Reading Achievement in Arizona Public Montessori Schools

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Abstract: In recent years, many state legislatures in the United States have implemented legislation and regulations requiring public schools to use evidence-based reading curricula. This study of reading achievement in public Montessori schools in Arizona was conducted to comply with one such piece of legislation. It compares public Montessori students' standardized state reading test scores to those of traditional public school students statewide. Through descriptive statistics and *t*-tests on aggregate measures, as well as simple regression, we demonstrate that students receiving Montessori reading instruction perform as well as or better than the comparison group in absolute terms. The longer students remain in the Montessori setting, the better they perform. This is also true for special education students, whose reading test scores after three or more years in a public Montessori program were indistinguishable from the general population. These results suggest Montessori instruction works as well or better than other reading curricula in use throughout the state to produce favorable results on Arizona's reading assessment, with noteworthy outcomes for students receiving special education services.

As of August 2024, 39 states in the United States have passed "science of reading" legislation: laws requiring schools to use evidence-based programs for reading instruction (Schwartz, 2024). Specific requirements of these laws vary by state. In Arizona, the policy allows schools to select any "evidence-based" reading curriculum for kindergarten through eighth grade (Arizona Department of Education, 2020). The U.S. Department of Education (USDE, n.d.) cites the definition of "evidence-based practices" as "activities, strategies, and interventions [that] are derived from or informed by objective evidence—most commonly, education research or metrics of school, teachers, and student performance." Because the Montessori Method de-emphasizes formal assessment (Lillard, 2017), such as end-of-year standardized tests, there is a philosophical mismatch between the push toward evidence-based instruction and this particular pedagogy. Thus, administrators of public schools utilizing Montessori instruction have found themselves needing

Figure 1
Rhyming Sound Objects. Photo by the authors.

to justify their pedagogical methods, using assessments that may not align with this constructivist approach to teaching and learning (National Center for Montessori in the Public Sector, 2019).

Montessori education is a popular school choice option, with 26 public schools offering Montessori programs in Arizona (National Center for Montessori in the Public Sector, n.d.). Although scholars argue that the Montessori Method aligns with the precepts of the science of reading (Zoll et al., 2023), the Arizona Department of Education did not initially list Montessori instruction as an evidence-based reading curriculum. In order to meet the requirements of the reading legislation, an empirical study was needed of literacy outcomes produced by schools using the Montessori approach.

This study examines evidence as to Montessori methods' effectiveness in teaching students to read, and whether the results meet or exceed other reading instruction methods. The authors compare the empirical reading and language arts achievement of Arizona public Montessori schools with statewide averages to assess evidence supporting Montessori education as an effective approach to reading instruction. Given the widespread passage of science of reading policies (Schwartz, 2024) and the nationwide reach of the public Montessori movement (National Center for Montessori in the Public Sector, n.d.), the significance of this study extends beyond the borders of Arizona.

Overview of Montessori Approach to Reading

The Montessori approach has been employed worldwide for more than a century; however, since it has historically been implemented in small independent schools, there is less research about its effectiveness compared to other methods of instruction. Recent decades have seen significant growth in the public Montessori movement; at the time of this writing, almost 600 public schools in the United States utilize the Montessori Method (National Center for Montessori in the Public Sector, n.d.). As more students gain access to Montessori programs, the body of research surrounding Montessori education also grows.

There is reason to believe the Montessori approach to reading instruction should yield positive outcomes for children. Zoll et al. (2023) leverage Scarborough's (2001) Reading Rope framework to demonstrate how Montessori curricula for Early Childhood and Lower Elementary years align with best practices described as the science of reading. Scarborough imagines reading as the intertwining of multiple strands of knowledge and skills divided into two categories: *language comprehension*, including all background knowledge to understand the written word, and *word recognition*, which implies all of the skills needed to decode written language. Scarborough's Reading Rope has become synonymous

with the science of reading. The Montessori approach is a systematic, explicit, and multisensory approach that relies on concrete manipulative materials to represent abstract concepts. In their book *Powerful Literacy in the Montessori Classroom: Aligning Reading Research and Practice*, Zoll et al. (2023) document a strand-by-strand comparison, tying the threads of the Reading Rope concept to Montessori teaching materials and practices. They find the Montessori approach aligns closely with Scarborough's Rope to include phonemic awareness, decoding and encoding, vocabulary (inclusive of academic language), grammar and syntax, reading fluency and oral reading, and reading comprehension. This theoretical alignment suggests the Montessori approach includes the components of evidence-based reading instruction. The following examples show how Montessori materials support development of both language comprehension and word recognition.

Word Recognition

In the category of word recognition, Early Childhood students—children ages 3 and 4—use a variety of manipulative materials to learn sound and letter recognition skills. For example, in the I Spy game, Montessori teachers call out a sentence like, "I spy with my little eye something that starts with 'p.'" The teacher applies the phoneme—the sound of the letter P—rather than calling out the letter. The children then look around the room to find objects that start with that sound: paper, pencil, pushpin, and so on. As students' skills of sound recognition improve, they engage in similar activities using miniature objects. For example, the objects pictured in Figure 1 show bat/hat, mouse/house, and bee/tree. The objects are stored in the small basket pictured, and children match the rhyming object pairs.

Auditory games precede work with graphemes: written letters. Once children are able to identify sounds of words, they can begin learning the letters. Sandpaper letters are the first sets of Montessori materials students use for this, as the shapes of the letters stamped in sandpaper are mounted to small boards. Teachers systematically teach the sounds and shapes of letters by modeling the sound while tracing the shapes with their fingertips on the sandpaper letter boards as shown in Figure 2. Children practice repeating the sounds while tracing the shapes with their fingertips. Next, the teacher models replicating the letter shapes in a tray of sand and then students practice forming letters in the sand tray. After students have learned the shapes and sounds of the letters, they match small objects to the letters (see Figure 3). At first, they match objects by the initial sounds, and with practice they learn to sort objects by medial and final sounds as well (Brown et. al, 2024).

Figure 2

Sandpaper Letters with a Sand Tray. Photo by the authors.

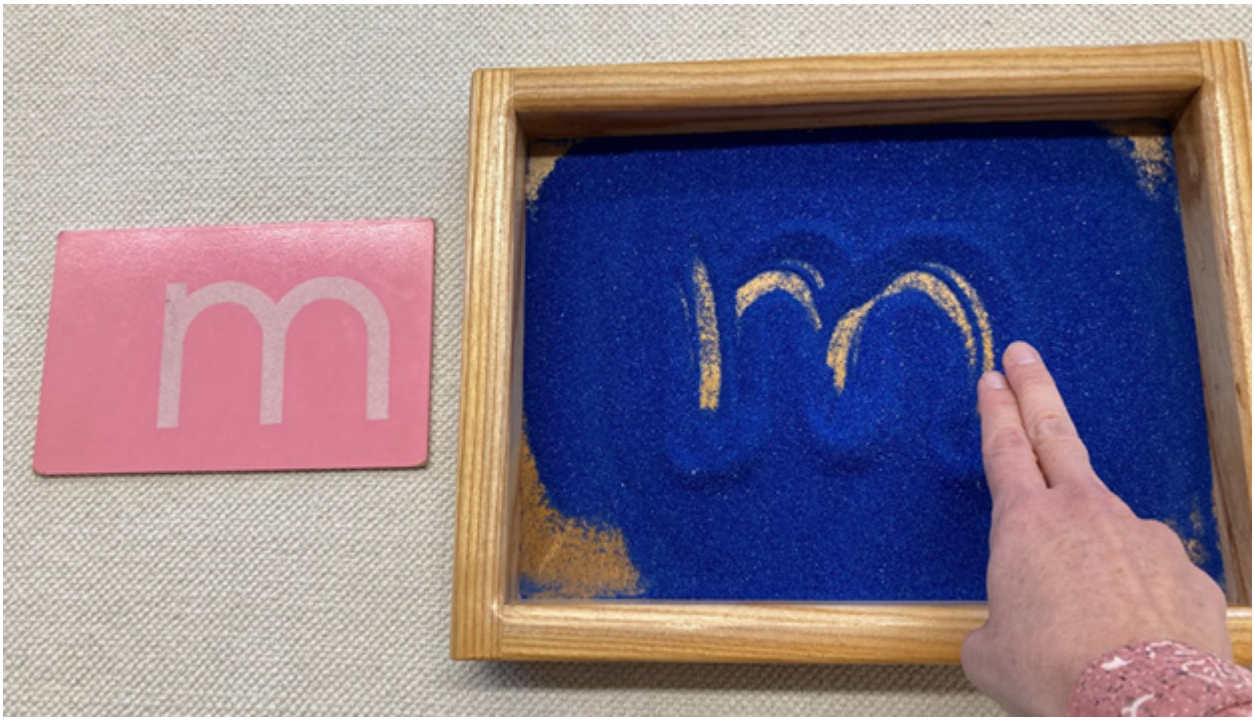
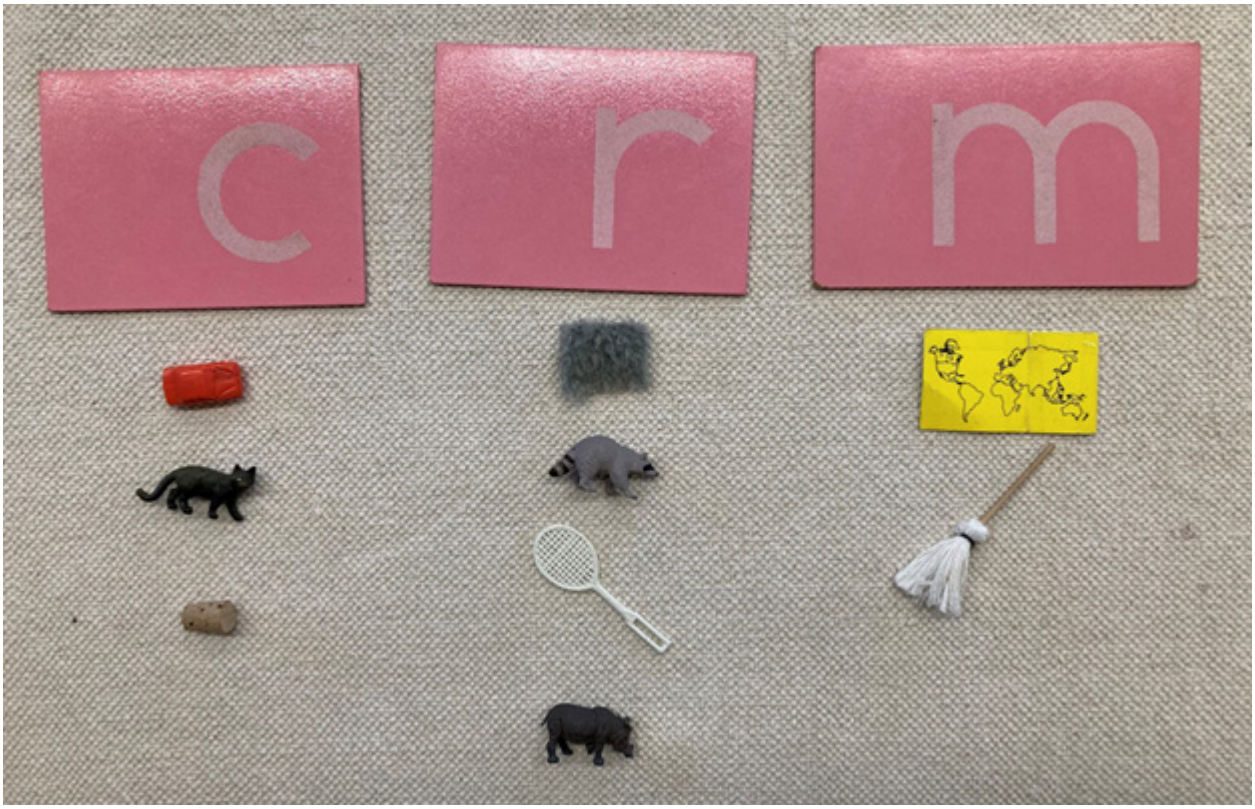


Figure 3
Sandpaper Letters with Sorted Objects. Photo by the authors.



Language Comprehension

To facilitate language comprehension, elementary students learn morphology—the study of parts of words including prefixes, suffixes, and root words—through systematic word study. Students are introduced to the concepts of prefixes and suffixes, by using objects and small cards. For example, in an introductory lesson, the teacher explains that the root of a word is represented by a tractor, as shown in Figure 4. The root "drives" the meaning of the word, and the suffix is like the trailer. Students might start with the root "farm" and the suffix "-er." Many Montessori classrooms use sets of movable Word Study cards informally called "The Montessori Skyscraper." A sample suffix assignment from this material is displayed in Figure 5. To complete the assignment, the student matches roots and suffixes from a mixed-up set of cards. The manipulative nature of the materials isolates the concept being taught. This helps students for whom handwriting might slow down the learning process (Brown et al., 2024).

The Montessori Skyscraper is comprised of more than 5,000 cards to teach the concepts of synonyms, antonyms, homonyms, compound words, capitals, periods, apostrophes, commas, quotations, alphabetizing, and dictionary guide words. Teachers use an introductory lesson—similar to the prior example with the tractor and trailer—that includes a story to teach each new concept.

Cultural Subjects

Children build background knowledge through age-appropriate lessons in Cultural Subjects: geography, history, botany, and zoology. For example, in the Lower Elementary classroom, students study the Timeline of Life (as shown in Figure 6), which introduces the history of the earth and its life-forms. The Timeline is a 9-foot poster-style visual that is rolled out onto the floor and includes moveable objects and images children can position in their correct locations along the printed timeline. Children are enthralled with the complex names of the various dinosaurs, other life-forms, and historic periods detailed in this material. The class spends many weeks studying, reading, and writing about the history of Earth.

The key in Montessori instruction is isolating the appropriate concept, and then using manipulative materials that allow students to learn and practice the

Figure 4
Introducing the Concept of Root and Suffix. Photo by the authors.

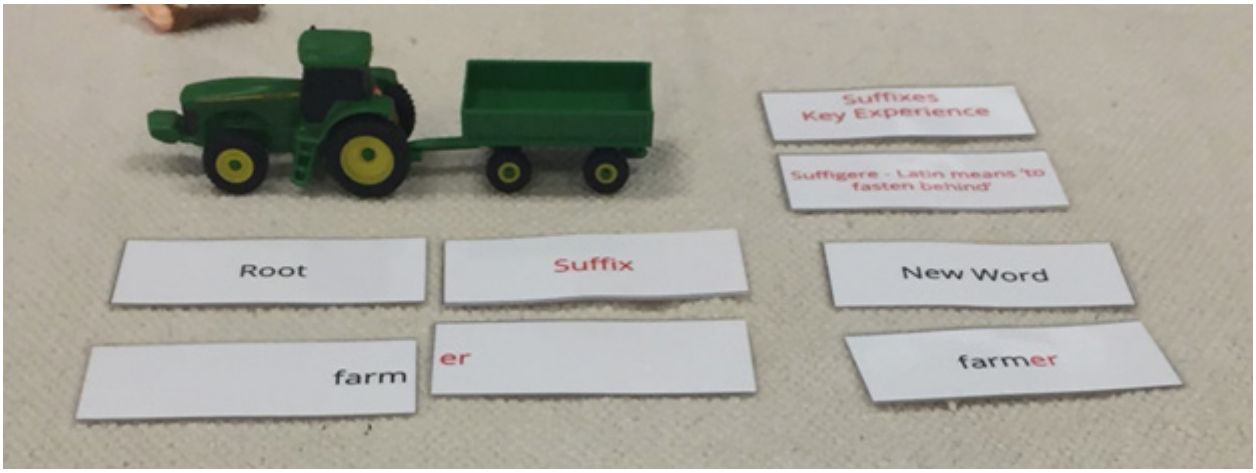
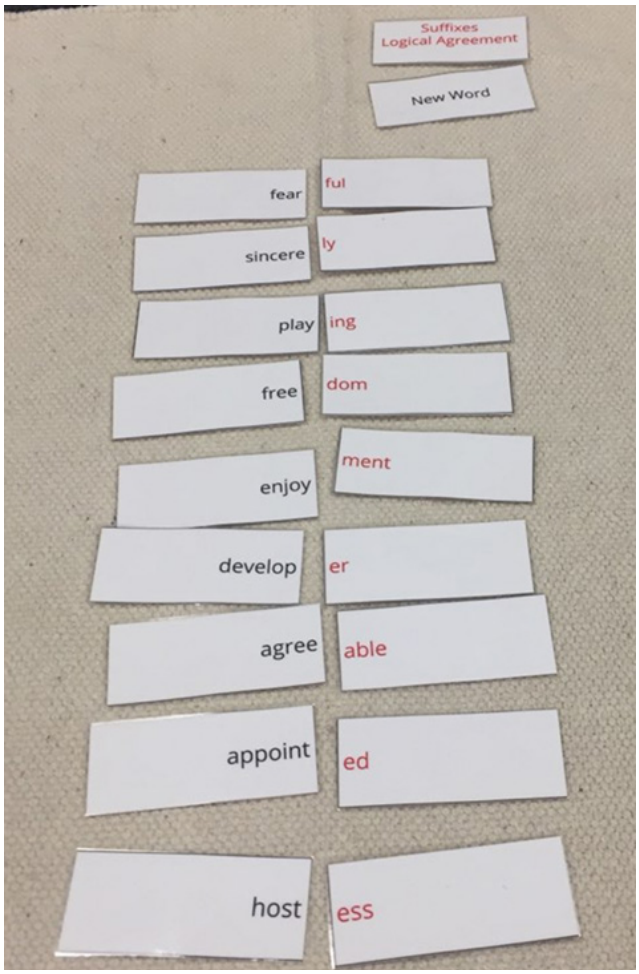


Figure 5
Systematic Practice of Roots and Suffixes. Photo by the authors.



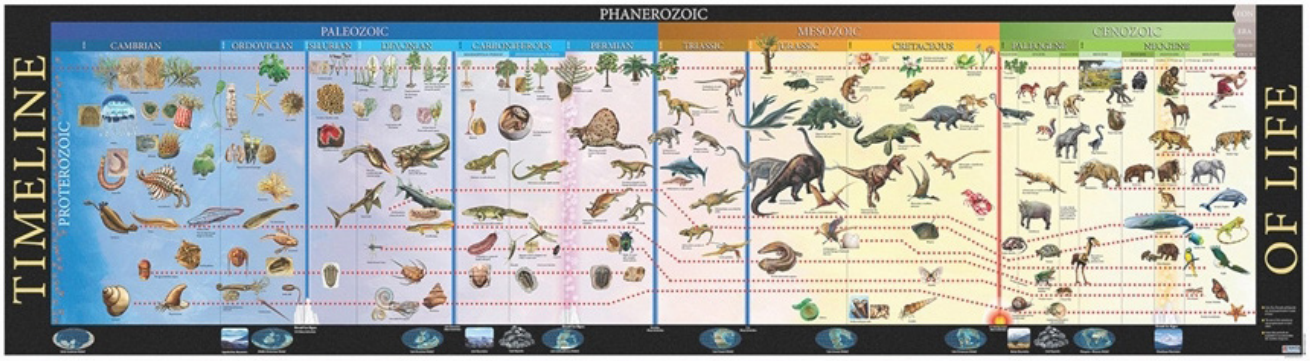
skills. Materials are selected for beauty and touchability, to draw children in and fulfill their natural curiosity. Those noted here are only a few examples of many materials used in Montessori classrooms. They demonstrate how Montessori education addresses the two main components required for skilled reading: language comprehension and word recognition. This instruction begins early with preschool-age children playing simple games that isolate letters and sounds, and culminates in third grade as children engage in in-depth reading assignments that involve students researching and writing about the history of Earth.

Literature Review

A review of the literature on reading outcomes for Montessori students suggests that, generally, Montessori students fare as well as or better in reading than their peers in other school settings. This literature includes large-scale studies of reading achievement for Montessori elementary and middle school students. In one of the most persuasive examples, Snyder et al. (2022) collected aggregated test score data from 195 Montessori schools in 10 states and compared each school with scores in its surrounding district. Overall, Montessori students were more likely to be proficient on state reading tests, and opportunity gaps were significantly smaller in Montessori schools. In a study somewhat comparable to the current one, Culclasure et al. (2018) studied outcomes for students in public Montessori schools throughout South Carolina and found Montessori students more

Figure 6

Timeline of Life. Image courtesy of Alison's Montessori and used with permission.



likely to perform at high levels on state English language arts (ELA) tests. Further, children from low-income backgrounds enrolled in public Montessori schools in South Carolina outperformed their peers in reading and showed more improvements than did demographically similar non-Montessori students. A recent meta-analysis (Randolph et al., 2023) found that Montessori education has a small but significant positive effect on literacy. Given that the Montessori approach de-emphasizes formal assessment such as standardized testing, the strong performance of Montessori students on these measures is particularly striking.

These large-scale studies document the benefits of Montessori education as viewed with a broad lens; additional investigation teases out specific benefits of Montessori instruction. Research suggests that early investment in Montessori instruction pays dividends for students later on, with Montessori students pulling ahead of their conventional school counterparts on tests of reading achievement after grade four (Mallet & Schroeder, 2015). Similarly, evidence shows exposure to Montessori education in early childhood may lead to stronger reading skills in elementary school, even for students who do not continue in a Montessori setting after preschool (Ansari & Winsler, 2020). This indicates Montessori instruction may provide a solid foundation in pre-literacy skills even before formal reading instruction begins and that these benefits may persist even after students exit a Montessori program.

Montessori instruction lays a strong foundation in the early years. Additionally, it benefits students from historically disadvantaged populations, including children of color and low-income students. Given the prevalence of inequitable academic outcomes in the United States, it is worth noting that racially minoritized students (Brown & Lewis, 2017; Debs & Brown, 2017; Fleming & Culclasure, 2023) and students from low-income families (Culclasure et al., 2018; Fleming & Culclasure, 2023) have demonstrated success after exposure to Montessori reading instruction. Lillard et al. (2017) found that children with low socioeconomic status most benefitted from Montessori education, and that by kindergarten, the typical socioeconomic opportunity gap had disappeared in Montessori classrooms.

Taken together, these studies suggest Montessori education can be an effective approach to reading instruction for a diverse population of children. However, none of these studies was accepted by the Arizona Department of Education as meeting requirements of the Arizona science of reading law. Specifically, the law called for studies that a) met the criteria to be considered Tier 1, Tier 2, or Tier 3 under the federal Every Student Succeeds Act, and b) demonstrate effectiveness in kindergarten through third grade (Arizona Department of Education, 2023). This study is designed to meet these requirements.

Though this research was conducted to meet a specific need in Arizona, it has application in other states as well. With the growing number of public Montessori schools in the United States, and the legislative push to adopt evidence-based curricula, many schools must defend the effectiveness of the Montessori approach in order to apply it. The challenge is confounded because the Method is not well understood outside of Montessori circles; thus, many such schools land in a position of having to either justify effectiveness of the Method or be forced to adopt teaching methods that do not align with Montessori principles. Research around Montessori implementation indicates a variety of child outcomes, including those related to executive function and early literacy skills, are better when the Montessori Method

is implemented with fidelity and not compromised by supplemental curricula (Lillard, 2012; Lillard & Heise, 2016). This study adds to the body of research that documents effectiveness of the model, thus allowing public schools to practice Montessori instruction with high fidelity.

Research Questions

This study was designed to address the following two research questions:

- How do Arizona public Montessori students perform on state English language arts (ELA) assessments after one, two, or three-or-more years of reading instruction compared to the general population of public students?
- How does the reading achievement of Arizona public Montessori students compare to state averages, controlling for student years of Montessori experience and demographics?

Methods

Research Design

A comprehensive set of student-level enrollment and demographic data, as well as state test data (Arizona Measurement of Educational Readiness to Inform Teaching [AzMERIT]) results for school year (SY) 2016–2019 for kindergarten through eighth grade, were provided by the Arizona Department of Education through a restricted-use data-sharing agreement and analyzed for this project. Prior to sharing, Arizona Department of Education staff cleaned the data. Though all enrollment, program, attendance, and test data were provided at the student level, student identifying information (such as names and ID numbers) was redacted. Specific data included enrollment and year-end code information, full academic year (FAY) enrollment information, student group information (race and ethnicity as well as program participation), school identifier, and test data for ELA and mathematics. For this study, data analysis is limited to ELA only. To determine the impact of Montessori instruction on students, state data records present the opportunity to do a quasi-experiment using Arizona's FAY indicator—which measures the number of years the student has remained at the school—as a measure of dosage for both the Montessori curriculum group and statewide comparison group.

Sample

The Montessori group was comprised of 4,781 students with state test results from 26 public Montessori schools in Arizona in 2019. Programs that comprise the Montessori group were identified by school mission statement and school name. Every effort was made to identify for the study group all schools that utilized Montessori methods, materials, and practices. All non-Montessori public elementary students in Arizona served as the comparison group for this study. Because the study was originally conducted as a program review to provide to the Arizona Department of Education, the whole universe of data was included rather than a sampling technique.

Measure

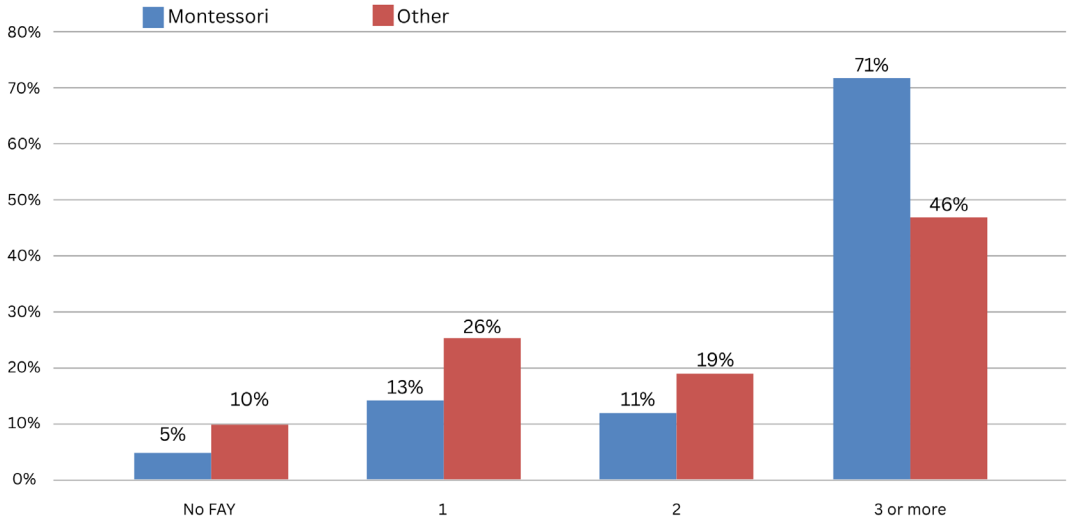
In Arizona, the universal outcome measure is the state test—AzMERIT. All Arizona public school students in grades three through eight took grade-level AzMERIT assessments in 2019 for English language arts (ELA) and mathematics. The tests are largely administered online, though a manual version of the test is available, and scores reflect student reading and writing performance. Although Arizona has changed the test name several times in the past decade, the state maintains utility of an item[1] pool that aligns with Common Core State Standards in mathematics and ELA. Arizona State Standards are based on Common Core with minor modifications. Only items that align with Arizona State Standards were used for the 2019 assessment (American Institutes for Research, 2020).

The key measures for this study are AzMERIT ELA scale scores and performance levels, as well as a state-created attendance stability measure: FAY, which represents the number of continuous full-academic years students remain enrolled in a school. For example, a FAY code of 0 indicates that the student has been at the school less than one school year (i.e. they entered the school in the middle of the school year). FAY 1 shows a student has been enrolled at the school for one full school year at the time of testing, FAY 2 indicates two years at the school, and FAY 3+ indicates a student has attended the school for three years or more. This data field is useful when considering the impact of a curriculum and an approach on outcome measures, since FAY is a basic quantification of Montessori dosage. The

[1] "Item" is test makers' word for "problem" or "question." Questions on the state assessment are "items."

Figure 7

Proportion of Students Full Academic Year (FAY) Status for the Montessori Group and All Others in the 2019 School Year



FAY field provides a quick measure of each student's history in a school setting and approximates "treatment" levels in a quasi-experimental sense. Though student participation in Montessori education is not randomly assigned, as in a true experiment, the FAY indicator gives us a measure as to what degree a student has been in the Montessori setting. This FAY measure helps compensate for the fact that this study lacks a measure of baseline equivalence. FAY is determined uniformly by the Arizona Department of Education, and is available to all schools in the state for review and correction through the course of school accountability modeling. FAY status for the Montessori and comparison groups is shown in Figure 7.

We measured the results of the AzMERIT for grades three through eight; however, because Arizona does not use a standardized statewide test in first or second grade, it is challenging to measure the effectiveness of early literacy programs. By reviewing FAY data, we were able to measure outcomes of literacy education in the three years preceding the state assessment, using a quasi-experimental design. The third-grade assessment results for students with three or more academic years of Montessori instruction reflect the outcome of Montessori reading instruction in the preceding years and provide some evidence as to its effectiveness.

Analysis

Through descriptive statistics and *t*-tests on aggregate measures, as well as simple regression, we demonstrate that Montessori curriculum and methods perform as well as or better than the comparison group in absolute terms, and student performance increases on state measures the longer students remain in the Montessori setting.

Results rely on standardized scale scores to ensure comparability across grade levels have tests of varying difficulty levels. Standardized scores, or *z*-scores, also allow for quick interpretation and comparison across groups and grades. For instance, a *z*-score of 0.0 indicates a group is at the state average for that grade level. *Z*-scores represent the number of standard deviations (SD) from the state average. Thus, a score of 0.68 indicates the group is 0.68 SD above the state average. A score of –0.13 is 0.13 SD below the state average for that grade.

Though multiple years of data were available, the majority of analyses was focused on data from the 2019 school year. This decision was driven by pragmatism with the availability of a three-year FAY measure, which allowed us to group students based on the number of years in Montessori or comparison group settings. We opted to use pre-COVID-19 data, because the pandemic interrupted regular educational instruction in most schools across the state. The restricted-use, student-

level data were aggregated and compared to historical school-level data from the National Center for Education Statistics (2025) to ensure accuracy of the records the state agency provided.

Results

Results for the AzMERIT ELA test are presented and discussed in the following paragraphs. Some basic demographics of the Montessori group, as well as Arizona as a whole, are provided in Table 1 for comparison purposes for the grade levels studied. Note that virtually all students in the Montessori group are enrolled in Montessori school by choice (even in the district schools). "Schools of choice" do not have attendance boundaries, and parents typically enroll and transport students to these schools because it is their choice. Sociopolitical factors in Arizona led to an artificially low reporting level of English language learners than would be recorded in other settings (Goldenberg & Rutherford-Quach, 2012).

Though the Montessori schools are demographically similar to the populations of surrounding local education agencies, there are some differences between the Montessori group and Arizona as a whole. Still, the Montessori group is far from being homogeneous as it represents students from all racial and ethnic backgrounds. In terms of special programs—English language development for multilingual learners and special education for students with disabilities—Montessori schools had fewer English learners but a comparable percentage of special education students.

Table 2 shows mean standardized ELA scores for students in the Montessori group and all schools in the comparison group. Due to the decline in student numbers in the middle grades in the Montessori group, grades six through eight were combined in the table below. The attrition occurs in schools of choice as students approach terminal grade levels and migrate to other schools to prepare for transition to middle or high school. Arizona had no public Montessori high schools in 2019.

State test scores were standardized within content area and grade level, so the mean standardized score (i.e., *z*-score) for an Arizona grade level is 0.0 with a standard deviation (SD) of 1.0. Based on the scores, it is apparent that Montessori schools on average across tested grades scored 0.46 SD higher than the comparison group. Montessori instruction in reading and writing as measured by Arizona's state test, AzMERIT, was associated with significantly higher scores than state averages and showed moderate effect sizes in all grade groupings.

Table 1

Special Program Group Percentages in Study (SY 2019)

	Montessori	Arizona
Asian	2%	3%
Black	2%	5%
Hispanic	31%	47%
Multiple races	11%	6%
Native American	<2%	4%
Native Hawaiian	<2%	<2%
White	55%	36%
English language development	2%	6%
Free or reduced lunch program	17%	44%
Special education	12%	13%

Table 2

SY 2019 ELA Student Counts and Test Results by Grade Level Grouping (in Standardized Form)

	Montessori			Comparison (Arizona Statewide)			Significance Testing	
Grade Level	*N*	Score	*SD*	*N*	Score	*SD*	*t*	*p*
3	605	0.48	1.03	80,662	0.00	1.00	11.46	<0.001
4	534	0.40	0.94	84,529	0.00	1.00	9.83	<0.001
5	519	0.46	0.91	88,000	0.00	1.00	12.29	<0.001
6–8	985	0.49	0.95	259,425	0.01	1.00	18.12	<0.001
Total	2,643	0.46	0.96	512,616	0.01	1.00	26.52	<0.001

Note. Probability (*p*) is considered statistically significant at or less than 0.05.

Table 3
Impact of Attendance History in Arizona Montessori Schools on 2019 Standardized Test Scores

Attendance History	Montessori Group			Significance Testing	
	N	Score	*SD*	*t*	*p*
Not FAY	115	−0.01	1.04	0.10	0.92
FAY	2,528	0.49	0.95	25.93	< 0.0001
Total	2,643	0.46	0.96	24.63	< 0.0001

Table 4
FAY Level and Aggregate Performance of Montessori Students

	Montessori Group			Significance Testing			
FAY Level	*N*	Score	*SD*	*t*	Lower Bound	Upper Bound	*p*
0	115	−0.01	1.04	0.10	−0.20	0.18	0.92
1	342	0.24	0.98	4.53	0.14	0.34	<0.0001
2	295	0.24	1.01	4.08	0.12	0.36	<0.0001
3+	1,891	0.57	0.92	26.94	0.53	0.61	<0.0001
Total	2,643	0.46	0.96	24.63	0.42	0.50	<0.0001

Also worth noting, the state average standardized score was not 0.0 since some students left Arizona schools between the date of testing and the end of the school year. Therefore, a slightly higher state average of 0.01 was apparent for the 512,616 students comprising the comparison group.

Full Academic Year

FAY is central to the Arizona accountability formula for determining school quality. FAY is used widely in Arizona and elsewhere to ensure that the students who "count" in accountability measures participated meaningfully in a school setting for the state test results to serve as an indicator. Compared to statewide FAY numbers as shown in Figure 7, the Montessori group is more stable with 71% of students identified as FAY3+, whereas only 46% of the comparison group were FAY3+. This pattern is typical with schools of choice. Parents select a school, usually in the early primary grades, and commit to the school until the student ages out of a terminal grade level.

Averaged across grade levels, students present for the full academic year fared better on standardized state test scores than did their non-FAY counterparts for both the Montessori group and comparison group. Students receiving one or more full years of Montessori instruction and methods outperformed their comparison group peers. Indeed, the comparison group performed on average roughly equivalent to non-FAY Montessori students (−0.01).

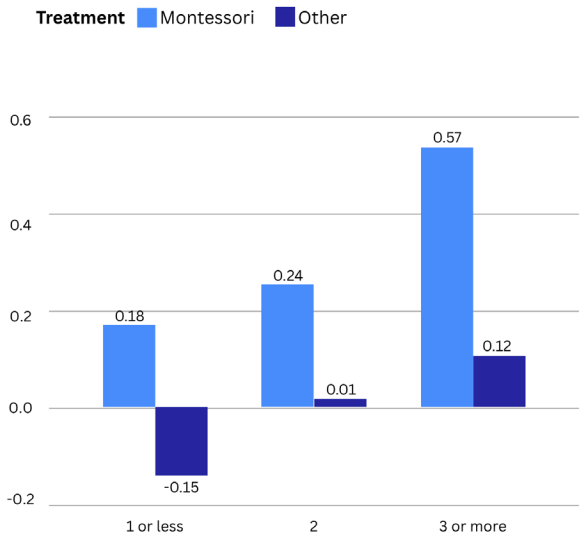
New Montessori students are similar to the comparison group. In contrast to the comparison group, with a mean score of 0.0 and SD of 1.0, the 2019 Montessori scores show significant differences for all levels of FAY, except FAY 0. Comparing the non-FAY Montessori group to the larger Arizona statewide context, no significant difference ($p = 0.92$) was found. Considering these students are new to Montessori schools but have transferred from the general Arizona public school population, this result is not surprising but meaningful. Indeed, given the significant impact of Montessori curricula on FAY students ($p < 0.0001$), this demonstrates an interesting pattern: Students enter Montessori schools statistically indistinguishable from the Arizona average, but score significantly higher after they attend a Montessori school for at least one full academic year. This difference is shown in Table 3.

In comparing these two groups' standardized ELA scores by FAY and grade level, researchers ascertained that students achieve at higher levels the longer they remain in the Montessori setting. All grade groupings (grades three, four, five, and six through eight) achieved higher standardized scores in the FAY 3+ group as compared with all other levels of FAY in all years, as presented in Table 4.

Though still well below the levels of the Montessori group, FAY 3+ students in the comparison group also had higher scores as compared to those with lower FAY levels. Also apparent from the scores is that though one

Figure 8

School Year 2019 Standardized Test Results for All Students by Full Academic Year (FAY) Status, Comparing the Montessori Group with the Statewide Comparison Group



or two full academic years in the Montessori setting significantly impacts student performance, with good effect sizes of 0.24, students who remain in a Montessori setting for three or more years benefit most (0.57). This pattern is evident in Figure 8.

The gap between the Montessori group and others is sizable and consistent. Though the metric of standard deviation units may not naturally conjure the magnitude of difference Montessori schools make, the results of other groups (such as special education students, as detailed in the following section) help provide additional context and interpretation to these analyses.

Special Populations

Montessori methods show promise for special populations, such as special education students, as detailed in Table 5. Special education (SPED) students are a diverse group, and student-level disability category details were not available in the restricted-use datasets. But from the 2019 data, the Montessori group had a proportionate and sizable SPED count—369 students, or 14% of tested students, compared to 12% in the statewide test data. The Montessori group saw an overall gap of 0.81 (−0.23 to 0.58) standard deviations between the SPED and other group, compared to a statewide gap of 1.05 (−0.91 to 0.14; see Table 5). Considering the FAY information, the gap between SPED and others in the Montessori sample seem to attenuate when "FAY 1 or less" students (a gap of 0.87) are compared to the FAY 3+ group (0.78). But the comparison group saw the gap grow from 1.01 in the "FAY 1 or less" to 1.09 standardized score units in the FAY 3+ group.

Based on Figure 9, stability in setting seems to serve special education students well; however, the impact is more dramatic in the Montessori group.

Since the FAY indicator truncates student history in the educational setting to only three years, it would be worth investigating whether or not the Montessori setting's impact measurably increases in years four, five, six and beyond, particularly considering the non-SPED data (see Table 6) with a similar dramatic increase in the FAY 3+ category. With no apparent drop-off in special

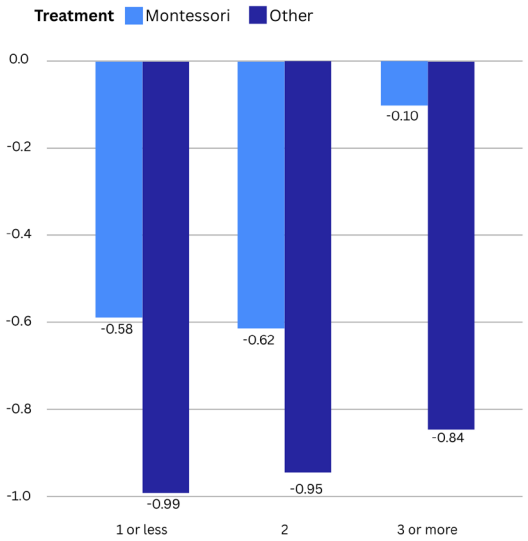
Table 5

Standardized Performance of Special Education and Non-Special Education Students in Montessori and Comparison Groups by Full Academic Year

	Non-Special Education		Special Education		Total	
	Score	Count	Score	Count	Score	Count
Montessori	0.58	2,260	−0.23	369	0.47	2,629
FAY 1 or less	0.29	388	−0.58	55	0.18	443
FAY 2	0.38	254	−0.62	41	0.24	295
FAY 3 or more	0.68	1,618	−0.10	273	0.57	1,891
Non-Montessori	0.14	444,776	−0.91	59,625	0.01	504,401
FAY 1 or less	0.02	149,834	−0.99	19,938	−0.13	169,772
FAY 2	0.14	85,910	−0.95	11,973	0.01	97,883
FAY 3 or more	0.25	209,032	−0.84	27,714	0.12	236,746
Total	0.14	447,311	−0.91	60,523	0.01	507,834

Figure 9

School Year 2019 Standardized Test Results for Special Education Students by Full Academic Year Status, Comparing the Montessori Group with the Statewide Comparison Group



education enrollment in the middle grades (the numbers are slightly higher in terms of student enrollees) the impact on performance at the FAY 3+ level is not likely due to students leaving Montessori schools.

It is noteworthy that there is no statistically significant difference between special education students with three or more years exposure to Montessori methods and curriculum as compared to the general Arizona population with all levels of FAY (−0.10 compared to 0.00).

Similar to the benefits special education students appear to receive by remaining in the Montessori setting, all students (the majority of whom do not have disabilities) experience their most dramatic results in the FAY 3+ category. This group was 71% of the Montessori sample in SY 2019, compared to 46% in the larger Arizona comparison group. Montessori programming retained students at a higher rate, and Montessori students performed better than non-Montessori students on the state ELA exam.

Table 6

Special Education Student Performance in Arizona Montessori Schools on 2019 Statewide ELA Test, Grades Three through Eight

	Montessori			Significance Testing	
FAY Category	*N*	Score	*SD*	*t*	*p*
1 or less	55	−0.58	0.94	4.58	< 0.0001
2 years	41	−0.62	1.07	3.71	0.0006
3 or more	273	−0.10	0.98	1.69	0.0929
Total	369	−0.23	1.01	4.37	< 0.0001

Regression Analysis

An ordinary least squares regression was conducted to evaluate the extent to which student subgroup status—FAY, English learner, special education, free/reduced-price lunch, race (dichotomously coded as White/non-White), and Hispanic group indicator (Hispanic/not Hispanic)—could predict ELA standardized test scores, with standardized test scores as the dependent variable and the following independent variables: FAY, English learner status, special education status, free/reduced-price lunch status, race indicator, and Hispanic group indicator. Though the amount of variance explained was quite modest ($R^2 = 0.268$, or about 27%), all variables in the model proved to be significant, and overall, the model was significant ($F = 31{,}451$ and $p < 0.001$). See Table 7 for the relative impact and significance of each variable in the model. The model was run for all 2019 test and student data ($n = 516{,}152$).

From the model, predicted scores that take into account demographic and student program differences

Table 7

Regression Model Coefficient Summary

			95% CI		
Variable	B	SE	LL	UL	*p*
Special education	−0.998	0.004	−1.0058	−0.9902	<.001
English learner	−0.836	0.005	−0.8458	−0.8262	<.001
Free/reduced lunch	−0.320	0.003	−0.3259	−0.3141	<.001
FAY	0.127	0.001	0.1250	0.1290	<.001
White	0.302	0.004	0.2942	0.3098	<.001
Hispanic	−0.085	0.003	−0.0909	−0.0791	<.001

were used to create a database of student-level predicted scores. For instance, the impact of FAY on scores for both the Montessori group and Arizona-wide comparison group was apparent. Predicted scores controlled for the advantage Montessori students may have with disproportionately higher numbers of FAY 3+ students. Predicted scores were subtracted from the standardized observed scores used throughout the descriptive data sections. The resulting measure estimates the difference between predicted scores and actual scores achieved by tested students in the 2019 school year, statistically accounting for any relative advantages students may have had because of their background. This suggests Montessori methods and instruction may have a positive effect on student language arts test scores independent of student background and experience.

Discussion

This study was designed to assess evidence of Montessori methods effectively teaching students to read and whether the results meet or exceed other reading instruction methods in use in Arizona. At the outset, we asked the following questions: How do Arizona public Montessori students perform on state English language arts (ELA) assessments after one, two, or three-or-more years of reading instruction compared to the general population of public students? Do Arizona public Montessori students perform as well or better than state averages, controlling for student years of Montessori experience and demographics?

Data from Arizona's state ELA tests indicate students in Montessori programs are well prepared to face the rigors of these assessments. Full academic year (FAY) data indicate families who chose a Montessori program for their student stayed with the program at higher rates than the general Arizona population and were rewarded with increasingly higher state test scores on the ELA exam. With regard to our first research question, we find increased dosage of Montessori education is associated with improved performance on ELA assessments, as compared with the general population of students. Although large sample sizes can lead to statistically significant results that are not actually meaningful in the real world, the differences in outcomes between Montessori and non-Montessori groups are substantial and not impacted by an overpowered sample.

With regard to our second research question, we find that across all grade levels and groups examined and explored for this paper, Montessori schools and the curricula and methods they employ with students outperform their statewide counterparts. Students who had not completed a full year of the Montessori curriculum in 2019 were statistically no different than the general population in Arizona. Enrollment stability appears to be associated with better ELA performance, and this relationship is more pronounced for students in Montessori settings. Students who remain in the same school for longer periods perform better, but students who remain in the same Montessori school for longer perform even better.

These results hold true even for the most academically challenged students—those with disabilities. Students receiving special education services in Montessori schools scored significantly higher than their peers in other settings across Arizona—a difference of nearly one standard deviation. It is plausible that the individualized and student-centered nature of Montessori instruction may be especially beneficial for these students.

As science of reading laws spread throughout the United States, reading instruction is becoming increasingly regulated by legislators rather than educators. These study results suggest Montessori reading instruction meets the criteria to be considered evidence-based under current Arizona legislation, and Montessori schools may not need to layer supplemental reading curricula on top of the Montessori approach. The Montessori approach to reading instruction may even be a source of promising practices.

Although formal assessment does not play a large role in Montessori pedagogy, public Montessori schools are subject to the same accountability requirements as any other public school. For Montessori programs in public schools to succeed and grow, more high-quality scholarship is needed to understand the outcomes these programs can produce for students—including for which students and under what specific circumstances. Because legislative and regulatory requirements constantly change, public Montessori practitioners and scholars of Montessori instruction must be flexible and adaptable.

Limitations

Several factors should inform interpretation and application of this work. Any standardized assessment provides only a snapshot of English language arts proficiency. AzMERIT may not fully capture all aspects of children's literacy development. This study utilized

data collected prior to the COVID-19 pandemic. The impacts of the pandemic on distance learning may mean replications of this work could yield different results. Although this quasi-experimental design leverages the FAY metric, this study did not include any measure of baseline equivalency between the Montessori and comparison groups. The Montessori and comparison groups may have differed in material ways not captured by our regression analysis. We attempted to statistically account for demographic differences between the Montessori and comparison groups, but these controls are often imperfect. Specifically, many public Montessori charter schools did not participate in the federally funded National School Lunch Program in 2019. As a result, the poverty level of these schools appears as zero, which may not accurately reflect the socioeconomic status of the student population. No attempt was made to document or account for the wide range of approaches to reading instruction in the comparison group, and we included no measure of Montessori fidelity for schools in this group.

Implications and Conclusion

Overall, the effect size magnitude of Montessori methods and curricula on standardized state test scores shows promise for other schools considering implementing Montessori instruction. The evidence suggests there may be significant positive impact from the Montessori approach on students learning to read and write proficiently, according to standards of Arizona's ELA test. Even for students with a single full academic year in a Montessori program, significant results were apparent with good effect sizes.

From the regression analysis, we learned Montessori methods and curricula were associated with positive student outcomes independent of student demographics and poverty, program differences, and years enrolled in a school (FAY), by comparing predicted student scores with actual observed scores from the 2019 school year.

The descriptive statistics, *t*-tests, and regression modeling indicate Montessori reading and English language arts instruction is an effective option for schools to teach students to read. After reviewing the data reported here, the state of Arizona has added Montessori as a vetted reading curriculum for Arizona schools.

Given the limitations of this study, future research could build on its findings by conducting a prospective study that includes baseline data on early literacy skill development across Montessori and non-Montessori students. It would also be fruitful to investigate how public Montessori schools teach reading, how program fidelity varies, and how this variability relates to student literacy outcomes. This work would add to the body of knowledge pertaining to Montessori education, reading achievement, and the science of reading.

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