Omega Graduate School

**Dissertation Research Prospectus Template (Pre-Proposal)**

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**Problem Statement**

The problem is that despite the Montessori Method's proven success, limited research exists on the effectiveness of using it to teach mathematics during the absorbent mind and primary period among lower-income students and students of color to address the academic gap and low test scores that exist between them and white students (Burbank et al., 2020, p. 1).

**Purpose Statement**

This study examines the impact of the Montessori approach on mathematics achievement among lower-income students and students of color. It aims to measure differences in math proficiency and engagement levels between students taught using Montessori during their primary years and traditional methods to determine whether Montessori-based instruction effectively addresses the academic gap in diverse populations. This research would contribute to strategies for reducing educational inequity.

**Background of the Problem**

A current issue of concern in America today is the educational disparity that still exists among diverse populations, including lower-income students and students of color. The data collected regarding this fact from state and standardized assessments is astounding and often highlights the “achievement gap.” The National Center for Educational Statistics has coined the term “achievement gap” as a group of learners outperforming another group, resulting in statistically different average scores (Chambers-Richardson, 2023, p. 12). The research conducted by Chambers-Richardson shows that White learners outperform African American, Latinx, and American Indian learners on standardized assessments, graduation and college admission rates, and cumulative grade point averages (Chambers-Richardson, 2023, p. 12). Social and economic disparities significantly influence children’s and adolescents’ academic, cognitive, and socioemotional development. Additionally, in the United States and Europe, socioeconomic status (SES) explains up to 15% of the variance in reading and math performance of high schoolers (OECD, [2016](file:///C:\Users\susan.holmes\Zotero\storage\S9L95KGC\cdev.html#cdev13575-bib-0050)) (Courtier et al., 2021, p. 1). Furthermore, children from disadvantaged backgrounds fall behind their more privileged peers in cognitive and socioemotional development (Farah, 2017). These socioeconomic disparities can be observed as early as age four and often widen over time (Jordan & Levine, 2009; OECD, 2016) (Courtier et al., 2021, p. 1). Therefore, research is needed to support closing the academic gaps for low-income students and students of color. The academic gap indicates that academic progress and proficiency are integral to societal and global advancement for historically underrepresented groups of color, especially in improving their mathematical outcomes (Chambers-Richardson, 2023, p. 12). The concern for educational disparity is not new, nor is its remedy. Research proves that structured preschool programs positively affect school readiness and the cognitive development of disadvantaged children. Policies have primarily targeted structural factors such as teacher qualifications (Jackson, Rockoff, & Staiger, 2014), class sizes (Chetty et al., 2011), and the physical learning environment (Sabol, Soliday Hong, Pianta, & Burchinal, 2013) (Courtier et al., 2021, p. 1). Hence the introduction of Head Start programs in America. However, according to Courtier et al (2021), preschool programs can differ significantly in their instructional content and curriculum (Jenkins et al., 2018). For example, curricula may vary in pedagogical tools and materials (e.g., concrete vs. abstract), the teacher's role (e.g., leading activities vs. facilitating child-led learning), instructional organization (e.g., small or whole group vs. individualized learning), and assessment methods (e.g., explicit vs. implicit). Despite these variations, there is limited research on which preschool curricula are most effective, especially for children from low-income backgrounds (Jenkins et al., 2018) (Courtier et al., 2021, p. 1). Therefore, more research is required on the impact of specific early childhood curricula like Montessori. In 1969, five years after the launch of the Head Start program, the Westinghouse Learning Corporation evaluated its effectiveness. The study's pre-and post-test data indicated that 19% of participating children showed significant improvement in reading, 13% demonstrated less progress than expected, and 68% showed no change in reading achievement (Jensen, 1973). Despite the modest success reported in these early studies, the Head Start program remains in operation today (Bailey et al., 2021, p. 2).

**Significance**

This study will examine assessments given in third grade to contribute to the gap in research on the effectiveness of Montessori public school programs in mathematics in elementary schools for low-income students and students of color. Research shows that elementary math achievement is crucial in shaping future student outcomes. According to Brown (2016), research has established a clear connection between early mathematical skills and later success in math (Bailey, Siegler, & Geary, 2014; Ritchie & Bates, 2013) (p. 21). The impact of elementary math learning extends well into adulthood, with Ritchie and Bates (2013) identifying mathematical knowledge at age seven as a strong predictor of socioeconomic status at age 42 (Brown, 2016, p. 21). Also, according to Brown (2016), this issue is especially relevant for students of color, as African Americans remain underrepresented in STEM (science, technology, engineering, and math) fields (National Science Foundation National Center for Science and Engineering Statistics, 2015) (p. 21). Therefore, strengthening math education for students of color could help increase the number of African American students pursuing careers in STEM (Brown, 2016, p. 21).

**Research Questions**

RQ1: What is the difference in mathematics achievement scores between lower-income students taught using the Montessori approach and those taught using traditional methods?

RQ2: How does student engagement in mathematics compare between students of color in Montessori classrooms and those in conventional educational settings?

RQ3: To What extent do demographic factors (e.g., socioeconomic status, race/ethnicity) influence the effectiveness of Montessori mathematics instruction on student outcomes?

RQ4: Should public school districts in the DMV area give more consideration toward establishing and funding Montessori programs to improve educational outcomes for the underserved?

**Research Methodology**

This study aligns with a quasi-experimental design, quantitative methodology, and archival data from three Montessori and three non-Montessori schools. It focuses on Pre-K through 3rd-grade students’ math scores.

**Theoretical/Conceptual Framework**

This study is framed by constructivism theory because, in a constructivist or discovery model, children learn concepts from working with materials rather than by direct instruction (Saha & Adhikari, 2023, p. 1). When children are learning, how do they receive the information? Is it by osmosis? Do they have an innate capability that allows them to learn, or is it by doing? Many constructivists believe it is the latter. In a constructivist or discovery model, children learn concepts from working with materials rather than by direct instruction (Saha & Adhikari, 2023, p. 1). In non-technical language, they learn by doing. Two of the most prominent constructivists in the early 20th century are Piaget and Vygotsky (Saha & Adhikari, 2023, p. 1). Piaget’s school of thought was that the learner must construct knowledge through operations, while Dr. Montessori, also a fellow constructivist, believed knowledge is acquired through manipulating an object (Saha & Adhikari, 2023, p. 2). Maria Montessori and Jean Piaget believed that knowledge acquisition is a spontaneous and natural process through action that forms logical structures (Saha & Adhikari, 2023, p. 2). Both theorists had similar perspectives, but Montessori was dedicated to practice, whereas Piaget was dedicated to theory. Together, their concepts create Vygotsky’s social construction of knowledge. This concept sees learning as a social activity and emphasizes the importance of engagement in school social life for learning to occur (Saha & Adhikari, 2023, p. 2). However, while Vygotsky’s theory focuses on the effects of teaching and learning on child development, Montessori’s method focuses on normalizing development, emphasizing the role of the prepared environment (Saha & Adhikari, 2023, p. 2).

* **Critical Pedagogy** (addressing educational disparities and equity)

In 1964, the Federal Government asked a panel of child development experts to develop a program to help communities meet the needs of disadvantaged preschool children ages 3 to 5. The ensuing program became the now famous “Head Start,” a “prep school for poor kids,” which aimed to help millions of children escape poverty (Levitan, 1969) (Bailey et al., 2021, p. 2). The need for a “Head Start” program is proof of an existing educational disparity. A disparity that still exists some fifty-plus years later. This is significant to this research because studies suggest that a Montessori education benefits low-income students and students of color who are typically educated in the public sector. In the United States, most public Montessori schools are Title I, primarily serving children of color (Lillard et al., 2023, p. 1).

* **Cultural Responsiveness and Sustaining Pedagogy**

The Montessori Method is philosophically aligned with the five tenets of culturally responsive pedagogy or CRP (Brown-Jeffy & Cooper, 2011), an approach to fair education (Ladson-Billings, 1995a). However, it is lacking in culturally sustaining pedagogy CSP. Paris (2012) developed the term “CSP,” building off of Ladson-Billings’ (1995) term Culturally Responsive Pedagogy (D’Cruz, 2022, p. 2). For example, Montessori’s approach and high academic expectations (reading, writing, doing math with 4-digit numbers, knowing parts of speech and the countries on all continents, etc., by age 6) fit the first principle of CRP, equity, and excellence in education (Lillard, 2021, p. 8). Second, CRP asks that teachers instruct and empower the whole child, attending to social-emotional needs and education. Montessori children are empowered as they can choose their activities freely, and the curriculum includes explicit lessons in social behavior. However, CSP further asserts that adults should represent students in schools and actively work to sustain and preserve students’ identities (D’Cruz, 2022, p. 2). The third CRP principle is to embrace constructivism, and as noted, Montessori is a constructivist education (Brooks & Brooks, 1999). For example, using Brooks’ formulation, children drive their education, are free to work collaboratively, and work mainly with hands-on materials; the curriculum is viewed as an integrated whole. There are no tests or grades, and assessment is formative. Studies also suggest that Montessori features strong and positive relationships (Lillard & Else-Quest, 2006; Rathunde & Csikszentmihalyi, 2005), the fourth principle of CRP. This may stem from staying with a teacher and same-age classmates for 3 years, allowing strong relationships to develop; children one year older and younger are classmates for two years and reconnect again as one moves up the classes. Since there are no grades, teachers cannot mark the quality of children’s work. Their focus is on how to help children develop. The fifth feature of CRP is respect for culture. Montessori classroom walls are typically curated with fine art from the children’s culture and photographs of cultural heroes and heroines, and the practical life exercises matter in a child’s culture – shoe polishing in some places, mandala making in others. However, more practice is needed to improve and humanize marginalized groups and children, including social and racial justice. This speaks more to CSP, which is crucial for Montessori adults in the U.S., mainly due to the large number of White Montessori adults in the field (D’Cruz, 2022, p. 2).

* **Policy Implications**

Evidence of effectiveness in these populations can influence educational policy and funding decisions, leading to broader implementation of the Montessori approach in underserved communities. Maria Montessori’s Method was and is intended to reverse oppressive constructs often found in traditional education (*Hybrid Montessori Education*, n.d., p. 4). Public Montessori education is expensive and often found in magnet and charter programs. However, the effectiveness of the programs is often skewed because many offer a hybrid method. Usually watering down the ideal effectiveness of an authentic Montessori educational experience:

“Montessori education aims to maintain its integrity and fidelity (to the elements that make it a complete and socially just method) within school environments impacted by neoliberal educational policy reform efforts that contribute in an immense way to the reproduction of injustice in our society (Hirsch, 2010) (*Hybrid Montessori Education*, n.d., p. 5).”

**Instrumentation**

**Data Collection Methods:** Outline potential instruments, such as standardized test scores, observation protocols, or student/teacher interviews.

**Research Design**

**Quasi-Experimental Design**

* **Rationale**: A quasi-experimental design is appropriate if I can identify distinct groups (e.g., Montessori vs. traditional classrooms) and measure outcomes (like mathematics achievement and engagement) without random assignment. This design allows me to compare outcomes between existing groups, making it well-suited for assessing the impact of the Montessori approach on diverse populations.
* **Implementation**: Using pre-existing classrooms to compare the performance and engagement of lower-income students and students of color in Montessori settings versus traditional ones, controlling for variables like prior math achievement or socio-economic status.

**Population and Sampling**

**Population and Sample:** Describe the target participants (e.g., lower-income students, students of color in Montessori programs).

**Hypotheses**

**Hypothesis 1**: Lower-income students who receive mathematics instruction through the Montessori approach will demonstrate significantly higher mathematics achievement scores than white students receiving traditional instruction.

**Hypothesis 2**: Students of color in Montessori classrooms will exhibit higher levels of engagement in mathematics compared to students of color in traditional educational settings.

**Hypothesis 3**: Demographic factors, such as socioeconomic status and race/ethnicity, will significantly moderate the relationship between the Montessori approach and mathematics achievement outcomes.

**Data Analysis Plan (Quasi-Experimental Design)**

**Research Design and Data Type:**

This study employs a **quasi-experimental research design** to evaluate the effectiveness of the Montessori Method in mathematics instruction for **Pre-K through 3rd-grade** students, particularly among lower-income and students of color. The analysis will use **state math or MAP Growth scores** using **a matched comparison group** or **statistical techniques** to reduce selection bias.

**Data Collection Methods:**

Data will be collected from (specific school districts, state databases, or MAP Growth Scores repositories). The study will compare:

* + Montessori public school students (treatment group).
  + Traditional public school students with similar demographics and prior achievement levels (comparison group).
  + Demographic variables: Socioeconomic status (SES), race/ethnicity, school type, and prior academic performance (if available).

MAP Growth scores will be beneficial for tracking **longitudinal progress** over time, as they provide **adaptive, grade-level independent** assessments for Pre-K through 3rd-grade students (OpenAI. (2025). *ChatGPT* [Large language model]. https://chatgpt.com).

**Data Analysis Methods**

1. **Matching Techniques (To Strengthen Comparability)**

Since students are not randomly assigned, statistical techniques will be used to create comparable groups:

* + **Propensity Score Matching (PSM):** Matches Montessori students with traditional school students based on similar demographic and baseline characteristics (e.g., SES, race, prior achievement).
  + **Inverse Probability Weighting (IPW):** Weighs cases to balance treatment and control groups.

1. **Descriptive Statistics**
   * Compute the **mean, median**, **and standard** **deviation** of math scores for Montessori vs. non- Montessori students (before and after matching)
   * Analyze demographic distributions to understand representation across SES and racial/ethnic groups.
2. **Inferential Statistics (assessing Montessori’s Effectiveness)**

To assess whether Montessori instruction significantly impacts math achievement:

* + **Independent Samples t-Test:** Compare mean math scores between Montessori and non- Montessori students.
  + **One-Way ANOVA:** If multiple subgroups (e.g., different SES levels) are analyzed, ANOVA will test for mean differences.
  + **Multiple Linear Regression:**
    - **Dependent Variable:** Math scores (state test or MAP Growth scores).
    - **Independent Variables:** Montessori instruction (yes/no), SES, race/ethnicity, prior academic achievement (if available).
    - **Purpose:** To determine the predictive effect of Montessori education on math achievement while controlling for confounding factors.

* **Effective Size Calculation:**
  + - Cohen’s d (for t-tests) or η² (for ANOVA) to measure the strength of Montessori’s impact on student outcomes.

1. **Growth Analysis (For Longitudinal Data Using Map Growth Scores)**

If analyzing student progress across multiple testing periods, longitudinal growth models will be used:

* + **Repeated Measure ANOVA**: To compare growth trajectories between Montessori and non-Montessori students over time.
  + **Mixed-effects modeling (Hierarchical Linear Modeling – HLM)**: To assess individual student progress while accounting for differences in school environments.

**Addressing Selection Bias and Confounding Variables**

To strengthen causal inference, the study will control for:

* Baseline Math Achievement: Using pre-test scores as covariates.
* School-Level Differences: Matching or controlling for school funding, teacher experience, and curriculum differences.
* Student Demographics: In statistical models, this includes SES, race/ethnicity, and parental involvement.

**Ethical Considerations & Validity**

* **Data Privacy:** Student records will be anonymized, and IRB approval will be obtained.
* **Reliability & Validity:**
  + Matching techniques will improve comparability between groups.
  + Statistical assumptions will be tested to ensure model accuracy.

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