

Montessori vs. Traditional Education in the Public Sector: Seeking Appropriate Comparisons of Academic Achievement

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Abstract

Recent years have provided an interest on the part of public school systems regarding Montessori as an educational choice, often as a magnet school option. "No Child Left Behind" legislation emphasizes the social and learning needs of individual children as well as a national spirit of accountability for academic achievement, and the public sector is making a comprehensive examination of curriculum delivery systems which can provide benefits for all learners in quantifiable ways, most often in the form of standardized test scores which demonstrate improved student achievement. This study examines the relationship of public Montessori education expressed as Stanford Achievement Test scores in reading and math in comparison with similar scores for students in traditional programs, using a within subjects, matched pairs design of repeated measures over a three year period. Math scores for the groups were not observed to be significantly different, although, following the initial observation, the Montessori group continued to produce increasingly higher mean scores than the traditional students. Marginal significance between the groups suggests that the data analysis should continue to elucidate a possible trend toward significance. Reading scores for the groups demonstrated significant differences, and in the second and third years of the study, Montessori students produced means which consistently outperformed the traditional group.

Introduction

The Montessori Method has long received consideration as an alternative to traditional educational practices. Interest was initiated in the early part of the twentieth century when Dr. Maria Montessori, an Italian physician, disclosed academic achievement among a group of children considered to be profoundly learning disabled. The startling effect of this disclosure, unimagined at the time, propelled Dr. Montessori and her academic ideas to the forefront of both educational and social circles where best practices in curriculum and instruction were of particular interest. Her method was subsequently applied in schools with normal populations, and equally exciting results ensued. Early reports identified academic achievements for this population which exceed expectations as well.

Following the initial burst of interest, educational professionals have often examined the ways in which the Montessori Method might provide benefits to a wide range of learners. Its virtues with respect to peace education have been extolled on numerous fronts, and its focus on

the individual child might be compared with existential ideas regarding personal journeys in education and in life. Another feature of Montessori which has received considerable attention relates to the role of the teacher, a role that is perceived as that of facilitator or coach, or, to use the Montessori vernacular, a preparer of the environment for young learners. This description does not include the type of direct and often whole-group instruction one might expect to find in traditional schools, and the elimination of this feature is often attractive to educators and parents who hope to fashion an educational experience for children based on individual choice and feedback.

The question of comparing academic achievement between Montessori and traditional methods, however, remains largely unanswered, although interest in the question persists. While many features of Montessori education seem attractive both to the educational community and to parents who are seeking the best school placement for their children, measurements of standardized achievement for Montessori have been in short supply. Some studies have undertaken to assess student performance in Montessori education, however they have often relied on anecdotal rather than quantitative and standardized measures, and they have often been confounded by challenges with competing independent variables and conclusions which might not be considered entirely justifiable. The issue of assessment seems to have languished for a long time, considering the scope of Montessori's longevity in the field of education. This may be, at least in part, because the Method, for many years, was practiced almost exclusively in the private sector. Many Montessori schools, both historically and contemporaneously, eschew both grades and standardized testing as inconsistent with the Method and with the goals of Montessori education in general. A change, however, has evolved in public school districts which has encouraged a new look at assessing the academic achievement wrought by Montessori education.

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Many public school systems have begun offering Montessori as a magnet option. Other districts are considering the same addition to their spectrum of school choice. These public institutions require an assessment of academic achievement that is consistent with the protocol used nationally. This protocol, of course, takes the form of standardized test scores.

The apparent disjoint between typical Montessori assessment, which relies most often on anecdotal and portfolio-type evidence, and that employed in the public sector creates a challenge in comparison. It is important to overcome the challenge for a number of reasons. Montessori has become a popular magnet option for school districts nationwide. Public schools are required to make achievement comparisons which will not be perceived as comparisons of apples and oranges. For them, the only acceptable type of evaluation is that which is provided by standardized testing. No Child Left Behind legislation poses a similar requirement, as standardized assessment and accountability have taken a prominent role in educational judgments regarding both schools and learners. An additional factor encourages a resolution to the assessment conundrum. Montessori programs have high start-up costs. Specific materials are necessary to outfit those classrooms using the Method, and modifications to the physical space may be required. Staffing requirements are different as well, employing Montessori certified teachers who hold two types of licensure: that which is issued by the state as well as a separate certificate earned from one of the authentic Montessori associations offering training and certificate programs. These costs are high, and though many districts are willing to bear them, they want assurances that their investments will reap desired outcomes in the form of appropriate academic achievement for learners in those classrooms.

The testing conundrum may seem somewhat surprising, given that Dr. Montessori's initial impact on international education came as the result of both teacher observation and

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national test scores. It was on the basis of both of these measures that her first group of learners, classified as idiots by the medical community in her native Rome, attracted the attention that they did and essentially launched the Montessori Method into worldwide focus. Contemporary private practice of Montessori, however, appears to support and rely on measures of achievement other than standardized testing. Public Montessori programs, in contrast, are required to include standardized testing of all students, as would be implemented in any public school.

The question of standardized testing goes beyond the simple consideration of whether or not it should be used for assessment. Any testing requirement for the public Montessori population asserts a new, potentially confounding, question for comparison. Public school students typically receive practice in testing simulations as part of their preparation for actual test administration. Such simulations are intended to give students skills in the test-taking process, including recognizing types of questions and formulation and expression of appropriate answering protocols. If Montessori students do not have similar experiences in test simulation, will this lack represent an unaccounted independent variable in any research comparisons based on test scores?

Additional challenges of comparison exist with respect to assessing Montessori versus traditional programs, and these challenges have frequently been ignored in early research. Intact samples have been examined, but often from the private sector, leading to questions about whether or not these samples represented a normal distribution, and whether or not fair comparisons could be made with other groups. A final issue must be addressed as well as we discover that the use of the term "Montessori", as a school descriptor, while subject to scrutiny, is not subject to controlled usage. This means that large numbers of schools may be using the name without authorization from one of the accrediting organizations which oversee authentic

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Montessori education. As a result, comparisons of traditional educational methods and those attributed to Montessori schools, which have not controlled for this important distinction, may yield conclusions which cannot be supported. The need for additional, well-designed research on the subject is clear.

The present study advances the knowledge base regarding achievement comparisons between Montessori and traditional programs by providing both an examination of former research over the history of the Method, as well as a design which includes controls for some of the confounding independent variables which appear to have been present at times in that earlier research. First of all, the present study employs standardized test scores as the basis for comparison of academic achievement in both reading and mathematics. Secondly this study removes the challenge associated with evaluating Montessori students who have no experience with test preparation practice by including subjects from a large, urban public school in which Montessori magnet students received the same test practice required by the school district for students in all programs. As a result, the Montessori contingent participated in the comparison without a potential disadvantage represented by lack of similar exposure to standardized testing. Additionally, the potentially confounding element of having Montessori students from a single socioeconomic background represented in the Montessori sample is removed in this study, because the participating Montessori magnet program registered its students by lottery. Since all students applying to the program had an equal chance of selection, a greater level of randomization would be anticipated than would be present in a sample possibly stratified by socioeconomic status or other elements. Finally, this study avoids the ambiguity of the term "Montessori" as it relates to school programs by providing a clear definition of the magnet

program, the classrooms, and a standard for the training of the teachers whose students were subjects.

Historical Perspectives

The earliest reports of Dr. Montessori's success occurred towards the beginning of the twentieth century when American educators and members of society heard news of her work in Europe. Some of these interested parties traveled to Rome and observed the doctor's classes firsthand. They returned to the United States to publicize their observations and to encourage the use of the new method in their own country. In the popular *McClure's Magazine* of this time, Tozier announced that Dr. Montessori was teaching three-year-olds to read. This assertion was considered miraculous by American standards of the era.¹ Private constituencies began to provide funds for the establishment of Montessori programs in the United States, and an interest developed in studying the efficacy of the new educational practices born in Europe. Fisher returned from observing Montessori's work in Italy and broadly described the positive metamorphosis her views on child-rearing had undergone as the result of her experience.² Halsey began a series of experiments using Montessori materials with his own and neighborhood children.³ He reported that this use led to increased independence on the part of the children, but with ambiguous definitions and apparent sampling errors, the robustness of his assertions cannot be considered conclusive.

Others made early attempts at experimentation. Benson designed a small study with her own kindergarten students in which a comparison was made between a group who used a partial

¹ Tozier, J. "An Educational Wonder Worker." *McClure's Magazine* 37 (1911): 3-19.

² Levy, D. M., and P. Bartelme. "Measurement of Achievement in a Montessori School and the Intelligence Quotient." *Pedagogical Seminary*, no. 34 (1927): 77-89.

³ Halsey, W. "A Valuation of the Montessori Experiments." *Journal of Education* 77 (1913): 63-64.

set of Montessori materials and a group who did not.⁴ She reported that the former group developed greater persistence, but the study was confounded by the same challenges as those which faced Halsey, including a lack of clarity regarding the teacher's knowledge about how the materials should be presented to the learners. One exception to the limitations of these early studies was provided by Kimmins who shared the results of a startlingly well-constructed study in which the author administered tests that had been normed on approximately twenty thousand London students to both Montessori and traditionally-educated groups.⁵ The results indicated that at two levels, specifically ages five to seven and ages seven to ten, the Montessori students were one to two years ahead of the others in school achievement. While thought provoking, these results are still somewhat suspect as demographics of the sample were not reported.

The question of teacher qualification and appropriate presentation of the Montessori materials was addressed soon after. Levy and Bartelme examined the efficacy of Montessori schooling with lower socioeconomic status students using the Binet-Simon Test of Intelligence with students in an inner city Chicago school.⁶ The study included the students of Ann George, the first Montessori teacher in the United States. Positive correlations were reported for IQ and completion of Montessori tasks.

A long decline in interest for similar studies ensued with a resurgence in the sixties, reflecting the movement toward compensatory education which encouraged examination of multiple curriculum delivery protocols. Montessori, along with other programs, was being reconsidered, but, as Edmonson expressed, no longitudinal studies of Montessori students had been done, and as a result Montessori theories remained largely doctrinal rather than sustained

⁴ Benson, T. "An Experiment in Montessori Work." *Primary Education* 21 (1913): 9-11.

⁵ Kimmins, C. "A Montessori Experiment at Sway, Hampshire." *Child Study* 69-72 (1915).

⁶ Levy, D. M., and P. Bartelme. "Measurement of Achievement in a Montessori School and the Intelligence Quotient." *Pedagogical Seminary*, no. 34 (1927): 77-89.

by a supportable research base.⁷ Educators wondered if apparent high student achievement in private Montessori schools were the result of the method or more closely associated with one or more rival hypotheses, such as the variety in Montessori practice which Pitcher described.⁸ Mills suggested that the children in Montessori schools would be doing well irrespective of what program they were in, and the apparent commitment of their teachers might add to this effect.⁹ Banta, however, reported his observations from numerous Montessori schools serving both lower and upper socioeconomic groups, in which an observed common feature of learner autonomy was described.¹⁰ He continued his inquiry and reported that Montessori preschool children had demonstrated superiority on nine of ten tests administered in comparison with traditional subjects. Once again, the findings were thought-provoking, but could not necessarily be generalized to older learners as long term effects were unclear.

Although research was being initiated, conclusions were sometimes fraught with potential challenges. Stodolsky expressed the common recommendation that more attention would be necessary to elucidate a comprehensive picture of the differential outcomes of Montessori and other approaches to education.¹¹ Questions persisted with respect to the longevity of apparent effects of different educational approaches. Miller and Bizzell evaluated test scores for more than two hundred Head Start children randomly assigned to four program groups.¹² At the end of second grade, results indicated that three of those four groups,

⁷ Edmonson, B. *Let's Do More Than Look – Let's Research Montessori, Montessori in Perspective*. Washington D. C.: National Association for the Education of Young Children, 1963.

⁸ Pitcher, E. "An Evaluation of the Montessori Method in Schools for Young Children." *Childhood Education* 83 (1966): 489-92.

⁹ Mills, W., and G. McDaniels. *Montessori-Yesterday and today, Montessori in Perspective*. Washington, D. C.: National Association for the Education of Young Children, 1966.

¹⁰ Banta, T. "The Sands School Projects: First Year Results." *ERIC* (1968).

¹¹ Stodolsky, S., and A. Karlson. "Differential Outcomes of a Montessori Curriculum." *The Elementary School Journal* 8 (1972): 419-33.

¹² Miller, L., and R. Bizzell. "Long Term Effects of Four Preschool Programs: Sixth, Seventh, and Eighth Grades." *Child Development* 54 (1983): 727-41.

Montessori, Bereiter, and the control, were all superior in reading. Following this report, the Bereiter group showed the greatest decline, and the question of persistence of effects developed prominence. Takacs and Clifford addressed this concern with a longitudinal study that followed students of the Marotta Montessori School which served inner city preschoolers.¹³ The graduates of this program were reported to score significantly higher in reading and math than their traditional counterparts, and these results persisted through grade six although no additional Montessori training was provided.

The emergence of Montessori into the public sector has required enhanced research methods in more recent times. Boehnlein asserted the view that public schools considering implementation of Montessori would need assurance that the time, effort, and money invested in such programs would yield positive, if not better, results than other programs.¹⁴ Test scores might be required, and Kripilani who actually trained with Dr. Montessori, pointed out that the demand for accountability must be answered.¹⁵ In recognition of this requirement, Montessori education might need to introduce testing to children to avoid leaving them at a disadvantage. In an editorial, *Tomorrow's Child* concurred by expressing the opinion that in present culture, test-taking skills are an example of practical life lessons which children need to experience and master.¹⁶

As Montessori has proliferated in the public sector, the pressing issues of accountability have been addressed with more consistent and comprehensive methods of comparison. Elements of Montessori education, in addition to those which are strictly academic, are being investigated

¹³ Takacs, C., and A. Clifford. "Performance of Montessori Graduates in Public School Classrooms." *The NAMTA Journal* 14, no. 1 (1988): 1-9.

¹⁴ Boehnlein, M. *Research and Evaluation Summary of Montessori Programs*. Edited by D. Kahn, *Implementing Montessori in the Public Sector*. Cleveland Heights, OH: North American Montessori Teachers Association, 1990.

¹⁵ Kripilani, L. *Toward a Montessori Evaluation Approach*. Edited by D. Kahn, *Implementing Montessori in the Public Sector*. Cleveland Heights, OH: North American Montessori Teachers Association, 1990.

¹⁶ Epstein, P. "Is Competition a Necessary Part of Learning?" *Tomorrow's Child* 5, no. 2 (1997): 19-20.

and reported as well by educators such as Robinson who points out that the Method is highly suited to help children be successful in culturally diverse settings.¹⁷ Of greater prominence, perhaps, is the academic performance accountability which is reported in programs of standardized testing. Robinson reports that the students at Indiana's Bunche Elementary are consistently among the highest performers on the state's tests of achievement. Other reports are not quite so compelling. Lopata, Wallace and Finn examined Montessori and traditional students on twelve separate measures and found mixed results, with Montessori students excelling on one contrast, but having significantly lower achievement on four others.¹⁸ He points out that conflicting evidence, limited empirical research, and weaknesses in the methodologies available in existing research underscore the need for additional study regarding the effectiveness of Montessori programs. In examining the Lopata, Wallace, and Finn study, Neuharth-Pritchett points out that the mixed results may be the result of idiosyncratic differences in schools as opposed to actual differences in curriculum delivery systems.¹⁹

The testing question continues to play a prominent role in the literature. Many Montessori educators persist in supporting alternative assessments, and Damore suggests that Montessori teachers and administrators who wish to defend lack of emphasis on standardized testing must take action.²⁰ They must develop a set of learner outcomes which reflect the whole child. Edwards, however, points out that the shortcoming of this concept might be that these measures do not really allow outside audiences to understand the outcomes they are seeking to

¹⁷ Robinson, Wendy Y. "Culture, Race, Diversity: How Montessori Spells Success in Public Schools." *Montessori Life*, no. 4 (2006): 9.

¹⁸ Lopata, Christopher, Nancy V. Wallace, and Kristin V. Finn. "Comparison of Academic Achievement between Montessori and Traditional Education Programs." *Journal of Research in Childhood Education* 20, no. 1 (2005): 5-13.

¹⁹ Neuharth-Pritchett, Stacy. "Research into Practice." *Journal of Research in Childhood Education* 20, no. 1 (2005): 57-60.

²⁰ Damore, Sharon. "A Road Map: Montessori Curriculum and Learner Outcomes" *Montessori Life*(2004): 30-35.

assess.²¹ The need for a commonly understood measure is required. As if in response to this perceived need, the recent work of Lillard and Else-Quest used the Woodcock-Johnson III Test Battery to compare public school Montessori and traditional students at five years of age and twelve years of age.²² They reported that the Montessori group appeared to have significant advantages over the control group at both of the ages studied on measures of letter-word identification, word attack, and math skills. Verification of international public interest in evaluation of the Montessori Method is provided by the example of the *London Times* which, on the basis of this recent study, reported that pupils in Montessori programs may have an advantage over those in traditional classrooms, although no differences were found for basic vocabulary, spatial reasoning, or concept formation.²³

Methodology

The present study was designed to elucidate possible differences in achievement test scores for groups of elementary students in Broward County, Florida public schools who participated in different forms educational programs and classroom instruction. The educational programs examined were Montessori and non-Montessori (or traditional) in this public school district. In order to avoid a testing disadvantage for the Montessori group, and thereby introduce a competing independent variable, the Montessori students received the same test practice experience required of all district schools prior to the administration of the Stanford Achievement Test. Testing practice mandated by the district consisted of timed activities for all students irrespective of program, using the same practice materials, practice items, and response

²¹ Edwards, Carolyn Pope. "Three Approaches from Europe: Waldorf, Montessori, and Reggio Emilia." *Early Childhood Research & Practice* 4, no. 1 (2002).

²² Lillard, Angeline, and Nicole Else-Quest. "Evaluating Montessori Education." *Science* 313, no. 5795 (2006): 1893-1894.

²³ Test-Free System 'Gives Children a Better Start in Life'. 2006. In, Times Online. (accessed 28 May 2006).

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booklets similar in format to those which students encounter in the actual test administration. All teaching staff, regardless of program affiliation, received prescribed inservice training related to the administration both of testing practice and the subsequent test itself. This training was designed and provided at the district level, and involved staff members across all schools in the county, thereby eliminating bias with respect to individual schools.

An analysis of variance, repeated measures design was employed, utilizing matched pairs of students from both types of program. The matched pairs of traditional and Montessori students were initially observed in third grade, and the matching was based on scores in reading and math. Gender, ethnicity, and socioeconomic status were not part of the matching process. However, the Montessori students were chosen for their magnet school participation by lottery which had been modified to ensure that the student body would represent the demographics of the community. With respect to cultural diversity and socioeconomic status, both schools participating in the study provided a balanced population profile.

The baseline test administration occurred during the spring of the subjects' third grade year. Pair matching then took place, based either upon Total Reading or Total Math scores on the Stanford Achievement Test. Subsequent to this first collection of data, scores on the measures of interest for the pairs, either Total Reading or Total Math, were examined during the next two school years. This strategy yielded the opportunity to track subjects over the period of three years, providing standardized scores in reading and math for grades three, four, and five. Thirty pairs were created for math. Thirty seven pairs were created for reading. In the event that a subject had more than a single potential match in the baseline year, matching was done by random selection. Scores for each pair were analyzed over the course of the three annual administrations of the Stanford Achievement Test for the appearance of significant differences in

reading and math, based on program membership, either Montessori or traditional. With a single exception, scores were available for all participants throughout the course of the study, so attrition was not considered to be a significant issue. The dependent variables of interest were either Total Math or Total Reading scores from the Stanford Achievement Test.

The tests were administered on the same date and at the same time for each of the groups over the three years of observation, as dictated by the school district. Instructions for each subtest are scripted, and testing conditions and time allotments are strictly controlled by staff trained at the district level. Since the single criterion which identified a subject for pair matching was a test score, it was assumed that other potential differences between subjects occur by chance. The research hypothesis proposed was that significant within subject differences in Total Reading or Total Math would be observed when matched pairs of students in traditional and Montessori groups were compared over time. Additional planned comparisons included comparing scores for the Montessori subjects with those of district averages. While the omnibus test of significance for the matched pairs was a repeated measures analysis of variance, the additional planned comparison was subjected to a one-sample t-test. An alpha level of .05 was employed, although cases of marginal significance, between .05 and .10 were also identified.

Definitions

Two groups of students participated in the study, Montessori and traditional. The former students were enrolled in an elementary Montessori magnet program in a large, urban school district. The latter students were enrolled in a traditional elementary school. Both school populations were representative of the demographics of the district. The Montessori group had teachers who were both state certified and either certified by the American Montessori Society or

in the supervised practicum phase of the Montessori training which leads to that credential. In the case of those teachers who were in the practicum phase of earning the Montessori teaching credential, periodic site visits, observations, and feedback were provided at intervals by the Montessori trainers assigned to those teachers, and who provide such supervision to ensure that candidates for the credential are conducting their classrooms in a fashion which is consistent with approved Montessori theory and practice. These Montessori trainers had been assigned by an accredited university charged with providing AMS approved preparation. Over the course of the study, these practicum-level teachers were followed to ensure successful completion of the credential. The non-Montessori group participated in classroom instruction of a traditional nature with teachers who possessed state certification, but who had no Montessori training.

Math Results

Results for the Montessori and traditional groups were evaluated in terms of Total Math scores as provided by the Stanford Achievement Test. A within-subjects ANOVA on math scores revealed a significant year effect as well as marginally significant difference by program, but no significant year by program interaction. Analysis of math scores for the matched pairs of three years revealed that a significant difference occurred across groups during the second year, as mean scores for both groups in grade four were elevated. Subjected to the Greenhouse-Geisser Adjustment Test, this difference, with an $F(2,58)$ value of 3.81, occurs at the .03 level of significance. This finding was supported by the Fisher's (post hoc) Least Significant Difference Test, in which the difference is reported at the .02 level between grades three and four, and .04 between grades four and five. A quadratic profile emerges in grade five, the third year of the study, in which the means which had risen for both groups in the second

year, subsequently dropped to a lower level. The significant findings in year two, however, occurred across programs, and, while interesting in tracking achievement, do little to elucidate year by program differences.

Year by group findings, of most interest to this inquiry, were not observed to be significant for the years evaluated, indicating that an interaction of program over the time of the study was not supported to the degree which would be required by this design. Both groups, of course, commenced the study at identical levels of achievement as the result of the pair matching protocol. Although the Montessori group consistently outperformed the traditional contingent in years two and three, the levels did not represent levels of significance consistent with rejecting a null hypothesis of no interaction. It should be noted, however, that in both the second and third years of the study, the gap between the Montessori and traditional group widened, from approximately three percentile points to more than seven points by year three. This may represent a trend which subsequent observations would reveal more clearly.

Summed across years, however, the differences between programs in math achievement were marginally significant, with a p value of .093, using the Greenhouse-Geisser Adjustment Test. These findings are represented in Appendix A.

Reading Results

Analysis of reading scores revealed marginally significant interaction and significant main effects of program and of year. The Greenhouse-Geisser Adjustment Test applied to reading scores across both programs indicated that all years of the study were significantly different from each other at the $<.001$ level. Using Fisher's Least Significant Difference Test

(post hoc), these findings were confirmed, showing differences significant at $<.025$. This is consistent with findings for math in which the years differed significantly from one another.

However, with respect to reading score differences between groups, summed across the years, the difference between Montessori and traditional subjects emerges with a much clearer focus that was evident on math measures. Reading means summed across years, at 50.125 for Montessori and 45.910 for the traditional students revealed a difference between groups significant at the .013 level. Since this was a measure of particular interest, a Fisher's Least Significant Difference Test was employed on a post hoc basis. In this case, at the .05 level, the two programs differed significantly in years two and three. In both cases, Montessori students had higher means than those achieved by traditional subjects.

Additional Planned Comparisons

In addition to other evaluations of test scores provided by the study, of interest was a comparison of Total Math and Total Reading scores of the complete Montessori group versus the school district averages on those measures for the years under investigation. Fifty-three Montessori subjects were included in this comparison, having been selected according to the following protocol. Montessori school records were examined for all fifth graders in attendance during the third year of the study. Those students who had consistently participated in classrooms led by Montessori certified teachers, as defined in this study, throughout the duration of the investigation were selected. Other students in classrooms directed by teachers who had not completed their Montessori training were not included in the sample in order to avoid rival hypotheses. Total Math and Total Reading scores for those students who met the criterion of

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consistent Montessori preparation were compared to the aggregate district scores of all other traditional students, as published annually by the school board.

Subjected to a one-sample t-test in the baseline year, results indicate that the Montessori group, at 46.528 did not score significantly higher than the district average of 40 ($p=.151$). This suggests that the groups began the study at similar levels of reading achievement. In the second year, however, a significant differences does emerge ($p=.009$), with the Montessori group, at 60.264 surpassing the district average. In the final year, the observed difference remains significant ($p=.045$) with the Montessori group averaging 54.827 against the district average of 46. Montessori superiority was maintained in spite of the fact that the district average increased in each year of the study. Appendix B represents these findings.

Comparisons of the Montessori sample with traditional students district-wide for math indicate that the Montessori groups scored significantly below district averages in the first and third years of the study, although in year two Montessori scores were not significantly lower. Subjected to a one sample t-test in the baseline year, results indicate that the Montessori group, at a mean score of 47.962 had significantly lower scores than those in the district average of 57 for all traditional students. In the subsequent year's administration, Montessori math scores, with a mean of 59.943, were no longer significantly lower than those of the district. In the final year, the observed difference becomes significant once again with the Montessori mean of 54.6 trailing behind the district average of 64.

Conclusion

A review of the literature regarding evaluation of Montessori students on standardized measures presents a clearer view of superior reading achievement than can be found for

mathematics. This is true for the present study as well, where within-subjects differences appear to represent significant or marginally significant differences in the Total Reading Score of the Stanford Achievement Test when the scores over three years for Montessori students are paired with those of traditionally schooled children. The first year, of course, held no difference because of the matched-pairs design. The significant differences which emerged in years two and three suggest that Montessori programming did produce superior results for reading. Questions then emerge as to what elements of Montessori education might lead to these findings. The self-paced, often self-selected work in Montessori, in conjunction with specific Montessori materials are likely candidates, as well as the sustained blocks of time for work which Montessori students are permitted to take.

Math results represent a challenge in interpretation, although means for the Montessori group outdistanced the traditional students' means in years two and three with an increasing gap. A new research question emerges in recognition of the widening gap, involving whether or not significance might be reached if a subsequent observation were to take place. An explanation which Montessorians might advance suggests that even in the presence of testing practice, typical classroom protocols for Montessori students do not include the same volume of paper and pencil calculation which typically occur for traditional students. This is because Montessori students will employ self-correcting materials in the solution of math problems. Calculations are often performed without recording operations or answers and this may represent a disadvantage in the testing situation. The purpose of the materials used is to create a concrete and sensorial aspect to math at a critical period in the learner's life. Solutions are not perfunctorily sought on paper at this level, but rather demonstrated physically by manipulation of the materials. The ultimate outcome of such practice is planned to evolve into competence with math at an entirely

abstract level. The point at which this type of mastery might be expected is not clear in the observations made here. Nonetheless, comparisons with district averages in this study do not support an advantage for math performance by the Montessori students.

The present study contributes to the research base about academic achievement in Montessori education in comparison to traditional programming as it confirms the elevated reading achievement found by other authors for the former program. Math result, however, remain difficult to interpret. In this study, the Montessori students appeared to be making increasing math gains when compared to the traditional group, so much so that an argument might be made in favor of continuing data collection to observe if the increase would represent a significant difference in subsequent observations. Nonetheless, math scores for Montessori simultaneously fell below district averages on the Stanford Achievement Test. A possible interpretation of these math findings has been offered in relation to the physical and sensorial experiences of Montessori learners in math curriculum, but the present status of evidence on this subject is ambiguous. As a result, this study informs us on some aspects of the overall Montessori inquiry, but provides a number of additional questions which further research should address.

Recommendations for further research would include proposing several new questions as well as attendant cautions. Reading scores should be studied longitudinally in order to support, through additional inquiry, the gains for Montessori students which have been found here. Math measures should be followed over additional years in hopes of discovering whether or not the Montessori subjects do produce higher scores at a later date, suggesting that the student's shift from concrete to abstract in mathematical calculations occurs later, but with equal or greater success, in Montessori schools. As new research is proposed, it will be important to continue

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avoidance of confounding independent variables and hypotheses by implementing controls on sampling protocols. In addition clear distinctions, defining approved Montessori programs and teaching staff as well as longevity of students' experience, will be essential to any continuation of this important research.

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Program	Mean	S.E.	F (1,29)	p
Montessori	54.756	4.47		
Traditional	51.289	4.27		
			3.01	.093**

**p<.10

Appendix A

Math Means by Program

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Year	District	Montessori	SEM	t	df	p
1	40	46.528	4.480	1.457	52	.151
2	42	60.264	4.119	2.735	52	.009**
3	46	54.827	4.299	2.053	51	.045*

* $<.05$

** $<.01$

Appendix B

Reading Means for Montessori and District by Year

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