If the classrooms were not being used by Montessori students, these students would be in regular classrooms throughout the district or in private schools, freeing these rooms for traditional classrooms or for other school programs.

This study compares the academic achievement of students in Montessori classrooms with that of students in traditional instructional programs in elementary grades 2 through 5 in order to analyze whether there is a significant difference between the two groups. First grade

Montessori students are excluded from this study because of their limited exposure to the Montessori program. The Helena Public School System does not have a kindergarten Montessori program. At the conclusion of this study, recommendations are made on whether the additional expense of Montessori startup and training is worthwhile, whether current classrooms should be maintained, and whether new classrooms should be created. This study also gives other researchers new information about Montessori student academic achievement in the public school environment.

Definition of Terms

Montessori Method: A method of instruction used by teachers trained and certified by the American Montessori Society.

Traditional: A classroom environment that has a behavioral orientation, characterized by management by objectives, behavior modification, and learning through reinforcement.

Multigrade: A designation given a classroom comprised of students from more than one grade level.

Level: The grade configurations given to Montessori classrooms. Students go through levels rather than traditional grades. The most common level names are preprimary, primary, and intermediate.

General Questions to be Answered

This study was designed to answer four questions.

1. Is there a difference in aptitude between those children whose parents elect to have their children placed in a Montessori classroom and all other students in traditional classrooms?
2. Do students in Montessori classrooms achieve at significantly higher levels in academic achievement than those in traditional classrooms?
3. Do the method of instruction given to students and the genders of the students interact on academic achievement scores?
4. Do the method of instruction and the aptitude of the student interact on academic achievement scores?

CHAPTER 2

REVIEW OF LITERATURE

Introduction

This study reviewed the historical development of Dr. Montessori's work in the area of child development and the teaching methods used in Dr. Montessori's classrooms. The study also traced the emergence of Montessori schools and classrooms in the United States. It examined the literature that describes the movement and the reasons for its rise in popularity.

Additionally, this study reviewed the literature on all known studies collected on academic achievement of Montessori versus traditional methods of instruction of students in public Montessori schools, private Montessori schools, and parochial Montessori schools. A comparison was made between this study and all known studies on student achievement.

Historical Development of the Montessori Method of Instruction in the Public Schools in the United States

The Montessori method of instruction was created at the beginning of this century by Dr. Maria Montessori (1870-1952), Italy's first female medical doctor. In 1896,

after graduating from medical school, she obtained a position at the Orthophrenic Clinic in Rome. There she began to study and observe the growth and development of children. Dr. Montessori was not trained as an educator but as a scientist. Through her observations, she concluded that the teaching methods being used were not appropriate for, or even adequate to meet, the needs of young children's development. Dr. Montessori's outstanding success with retarded (handicapped) or "defective" children, as she called them (Stephenson, 1992), led her to believe that there was a better way to educate children than the methods used to teach handicapped children at that time.

In 1907, after having served as Professor of Pedagogical Anthropology at the University of Rome, Dr. Montessori opened the Casa dei Bambini (Children's House) for normal children in the poorest section of Rome. This school served children from three to seven years of age (Brehony, 1994). Her school, and others that followed and used her techniques, almost immediately gained Dr. Montessori worldwide attention.

Dr. Montessori's techniques and methods quickly spread from Europe to the United States. The first Montessori School in the United States was established in Tarrytown, New York in 1911. By 1915, there were over 40 Montessori Schools in existence in the United States. The Montessori

method had broad support as an alternative to traditional types of instruction. Samuel McClure made Montessori known throughout educational circles in the United States with several articles in McClure's Magazine. These articles espoused the Montessori method of instruction. In a trip sponsored by McClure, Dr. Montessori visited the United States for the first time in 1913. Her arrival was greeted enthusiastically by disciples who had trained under her in Europe and by prominent supporters such as Alexander Graham Bell and Thomas Edison (Hainstock, 1986).

In early 1913, William Heard Kilpatrick at Columbia Teacher's College, known as the million-dollar professor, nearly killed the Montessori movement with a speech before the annual meeting of the International Kindergarten Union. In 1914, Kilpatrick added to his criticism by writing a book entitled The Montessori System Examined in which he declared that Dr. Montessori's ideas were not new. This attack, coupled with the emerging pedagogy of Professor John Dewey, helped bring an end to the Montessori movement in the United States almost as fast as it had begun (Hunt, 1964). During the height of the first Montessori movement in the United States, there were 104 Montessori schools in the United States in 29 states (Applebaum, 1971), but by 1925 these schools were nearly non-existent (Chattin-McNichols, 1992c). However, in Europe the Montessori

movement continued to thrive as an alternative method of instruction, especially for preschool children.

The second Montessori movement did not appear in the United States until 1958, six years after Dr. Montessori's death. The first school was started by Nancy McCormick Rambusch in Whitby, Connecticut, in what Hainstock (1986) called correct timing for this reemergence. McCormick Rambusch in subsequent years founded the American Montessori Society and wrote the book Learning How To Learn: An American Approach to Montessori. This book helped parents understand the Montessori approach to education.

In 1965, the first Montessori Head Start program was formed in Philadelphia (Duax, 1993a); that same year the first Montessori public school was started in Cincinnati (Hainstock, 1986). Although most of the expansion of Montessori schools was in the private preschool sector, new programs were beginning to appear in public schools as well. In the mid 1970s, Montessori public schools receive a big boost from federal funds used to create the magnet schools that assisted in desegregation. In the 1980s there was an increased interest in early childhood education and in providing choice for parents. All these movements created more opportunities for the Montessori method to move into the public schools (Cohen, 1989).

Today over 110 public school districts and over 190 public schools have Montessori programs. It is estimated that there are over 3000 Montessori schools in public, private, and parochial sectors (Schapiro, 1995).

The biggest problem in starting a Montessori program, according to Chattin-McNichols (1992a), is hiring public school teachers qualified to teach Montessori. Although there are over 100 training programs in the United States, it is often very difficult to find a teacher who is certified by the state and who is also Montessori trained (G. J. Turner, 1992). According to Duax (1993b), Montessori programs are being added to public school systems at a rate of five school systems per year. Even with this small growth rate, there does not appear to be a serious lack of interest in the Montessori movement in the public schools in this country.

A new development in public education is Montessori in the middle schools. At the beginning of the 1995-96 school year there were 13 Montessori public middle schools in the United States. Only three of these schools are over five years old. The oldest Montessori middle school is the E. M. Dagget Montessori Middle School in Fort Worth, Texas, which began operations in 1984. All but one of these schools are either housed within a traditional middle school or junior high school or within a K-8 Montessori building. Only the Renaissance Montessori School in Grand

Rapids, Michigan is a self-contained Montessori middle school (Gordon, 1995).

The newest form is the Montessori charter school. This new development in Montessori public schools began in Minnesota in 1993. This type of school allows those applying for a charter to create their own school with public funds. The first Montessori charter school in the United States was the Bluffview Montessori School in Winona, Minnesota (Gordon, 1994). The basic concept of these schools is that state funding goes directly to the school. Today (1995) there are eight Montessori charter schools, located in Arizona, Georgia, and Minnesota (Schapiro, 1995).

Studies of Academic Achievement of Students
Taught by the Montessori Method

Montessori held the strong belief that the child's early years were the most critical in his or her development. Most of the Montessori schools in the United States and around the world are devoted to the education of very young children. Of the 3,000 plus Montessori schools in the United States today (Schapiro 1995), most are structured to serve the three- to six-year-old child (Chattin-McNichols, 1992c). Studies conducted in the last 38 years have concentrated on the theoretical philosophy of Dr. Montessori and on how well children scored on academic

achievement tests in school after having attended a Montessori preschool. Many of the studies in both private and public schools report that students who attend a Montessori program do as well as or better than students who attended a traditional classroom. Epstein (1990) noted, "The Montessori method has proved its effectiveness. Nationwide, students in public Montessori programs score 10 to 20 points higher on California Achievement Tests than students in traditional classrooms" (p. 20). Though this may be true in some districts, other research cited in this paper indicates that there is little difference between students taught by the Montessori method and students taught by traditional methods.

There is very little research in the area of student academic achievement by students who have attended public school Montessori programs (Chattin-McNichols, 1992c; Cisneros, 1994; Claxton, 1982; Meuwese-Ribberink, 1977). In the most recent study on Montessori academic achievement, Cisneros (1994) found that most research has been conducted in the private sector and only limited studies have been completed in the public sector. This may be attributed to the fact that of the 3,000 Montessori schools in the United States today, only about 200 are in public school systems.

In the area of student behavior, Baines and Snortum (1973) stated, "For over 60 years the Montessori method has

posed a radical alternative to traditional teaching practices, but there has been little documentation of the impact of this approach upon classroom behavior" (p. 313). Though this observation is over 20 years old, it is still true: little research has been completed on behavioral changes resulting from Montessori programs, particularly in the public school setting.

A majority of the research on the Montessori method of instruction has been conducted in preschools and the private sector. Although the preschool studies are not directly applicable to this research study, they do add to the understanding of the effectiveness of the Montessori method of instruction. The study that contributed the most in the preschool area was the longitudinal study by Miller and Dyer (1975). This study and follow-up studies by Jones and Miller (1979) and Miller and Bizzell (1984) considered four different types of preschool programs including Montessori programs. The results of these studies showed some gains by Montessori students.

Though agreement on whether a Montessori preschool experience is better than other preschool programs cannot be obtained, there are many studies that state there are advantages to the Montessori program. In the 15 Montessori preschool studies reviewed, most reported favorably on the positive academic effects of a Montessori preschool experience compared to other preschool programs.

In the private Montessori school setting, there have been studies on student academic achievement that can be compared with the studies in the public setting. Ongoing studies, like the 18-year longitudinal assessment study being conducted at the Franciscan Montessori Earth School in Portland, Oregon, can bring added information to the research (Glen, 1993). This study, now in its 10th year, has found that Montessori students achieve at above average levels on academic achievement tests; however, the researcher in this project had to rely on parents voluntarily submitting their child's scores after these children left the Franciscan Montessori Earth School.

More recently, Duax's (1995) study in a private elementary school has contributed to the body of knowledge on student academic achievement by students taught by the Montessori method. He conducted a study of academic achievement of students in a private school in a Milwaukee suburb. Students were given the Stanford Achievement Test at the completion of the eighth grade. Students in this longitudinal study showed steady gains from second grade to eighth grade. Duax (1995) concluded that "Montessori elementary education can take high-achieving students and produce even higher academic results when compared to other students through national academic achievement norms" (p. 147).

The movement of Montessori education in the public schools has been most affected by desegregation and by the creation of magnet schools. Though there are some studies on the effectiveness of these programs in the urban environment, there are very few studies of student academic achievement of Montessori students in other school environments. However, the few studies conducted have contributed to the literature on the effectiveness of Montessori in the public school setting.

One of the earliest and most comprehensive studies was conducted in Cincinnati in the late 1960s and the 1970s. This study was known as the Sands Project. Three separate reports on its success were made over a six-year period and were relevant to the effects of Montessori instruction on student academic achievement. The first year report, completed by Banta (1968), compared four groups of students. These groups included two experimental classes of non-graded primary classrooms and two control groups of students who received traditional methods of instruction. The two experimental groups consisted of a Head Start preschool and a Montessori preschool. The report concluded that the non-graded primary with preschool exhibited the best results regardless of whether Montessori or Head Start were used.

A more comprehensive evaluation of the Sands Project was conducted by Gross, Green, and Clapp (1970). After

three years, evaluation of the above-mentioned classes showed that Montessori students ranked highest on 10 of the 13 measurements. Though students in the Montessori classes did well, no statistical significance in academic achievement was noted.

The third study on the Sands School Project was conducted by Sciarra and Dorsey (1976). Their results were similar to the first two studies with "no statistically significant results obtained" (p. 8). They did find, however, that students taught by the Montessori method scored higher on all seven of the subtests on the Metropolitan Achievement Test than a control group.

In a study completed by Dawson (1987) in the Montessori Magnet School in Houston, Texas, academic achievement by race was examined. Dawson found that the Montessori method of instruction was effective for all races but was especially effective for Hispanics. Seventy percent of the test scores were significant. However, it should be noted that the Montessori classrooms were at a 1:13 teacher/student ratio with an aide in each class. In addition, Dawson (1987) stated that the screening or selection was for "more able and motivated students" (p. 3).

A more comprehensive study based on gender and ethnicity was conducted by Curtis (1993) and analyzed student academic achievement in a Montessori program.

Curtis's results did not agree with Dawson's results. Curtis found that both Anglo-Americans and African-Americans did significantly better than Hispanic-Americans on most subtests of the Metropolitan Achievement Test.

One of the most current studies on academic achievement in the public school setting is being conducted by the Kansas City School District in Kansas City, Missouri. Two separate evaluations were conducted by Moore (1991a, 1991b). A summative evaluation of the Faxon Montessori Magnet Elementary School and a formative evaluation of the Holliday Montessori Magnet Elementary School were completed. Both schools are operating under a court-ordered desegregation plan. A comparison of ITBS scores between Faxon Montessori students and traditional K-3 students was statistically analyzed using an ANCOVA procedure and, when a covariant was not available, with an ANOVA procedure. There was a significant difference favoring those taught by the Montessori method in second grade reading and third grade language. Students taught by traditional methods did significantly better in first grade language; traditional kindergarten students did significantly better in math. Other results in reading, language, and math were inconclusive.

At the Holliday Montessori Magnet Elementary School, Moore (1991b) did not do a statistical analysis as he had at Faxon, but he did find that minority students scored

below the national norms while majority students exceeded the national norms. Only kindergarten was examined since this was the first year of Holliday School's implementation of a Montessori method plan.

The first dissertation study comparing student academic achievement in the public school setting was completed by Claxton (1982). Prior to her study, Meuwese-Ribberink (1977) had completed a study of five-year-old children in a private Montessori school. Claxton (1982) did her study in a metropolitan school district in north Texas, comparing the academic achievement scores of kindergarten, first, second, and third grade students taught by the Montessori method to those students taught by traditional methods. A two-way analysis of covariance was used as the statistical technique. The tests used included the Bilingual Syntax Measure, the California Achievement Test, the Iowa Test of Basic Skills, and the Metropolitan Readiness Test. Claxton found no significant difference at the kindergarten, second, and third grade levels, but did find a significant difference at the first grade level. The absence of a difference at the second and third grade levels indicates that overall academic achievement was not affected by Montessori instruction.

In a more recent dissertation, Cisneros (1994) studied third grade students in the Dallas Public Schools. She used the Iowa Test of Basic Skills as a pretest and the

Norm-referenced Assessment Program for Texas as the post test. Her study analyzed the data from test scores in both reading and mathematics. The test scores of the students in grade 3 were statistically analyzed using the multiple regression technique. She found no significant difference between students taught by the Montessori method of instruction and those taught by traditional methods. In reading she found that the mean of the Montessori group of students was higher than the mean of the non-Montessori group, but that the mean scores of the Montessori group declined in reading over a one-year period while those of the non-Montessori group increased. Similarly, in mathematics, she found that the Montessori group scored much higher than the non-Montessori group but that the non-Montessori group's scores had increased gains made from one year to the next while the scores of the Montessori group declined.

Thus it can be seen that the literature on the effectiveness of student academic achievement by students taught by the Montessori method of instruction indicates that most results are not significant. In general, studies conducted at the preschool levels and at the elementary school levels have shown that students taught with the Montessori method achieve at a rate equal to or greater than those taught with the traditional method of instruction in some subjects, but not in others. However,

those who conducted these studies appear to be most interested in whether or not students achieve at a level equal to or above the district mean on the academic achievement tests and not whether there is a significant difference in test scores.

During 1996, four dissertations were completed that had to do with Montessori education. Those dealt with Christian communication for children and the curriculum connection to Montessori; Lensgrinder's study and its application to the Montessori learning-teaching model; a study of Plato, Piaget, and Montessori developmental theories; and the value of a public school Montessori parenting program. However, none of these dissertations added to the knowledge base on student achievement in Montessori education.

There does continue to be a considerable amount of attention to and writing on the Montessori method. Most of the literature is written by Montessori advocates.

According to Lakshimi Kripalani (1997), who was trained by Dr. Montessori and is a Montessori trainer and consultant,

Montessorians claim that they have the answers, and are quick to differentiate themselves from others and lump them as traditionalists. This results in alienation and creates barriers and antagonism. It not only closes minds of other educators but results in constant battles of who is right or who is wrong.

Not only must Montessorians engage in more productive discussions with other educators to test their answers, they must look within to see

how well they and their colleagues are putting into practice the insights that have been handed over to them within the framework of the Montessori approach. (p. 2)

If the Montessori method of instruction is to be seriously considered as an alternative for parents in the public school setting, this attitude must be a part of the ongoing discussion about Montessori in the public school setting. Openly examining the academic achievement of Montessori students is one of the many areas that should be examined. This study has added to that body of knowledge.

CHAPTER 3

METHODOLOGY

Introduction

This chapter describes the procedures by which data were collected and analyzed to determine if there was a significant difference between students taught by the Montessori method of instruction and those taught by traditional methods of instruction in the Helena Public Schools. The major sections of this chapter are as follows: (1) theoretical framework, (2) explanation of the Montessori method, (3) population description and sampling procedure, (4) hypotheses, (5) method of collecting data, (6) analysis of data, (7) control over extraneous variables, and (8) limitations and delimitations.

Theoretical Background

The theoretical base of this study on student academic achievement of students taught by the Montessori method of instruction comes from two backgrounds. Dr. Montessori credits the foundations of her methods to the works of Jean-Marc-Gaspard Itard (1775-1838), a physician in Paris who worked with deaf mutes, and Edouard Seguin (1812-1889),

a student of Itard's who developed a series of exercises to aid retarded students (Hainstock, 1986). Montessori studied these works and those of Giuseppe Sergi, her anthropology teacher, to help her develop skills in scientific investigations.

However, it was not just through these individuals that she developed her theoretical foundation. According to Hainstock (1986), the groundwork for Dr. Montessori's ideas was rooted in the work of Jean-Jacque Rousseau and, before him, John Locke. Another person given considerable credit for Dr. Montessori's methods is Friedrich Froebel, a disciple of Johann Pestalozzi. Standing (1984) sums up this background by stating that

it would be absurd to suppose that Montessori, who was for ten years a lecturer at her women's training college at Rome, was ignorant of that other--that mainstream of educational development--which flowed through Rousseau, Pestalozzi, Herbart and Froebel. She could not have read through, as one of the examiners, "all those 150 theses on all possible pedagogical authors from the best known to the most forgotten" without becoming acquainted with their ideas. (p. 59)

Dr. Montessori's work is often compared with that of Friedrich Froebels, the founder of kindergarten. Standing (1984) goes on to say that, "It cannot be doubted that Froebel's spiritual approach to childhood and the emphasis he laid on the training in infancy prepared the soil in which later Montessori's ideas were to take root and flourish" (p. 321).

When the stages of growth that Rousseau espoused are compared with those of Montessori, striking similarities can be noted. Both Montessori and Froebel placed emphasis on self-directed activities. By combining these similarities and comparing them to the earliest writings on early childhood development by John Locke, a clear picture of the philosophical foundations of Dr. Montessori's work can be seen. Though no one person can be credited with all the methodology seen in her work, one can trace many of her concepts to individual educational philosophers of the past four centuries.

Population Description and Sampling Procedure

The population which was used in this study was composed of second, third, fourth and fifth grade students enrolled in the Helena Public Schools in Helena, Montana. Helena is a capital city in which the chief employer is the State of Montana. Located in the west central part of the state, Helena and the surrounding area have a population of approximately 30,000. The community has a rich history of mining and government.

The Helena Public Schools enrollment is 8,372 students (Appendix A) and the certified staff number 628. The student population is 95% white, 4% Native American and 1% other. The socioeconomic status of the population is measured by the free and reduced lunch formula established

by the federal government. The overall average ratio of those students receiving free or reduced-priced lunch to the total population is 16.7%. The average household income in Helena is \$25,462.

Currently there are five Montessori classrooms in Helena serving 107 students. The student population in these five multigrade classrooms is composed of 24 first graders, 24 second graders, 23 third graders, 23 fourth graders, and 13 fifth graders. The three primary classroom student populations are composed of first, second, and third grade students. The two intermediate classrooms serve fourth and fifth grade students. First grade students were not included in this study because they had not had a minimum of two years in the program.

The Helena Public Schools Montessori program is in its sixth year of operation. All classrooms are located in traditional rooms at Central or Jefferson Elementary Schools. All classes participate in normal school-wide activities and programs. Funding for supplies and operating expenses is the same for Montessori classrooms as it is for traditional classrooms. Within the Montessori classroom setting, all students are taught by the Montessori method. Only Montessori students that were in grades 2 through 5 at the end of the 1995-96 school year and had been in the Montessori classrooms for a minimum of

two consecutive years were included in the statistical analysis outlined in this study.

The Montessori classrooms are open to all students in grades 1 through 5. Selection is made through an open lottery held once each year for those entering the first grade. Notifications are placed in the Helena newspaper and in school flyers. There are no preferences shown for any students, including those who have siblings in the program. However, once a student is selected, he/she may stay in the program as long as the parent wishes or until the child moves to the middle school. Those students not selected in the lottery are put on a seniority waiting list until there is an opening. There are currently 15 students in the Helena Schools who have applied for the Montessori program through the lottery but who are not in the program. They include one second grader, three third graders, four fourth graders, and five fifth graders.

The sampling technique used in this study was a matched pair design. This design was selected to control as many variables as possible. According to Kerlinger (1973), the matched pair design can be a very desirable technique when all variables can be matched. In this study, the researcher matched each student on the five independent variables of grade level, gender, aptitude, handicapping condition, and family socioeconomic conditions. Each Montessori student in grades 2 through 5

was matched by grade level, gender, aptitude, handicapping condition, and family socioeconomic status to another student from the school district who had been taught in a traditional classroom. Aptitude was measured by the Test of Cognitive Skills (TCS/2) (Test of Cognitive Skills Technical Report, 1993). Socioeconomic status was matched according to students on free lunch, students on reduced lunch, and those not on assisted lunch. Handicapping conditions were matched by a handicapping label for cases in which a Montessori student has been identified as handicapped.

Matching was accomplished by selecting students taught by traditional methods of instruction through computer data alignment. The computer was programmed to select students from the total population by matching the independent variables listed above. When more than one student matched a Montessori student, the first on the list was used as the matched pair. If an exact TCS/2 aptitude score did not match a Montessori student, the researcher moved up one point at a time until a match was made. The sample from the total traditional population was complete when all Montessori students in grades 2 through 5 were matched. Since this study used a very small number of Montessori students at each grade level, the match of the listed independent variables was imperative.

Hypotheses

The null hypotheses for this study are:

1. No statistically significant differences exist between the aptitude scores of those children whose parents elect to have their children in a Montessori classroom and all other children in traditional classrooms in grades 2, 3, 4, and 5 in the Helena Public Schools.
2. No statistically significant differences exist between the academic achievement scores of students taught by the Montessori method of instruction and those students taught by traditional methods of instruction in grades 2 and 3 in vocabulary, reading comprehension, language mechanics, language expression, math concepts and application, math comprehension, word analysis, and spelling.
3. No statistically significant differences exist between the academic achievement scores of students taught by the Montessori method of instruction and those students taught by traditional methods of instruction in grades 4 and 5 in vocabulary, reading comprehension, language mechanics, language expression, math concepts and application, math comprehension, spelling, science, social studies, and study skills.

4. The method of instruction given to the students and the gender of the students in this study do not interact on academic achievement scores.
5. The method of instruction given to the students and the aptitude of the students in this study do not interact on academic achievement scores.

Montessori Method Used in Helena Public Schools

The Montessori program in the Helena Public Schools follows the American Montessori Society (AMS) model. All teachers in the program have been trained to use AMS techniques. There are currently five Montessori teachers serving 107 students. Three of the five Montessori teachers have master's degrees. In the traditional elementary classrooms, 44% of the teachers have master's degrees and another 30.2% have bachelor's degrees plus 45 hours of additional course work.

Class size for all Montessori classrooms in the Helena Public Schools is set at the Montana state accreditation standard level for multi-aged classrooms. These class sizes are 20 students for grades 1, 2, and 3 and 24 students for grades 4 and 5. In the five full years that the Montessori program has been in the Helena Schools, all classes have been filled to the maximum level allowed by these standards. Numbers of traditional classrooms in the Helena Public Schools do not exceed the levels set by

the state accreditation standards. These standards for single grade classrooms are 20 students for grades 1 and 2, 28 students for grades 3 and 4, and 30 students for grade 5. Actual class sizes in Helena vary from school to school depending upon school enrollment. Multi-aged classrooms are occasionally used for traditional classrooms as well as for Montessori classrooms.

The Montessori model is based on the ideal teaching program as espoused by Dr. Montessori. However, Montessori classrooms today in the Helena Public Schools and other public schools are not identical to original Montessori schools. According to Chattin-McNichols (1992c),

Some writers on Montessori have chosen to comment on Montessori's original writings, rather than focusing on current practices in American schools today. While this has the advantage of certain authenticity, it neglects the changes that have come about in Montessori practice since 1907.

(p. v)

The underlying philosophy of the Montessori program consists of an environment that is carefully planned to assist students in developing independent learning styles and self-direction. All classes are multigrade and emphasize learning through the students' own discovery. The method of instruction in the Montessori classroom is highly individualized and student-driven. Students progress through the content of the curriculum at their own pace with the teacher acting as a facilitator. Careful records are kept on student progress. In the Helena Public

Schools, there is a very high number of thematic presentations. The classroom environment exhibits a constructivist orientation that places great importance on discovery, manipulation, broad concepts, student-driven instruction, current meaningful problems, a curriculum that is adaptive to student needs, and an assessment program that helps guide student learning. According to Loeffler (1992),

Montessori's prepared learning environment--with self-selection and free choice for the child as its major components, coupled with interesting manipulable objects as stimulation for activity, and a three-year age span for social and intellectual collaboration and challenge--provides an ideal setting for the child's self-construction process. (p. 102)

There are vast differences between the Montessori method of instruction and traditional methods. The differences center around the classroom environment, the didactic materials used for student learning, the role of the teacher, and the development of the individual.

The environment of a Montessori classroom is structured much differently than a traditional classroom. There are areas in the room that have special meaning to the Montessori method. These include areas for practical life, sensorial life, math, language, and cultural subjects (science and social studies). The didactic materials are very important to the environment of the classroom. Instead of being oriented by means of traditionally-arranged desks,

the above-mentioned areas are divided into sections or areas by specialized shelving, child-sized tables and chairs and other instructional materials. According to Chattin-McNichols (1992c), "Indeed the classroom is obviously not designed for long periods of direct whole group instruction" (p. 51). In a Montessori classroom, the floor is an area that is a regularly used "station" for learning. It is the environment and didactic materials that set the foundation for the Montessori method. Both serve very specific purposes that together encourage the child to be self-directed.

The child is the center of a Montessori classroom. In the Montessori classroom the teacher is not the most important component. The teacher in a Montessori classroom is taught to observe and assist the child in using materials that are highly organized and sequenced and give a meaningful learning experience. According to Dr. Montessori, in her own book, The Montessori Method, (1964), "The fundamental principle of scientific pedagogy must be, indeed, the liberty of the pupil; such liberty as shall permit a development of individual, spontaneous manifestations of the child's nature" (p. 28). Though this sounds like a classroom in which the child does what he or she wants at any time, in fact, the classroom is highly structured through design by the teacher. The teacher is a facilitator or guide for the students. Whole group

instruction typically takes up only 20 to 40 minutes in any half day (Chattin-McNichols, 1992c). Techniques of observation and intervention are part of the Montessori training program.

Montessori advocates believe that children taught by their method of instruction are not only more successful academically, but also are more successful in other areas of development. In a study completed by Neubert (1992), 200 Montessori teachers were randomly selected and surveyed about what they considered the most important overall goals of the Montessori method of instruction. The goal given the highest overall rating was independence. This was followed by self-confidence, respect for others, joy of learning, self-respect, creativity, self-control, concentration, and developing the child's potential. Additionally, Neubert asked these teachers what their goals were for the children in their classrooms. The top six responses were love of learning, socialization, independence, self-esteem, self-confidence, and respectfulness. Further analysis of the results obtained by Neubert indicated that teachers reported that students spent 63% of their time working independently, 23% their time involved in total group work, and 14% their time involved in transitional activities.

Today Montessori classrooms in the public schools have adapted to the needs of the schools, the teachers, and the

students. Though the Montessori philosophy is the same, adaptations have been made to meet the needs of the child. Chattin-McNichols (1992c) stated that, "The program is, then, the result of one teacher's interpretation of the model in which she has been trained. That model is derived from Montessori's ideas, both those written in books and those given primarily in training programs" (p. 8). Barron (1992) summarized this by stating that

the aim of Montessori education is to develop each person's abilities to the fullest extent while celebrating and enhancing his or her uniqueness and cultural background. The goal of education is the development of autonomous, competent, responsible (to themselves, other human beings, and the environment), adaptive citizens--lifelong learners and problem solvers. Respect, competency, responsibility, self-initiative, and self-management are valued. (p. 268)

The above statement is very similar to the mission statement and goals of the Helena School District No. 1 (1996). This mission statement is as follows:

The mission of the Helena Public Schools is to challenge and empower each student to maximize individual potential and become a competent, productive, responsible, caring citizen.

This mission will be supported through the wise use of resources to meet students' needs, regardless of interest and talents. Students, families, educators, and community are committed to sharing the responsibility for creating a student-centered educational community that acknowledges learning as a lifelong process. (p. 1).

In addition to this mission statement, Goal Number One of the Helena Public Schools (1996) is to "challenge all

students to learn and achieve at their maximum potential and provide students with the necessary skills and knowledge to success in the 21st Century" (p. 3).

Since academic achievement is a primary goal of the Helena Board of Trustees for all students, analysis of data on all students is used to measure the success of the instructional programs. This study examined the difference between the academic achievement scores of those students taught by the Montessori method of instruction and those taught by traditional methods of instruction in grades 2 through 5. The study was limited to examining the academic achievement of Montessori students and traditional students who have spent a minimum of two consecutive years in either traditional or Montessori programs. It is important to note that although the methods used in the Montessori classrooms are quite different from those of the traditional classroom, the language, mathematics, and other curriculum areas are not. According to an independent evaluation of the Helena Montessori curriculum and the Essential Skills and Content List (ESCL) of the Helena Public Schools by Dr. Gerald Kulm of JK Associates (1996),

The content outlined for the Montessori program is comprehensive, covering all the topics outlined by the Helena ESCL. The Montessori Language and Mathematics curricula are very close to the ESCL Communication Arts and Mathematics lists. It is clear that in these two important areas, the Montessori curriculum meets district guidelines. (p. 5)

Traditional Method Used in Helena Public Schools

The traditional method of instruction in the Helena Public Schools is representative of that used in schools across the state of Montana. Teachers follow the approved district curriculum guides using a variety of approaches. The most common method of instruction is following the teachers' guides in the adopted textbooks with questions, exercises, and evaluations taken from the guides. Teachers adapt the guides to their individual styles and interests. The teaching strategy most commonly used resembles the Madeline Hunter model of Instructional Theory Into Practice (ITIP). This model, as used in most classrooms in the Helena Public Schools, resembles a behaviorist orientation that is representative of direct instruction. The model is characteristic of generally teaching a behavioral objective, attempting to teach at a level appropriate for the students, monitoring and adjusting instruction, and using reinforcement as a motivation. Though both Montessori and non-Montessori based classrooms follow the district curriculum guides, the Montessori classrooms also sequence the Montessori material using the techniques established by Dr. Montessori.

Method of Data Collection

Two instruments were used as the primary method of data collection. These instruments measured student academic achievement and student aptitude. The validity and reliability coefficients and norms of these two instruments were established through national stratified random samples.

The Comprehensive Tests of Basic Skills, Fourth Edition (CTBS/4) was the primary instrument used to gather academic achievement data on both Montessori students and students from traditional classrooms. According to the Hopkins review in The Eleventh Mental Measurements Yearbook (1992), "The CTBS/4 continues to be among the very best general academic achievement test batteries" (p. 217). This test was selected from among other major tests by the Helena Public Schools, upon the recommendation of the district-wide testing committee, because it best matched the curriculum of the school district (Appendix B). Only one form of the test was used for all students. The test is designed to measure academic achievement of basic skills in the areas of reading, language, spelling, mathematics, study skills, science, and social studies. For this study, the full batteries were given only to fourth and fifth grades. Grades 2 and 3 were given the subtests in vocabulary, reading comprehension, language mechanics,

language expression, math concepts and application, math comprehension, word analysis, and spelling.

The reliability of the CTBS/4 was established using the Kuder-Richardson Formula 20 (KR20) for internal consistency. The split-half coefficient was obtained by correlating one-half of the test with the other half of the test, then adjusting the correlation with the Spearman-Brown so that it would apply to the whole test (Comprehensive Tests of Basic Skills [CTB], 1991). The correlation, as shown in Table 1, indicates that at all grade levels used in this study the total battery has a KR20 correlation of 0.94, or 0.95, depending on the grade level.

Table 1. Kuder-Richardson correlation for CTBS/4 total battery.

	Number Items	Mean	SD	Average P-Value	SEM	KR20
Grade 2	120	83.1	18.6	.69	4.2	.95
Grade 3	120	80.9	17.7	.67	4.3	.94
Grade 4	120	73.8	19.4	.62	4.5	.95
Grade 5	120	74.4	18.9	.62	4.6	.94

The aptitude test that was used as the instrument to match traditional students with Montessori students was the Test of Cognitive Skills (TCS/2). This is a test that measures the academic aptitude of all students in the areas

of verbal, nonverbal, and memory abilities. The subtests covered sequencing, analogies, memory, and verbal reasoning. Standardization of the test was completed in 1991 with samples from approximately 7,300 students in 42 schools representing 17 school districts geographically dispersed across the United States (CTB, 1993).

According to the TCS/2 technical report (CTB, 1993), this version of the TCS has the same basic structure as the 1981 version with revisions which include the addition of new items and of a new high school level. In addition, verbal reasoning in level one is now in a textual format and the obscure words to nonsense in the memory subtest have been changed to nonsense words. Both Keith's and Sternberg's reviews in The Ninth Mental Measurements Yearbook (1985) of the TCS/1 were very supportive of the test, except for the lack of technical data available for both reliability and validity. This has been corrected in the TCS/2 technical manual. Both TCS/1 and TCS/2 rely on the Item Response Theory to ensure freedom from bias and to require higher level abstract reasoning skills. According to Keith (1985), "Based in part on Item Response Theory (IRT), reportedly rigorously tested to ensure freedom from bias, and requiring primarily higher level, abstract reasoning skills, the TCS appears a promising addition to the group intelligence test market" (p. 1555). The reliability of the TCS/2 is reported using the KR20 for

internal consistency. The KR20 at all tested grades range from 0.68 to 0.79. Test-retest reliability shows a total test correlation at grade 2 of 0.84 and at grade 4 of 0.90. The second and third grades use level one and the fourth and fifth grades use level two.

The validity of the TCS/2 was established by experts in the field who did a review of items for both bias and content. According to CTB (1993),

The purpose of the content review was to examine the items' face validity for measuring the cognitive abilities intended to be measured. The goal was to eliminate any items that were not optimum measures of the cognitive abilities being assessed by TCS/2. (p. 7)

The TCS/2 was designed specifically to use with the CTBS/4 achievement test. CTB has established an intercorrelation coefficient between the TCS/2 and the CTBS/4. Since both were administered at the same time and to all students in the Helena Public Schools, all test scores were current and complete.

A concern of the researcher was the question of whether Montessori students have had as much experience in paper-and-pencil activities as traditional students. Students need this experience in order to be successful in standardized test taking. Interviews with three different Montessori teachers were conducted to assess whether this possible lack of experience would have an effect on Montessori students' standardized tests scores. The three

teachers interviewed had taught a combined total of 45 years in the Helena Public Schools in traditional classrooms prior to teaching in the Montessori classrooms. All three teachers felt that ample paper-and-pencil tasks were completed throughout the school year in the Montessori classrooms. These tasks were comparable to those undertaken in traditional classrooms. All three teachers felt that the context alignment was equal to that of traditional classrooms. Tina Veroulis (personal conversation, October 15, 1996), a Montessori teacher, stated,

Students complete more paper-and-pencil tasks in the second through fifth grade than those students in the first grade. The first grade students have a more difficult time taking the standardized achievement test than those in the other Montessori grades. We do enough paper-and-pencil work that is so similar to that done in the regular classrooms that I feel our Montessori students are as well prepared to take the tests as those in regular classrooms. The tests and the format are not foreign to the Montessori students.

Analysis of Data

This study compared the academic achievement scores of students taught by the Montessori method of instruction to those of students taught by the traditional method of instruction in grades 2 through 5.

Careful selection was used to match traditional students with Montessori students in terms of grade,

gender, socioeconomic status, aptitude, and handicapping condition if applicable. The researcher used a two-factor analysis of variance to analyze the data. In addition to the method of instruction, the researcher examined whether gender and method of instruction interact and whether aptitude and method of instruction interact. The analysis allowed the researcher to look at more than one independent variable at a time. According to Kerlinger (1973), "It can be argued that, of all methods of analysis, multivariate methods are the most powerful and appropriate for all behavioral scientific and educational research" (p. 149).

The two-way analysis of variance was used to test Hypotheses 2, 3, 4, and 5. Raw scores on the CTBS test were used as the dependent variable in the statistical analysis. The alpha selected for this study was at the .05 level. McNemar (1969) states,

There is the balancing of risks: that of accepting the null hypothesis when to do so may mean the overlooking of a real difference against that of rejecting the null hypothesis which may lead to the acceptance of a chance difference as real. (p. 66)

In this study, the researcher was trying to protect against both Type I and Type II errors by balancing the risk with a .05 alpha. A Type I error would involve rejecting the null hypotheses; this rejection would imply a significant difference between students taught by the Montessori method and students taught by traditional methods, when in fact

there is no such difference. Since adding classrooms would cause an additional expense for the district in terms of materials and teacher training, this study intended to guard against rejecting a true null. In a Type II error, the null hypothesis would be falsely retained; this retention would imply that there is not a significant difference between students taught by the Montessori method and students taught by traditional methods, when in fact there is a difference. If error occurred true, there might be a likelihood that the district would not add classrooms to the Montessori program and therefore deny some parents the choice of the Montessori program as an alternative method of instruction for their children.

The two-way analysis of variance was used to test Hypotheses 4 and 5 for interaction. The researcher was interested in knowing if gender and method or method and aptitude interact on achievement.

Control Over Extraneous Variables

This study was centered around the Montessori classrooms in the Helena Public Schools. The students in these classrooms participated in all school activities, and followed all schedules and school-wide programs, but functioned independently in terms of the instructional methods used. This research design made every effort to

adhere to what Kerlinger (1973) calls the "maxmincon" principle. Kerlinger states,

According to this principle, by constructing an efficient research design the investigator attempts (1) to maximize the variance of the variable or variables of his substantive research hypothesis, (2) to control the variance of extraneous or "unwanted" variables that may have an effect on his experimental outcomes, but in which he is not interested, and (3) minimize the error or random variance, including so-called errors of measurement. (p. 306)

Specifically, this study reported the maximization of the active variable. As reported in this chapter in the section explaining the Montessori method, the instruction is very controlled and well-monitored. In order to maximize this active variable in both method and time, all Montessori students considered in the study had to have had a minimum of two years of Montessori instruction. Outside evaluation was conducted on both the program and on teacher adherence to the Montessori method by Kulm of JK Associates (1996) to determine if the Montessori method of instruction was adhered to.

Controlling the extraneous independent variables in this study is of extreme importance. Though it is impossible to control every variable that has an effect on student academic achievement, minimizing the effects of the independent variable becomes critical to measuring academic achievement scores.

