Struggling Learners and Kinesthetic Strategies

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May 31, 2021

Abstract

The study investigated the effect kinesthetic strategies have on learners as a means to improve number sense and letter-sound recognition. The researcher conducted the experiment in a first grade in-person math class and a kindergarten ELA virtual class. The kinesthetic strategies the researcher used were math floor mats in the first grade class and body movement and song in the kindergarten class. The researcher collected data after a two-week period of regular instruction and after a two-week period of treatment. The investigator examined the differences in participant scores before and after treatment. The null hypothesis states that no difference exists in participant scores after treatment. Prior research regarding the use of kinesthetic strategies during instruction implies that the use of kinesthetic strategies can have a positive impact on learning and acquiring basic literacy and number sense skills. Furthermore, related literature suggests that students learn best when information is presented in more than one way. In addition, according to related literature it can also be deducted that the use of movement in the classroom can boost student engagement and promote a positive attitude in learners resulting in better learning outcomes. The findings indicated that the addition of body movement and song had a positive impact on the kindergarten students in the virtual classroom. At the probability level of .05 (a 95% confidence level), the paired samples *t*-test revealed a significant difference in score (t (4) = -3.08, p = < .037), therefore the null hypothesis (Ho) was rejected at the .05 level. However, the results from the paired samples *t*-test from the math scores indicated that the difference between the two means is statistically not significant (t = -1.46, df = 15), therefore the null hypothesis (Ho) was rejected a the α = .05 level. It is suggested that further research be done prolonging the duration of treatment and expanding the research to more grades and larger classrooms.

Struggling Learners and Kinesthetic Strategies

This study was done with the struggling learner in mind. According to Brabec, Fisher and Pitler (2004), teachers present new knowledge to students primarily by speaking and reading. However, psychologists postulate that people store knowledge in both linguistic and nonlinguistic forms. The nonlinguistic representations can include graphic representations, physical models, mental pictures, illustrations, and kinesthetic classroom activities. Previous studies suggest that nonlinguistic representations increase content comprehension.

The researcher used kinesthetic strategies as an alternative to the traditional methods of teaching. The benefits of this study are many. First, this study can potentially benefit students who have more difficulty learning with the traditional methods of instruction or with linguistic representations. Second, this study could potentially bring equity, inclusion and ‘whole person’ approaches to instruction, as well as promote meaningful learning,

Problem

There has been some research on how kinesthetic strategies can improve both math and ELA outcomes in students. Especially for those students who find it difficult to learn with the more traditional methods.

It is an interesting fact to find out that movement and song can foster learning in both struggling and non-struggling students (Hall, B.S., 2019). It is also a known phenomenon that students with ACES (Adverse Childhood Experiences) can benefit from movement because movement creates a substance called BDNF which is a natural "protector" against the effects of toxic stress in the brain cortex (Mathandmovment.org, August 2020).

Some teachers have 'unknown' bias against such students. They may not be aware of it. Camille Wilson Cooper (2003) quoted Bartolome (1994); Solorzano (1997) and Valencia (1997) in her article *The Detrimental Impact of Teacher Bias* as follows: "Teachers' willingness to reject deficit thinking and stereotypes, while embracing a belief that students from all backgrounds can learn and flourish is also essential (Bartolome, 1994; Solorzano,1997; Valencia, 1997, cited in Wilson Cooper, 2003, p. 101). Wilson Cooper further states that most scholars as well as educators agree that a teacher's capability to help his or her students succeed is connected to his or her own knowledge of pedagogical practices that promote student success and that additionally, the teacher's efficacy is connected to his or her inherent beliefs about their students' intelligence, character and potential. (Bartolome, 1994; Cochran-Smith, 1997; Fueyo & Bechtol, 1999; Oakes & Lipton, 1999, as cited in Wilson Cooper, 2003, p. 101).

In education, one size does not fit all. Sometimes, it is a matter of trying different strategies until one of the strategies yields positive results for a particular student. Research can make an impact in the right direction. Research can turn a 'myth' into an evidence-based practice. It is important to note, that even evidence-based practices cannot become a rule of thumb or a one-size-fits all 'solution' for all students. Each student has a different learning style and learns at a different pace. Todd Rose (2016) stated that we are constantly measured against a mythical yardstick. Rose is an avid advocate for those students that fall outside of the "bell" curve and defends a "whole person" approach to teaching and learning (Rose, 2016a; Rose, 2017b).

Todd Rose also stated that a multidimensional perspective can set us all up for success (as cited in Corcoran, 2017).

Movement-based and voice-based strategies can be a way to bring this multidimensional perspective as well as a means to incorporate equity, inclusion, and trauma-informed practices into the classroom. These strategies are believed to be a successful resource to help students learn and make connections as well as being an effective way to differentiate instruction.

Purpose of the Study

It is a well-known fact that developing a strong fluency in literacy and math and acquiring a solid foundation in these two content areas is crucial to succeed academically in higher grades.

According to Arthur Baroody (2006), most difficulties in mastering basic number facts are due to instruction that focuses on memorization and also due to gaps in informal mathematical knowledge. According to Baroody, the difficulties are not due to cognitive deficits.

According to McGraw Hill (2019), research on the effectiveness of math worksheets and timed math drills varies. However, research shows that the worksheets and timed drills approaches to developing fact fluency may impact student's feelings toward math in a negative way. McGraw Hill states that learning science research can identify strategies that foster a more positive attitude toward math and also help develop math fact fluency.

McGraw Hill agrees with Baroody in that fluency should not require rote memorization. As stated in the article by McGraw Hill, Kling and Bay-Williams (2015) state that fluency allows math fact retrieval, internalized from prior experience, with automaticity. Kling and Bay-Williams explain that in order for students to acquire fluency, they need to notice relationships and use strategies. Kling and Bay-Williams also explain that students need flexibility in their thinking. McGraw Hill suggest Interleaving, games and formative assessments as part of the research-based strategies that promote a positive attitude toward math.

Powell and Fuchs (2012) emphasize the importance of acquiring a strong number sense in the early grades in order to move on to more complex mathematical tasks.

Louisa Moats wrote that poor reading became more than national news. She stated: “It is a national crisis, an epidemic in the urban landscape”. She continued writing that according to research, when teachers put into practice instructional components supported by reading research, most students can learn to read. However, she also writes that despite the use of research-based methods of direct, systematic, and explicit instruction and despite the progress made by students, the gains were hard to sustain, especially after fourth grade (2006, p. 3).

Jennifer Gonzalez wrote that people, in general, learn better when information is presented in more than one way (Sankey, Birch & Gardiner, 2010, as cited in Gonzalez, 2020). Gonzalez goes on to say that the use of gestures yields more enduring learning than learning without gestures (Cook, Yip & Goldin-Meadow, 2010 as cited in Gonzalez, 2020). Gonzalez also states that research shows that physical activity stimulates the brain, improves cognitive function, and is associated with better academic performance (Donnelly & Lambourne, 2011, as cited in Gonzalez, 2020).

Cook, Yip and Goldin-Meadow (2010) state that when people talk they often use their hands which adds an action component to talking. Cook, et al. found that gesturing during encoding resulted in better recall. Cook, et al. go on to state that saying a list of words does not improve our memory for those words (Bahrick & Boucher, 1968; durso & Johnson, 1980; Paivio & Caspo, 1973, as cited in Cook, Yip, & Goldin-Meadow, 2010, p. 1).

Cook, et al. write that there are two ways in which doing an action can influence the recalling of that action later on. One is doing the action when the action is encoded for the first time and the other one is doing the action when the action is recalled later on (Cook, et al, 2010).

Therefore, according to the research mentioned above, body movement, voice and song can help students make the connections to literacy and math content in a more contextualized and meaningful way.

Research Hypotheses

Hypothesis 1 The use of kinesthetic strategies will help students make connections to both prior knowledge or schema and new information to be learned. The use of kinesthetic strategies will help students acquire the necessary content knowledge and skills to progress academically. The use of math floor mats and movement will make a difference in helping students develop a strong number sense and learn essential addition and subtraction facts.

Hypothesis 2. The use of body movement, song and voice will make a difference in helping students acquire the necessary letter-sound recognition that is paramount to develop reading and language fluency to progress academically in higher grades.

The hypotheses predict that using floor mats and hoping for math and body movement and voice for literacy instead of using linguistic representations will engage students and facilitate learning. Students will be able to make the connections they are not able to make when being static at their desks. There will be a difference between students who receive regular instruction and students who receive the kinesthetic treatment. The instruments that will be used to measure this difference are a 15-item quiz for math and a 26 lower-case recognition quiz for ELA.

This study aims at answering these questions: Can the use of kinesthetic strategies such as math floor mats and hoping improve math outcomes such as addition and subtraction in a first grade in-person classroom?

Can the use of body movements, voice and song improve letter-sound recognition and “alphabetic principle” outcomes in a kindergarten virtual class?

The Null Hypotheses

There is no difference in participant scores between the traditional method or regular instruction and the use of kinesthetic strategies during instruction in the first-grade math class.

There is no difference in participant scores between the traditional method or regular instruction and the use of kinesthetic strategies during instruction in the virtual kindergarten ELA class.

Variables

The study included an independent variable for math which was operationally defined as the two groups of students: The first grade in-person math class before treatment and the same first grade in-person class after treatment.

The study also included an independent variable for ELA, which was operationally defined as the two groups in the kindergarten class: The group of students in the virtual kindergarten class before the treatment and the group of students in the virtual kindergarten class after the treatment.

The dependent variables were continuous for both math and ELA and were operationalized via a 15-item quiz for math and a 26-item quiz for ELA. Scores were measured on a scale of 0 to 15 for math and a scale of 0 to 26 for ELA. The 15-item quiz for math contained mixed single- and double-digit addition and subtraction problems. The 26-item quiz for ELA was the lower-case recognition part of the BAS assessment.

Definition of Terms

The word kinesthetic comes from the word kinesthesia which means the sensory perception of movement. Kinesthetic strategies are part of a learning style that uses a multi-sensory approach. These techniques are usually used with visual or auditory techniques, allowing the students to ‘experience’ the learning. Kinesthetic strategies include the use of tact, body movement, dance and song.

Fountas & Pinnell Benchmark Assessment System© (BAS) is used to determine the student’s independent and instructional reading levels. The BAS© System allows teachers to observe student reading behaviors on an individual basis. The only part of the BAS© assessment that was used for the study is the 26-item lower-case recognition assessment.

Fundations© Picture Cards are part of the Wilson language training program used to teach critical foundational skills to children, including phonemic awareness and phonics.

Jack Hartmann is a nationally recognized children's singer, songwriter, and author. Jack Hartmann’s music is research-based, and teacher approved.

Math & Movement© floor mats and exercises are designed to practice movement-based learning. Math & Movement© floor mats were used for the math experiment in the first-grade general education class. This multi-sensory learning approach is aligned with state standards.

Reliability and Validity

The validity of the study was measured via test content. The math study measured addition and subtraction facts before and after treatment. The ELA test measured lower-case recognition before and after treatment. Data was collected by means of a pretest and a posttest which were administered in both classes. The pretest and posttest were graded, and the results analyzed using a paired samples *t*-test in both studies.

The math content was measured using a 15-item quiz with possible scores from 0 to 15. The quiz measured addition and subtraction facts. The quiz measured how many problems on a scale of 0 to 15 a student was able to solve before and after treatment.

The ELA content was measured using a 26-item quiz with possible scores from 0 to 26. The quiz measured how many lower-case letters a student was able to recognize before and after treatment.

Limitations and Delimitations

The math sample is one of convenience, therefore it is not representative of all first-grade students across the district. The ELA sample is also one of convenience, furthermore it contains only 5 students which formed one of the small groups receiving intervention. The ELA sample is not considered representative of the kindergarten grade across the district. In addition, the ELA class was conducted virtually via Google meet. The researcher only had access to the math class once a day for 50 minutes. The researcher had access to the ELA class four times a week for 30 minutes each session. Class attendance presented a further challenge in the ELA class. However, the researcher was able to conduct the experiment and collect the necessary data.

The research project was conducted in the classroom for the first grade math class and via a Google meet platform for the ELA class.

Literature review

According to the Centers for Disease Control and Prevention (CDC), physical activity in the classroom can improve students' concentration and ability to stay on-task, reduce disruptive behavior in the classroom, improve students' motivation and engagement in the learning process, boost self-esteem and create a sense of safety and unity in the classroom (2018, p. 7).

According to Murphey and Sacks: "…schools should focus on fostering the kinds of positive relationships that can help these students recover and respond resiliently to future adversities. This approach is not about singling out students who have experienced adversity, but about shifting the culture, norms, and practices of an entire school to create a safe and supportive learning environment for all students." (Murphey & Sacks, 2019).

According to Marzano, Gaddy & Dean: "Kinesthetic activities involve physical movement. Physical movement associated with specific knowledge generates a nonlinguistic representation of the knowledge in the mind of the learner" (2000, p. 85).

Movement and kinesthetic practices may also promote a "can do" attitude by changing the 'mindset'. Dr. Carol Dweck came up with the term 'Mindset' and 'Growth Mindset'. Can kinesthetic strategies promote a 'Growth Mindset'?

Dr. Carol Dweck's theory of 'Mindset' (2006) believes that kinesthetic strategies can promote a 'can do' attitude. Dr. Dweck explains that a positive attitude is more important than IQ. It can be inferred that the use of kinesthetic strategies can promote the confidence and 'can do' attitude' as well as reducing frustration. Even through a 'Growth Mindset' is not the focus of the study, it can be hypothesized that the use of kinesthetic strategies can promote a 'Growth Minset'.

Don Clifton is the "Father of Strengths-Based Psychology". Tom Rath states in his book "StrenghtsFinder 2.0": "Our goal was to start a global conversation about what's right with people", (Rath, T., & Gallup, 2017, p. 1). Rath explains that the focus needs to be on what is right rather than being fixated on peoples' weaknesses. This would back Dr. Dweck's 'mindset' theory of "Growth Mindset" as opposed to a "Fixed Mindset".

There has been some research that proves that kinesthetic strategies work. For example, Kyle Curtis (2019) did a study for his doctoral thesis that focused on the use of kinesthetic strategies during literacy instruction. He states that, based on the interviews he conducted, the participating teachers reported that their kindergarten students responded positively to kinesthetic strategies. The teachers also reported that these strategies were successful with adult support.

Marzano, et al. explain the importance of non-linguistic representations based on Paivio's dual-coding theory. In reference to the use of linguistic and non-linguistic forms (imagery), they go on to say: "…the more we use both systems of representation, the better we are able to think about and recall our knowledge." (Marzano, et al., 2000, p. 86).

Dean, Ceri et al., in their book "Classroom Instruction That Works", in the section about non-linguistic representations, explain that in 2010, they tested a hypothesis in a classroom. The classroom was divided in two groups. One group of students used a more traditional activities, such as completing worksheets. The experimental group used kinesthetic activities. Dean, Ceri et al. report that: "his kinesthetic activity helped students in the experimental group make greater achievement gains." (Dean, Ceri et al., 2012, p. 87).

Kinesthetic strategies can also improve fine motor skills and coordination. Schafer states that: “Because the brain relies on kinesthetic memory, it does not have to concentrate on how to move body parts. Instead, the brain can be focused for more complex thought processes and enhancement or refinement of movements.”. (Schafer, 2019, para. 3).

Culp, Oblerton and Porter, talk about the environment of classrooms that use active-based learning and kinesthetic strategies. They state: “In addition to being physically and psychologically secure, they foster opportunities for social contact and collaboration to occur.” (Culp et al., 2020, p. 11).

Cooperative learning has its roots in the Bible, the Biblical Hebrew word for fellowship comes from the word (with suff. ־חֲבֵיר) 1) which means “associate, friend, partner (in sacrifices); colleague, fellow-student; fellow-being; of the same kind (also of things). (Jastrow, 1903, (2), p. 421). It is a Talmudic tradition to learn in pairs and to find a ‘heber’ (partner in study). It is also interesting to note that in the Bible, the word for ‘living water’ denotes a sense of flowing and moving as in John 7:38. For water to flow in a fountain, it needs to move.

Maria Valdez (1994) studied the use of tactile and kinesthetic strategies within a whole language approach in a bilingual first-grade class. The findings of this studies conclude that students improved in the specified areas where interventions were applied.

Riley et al. conducted a movement-based mathematics study in Australia. They interviewed four classroom teachers and 66 students participated in this study. Riley et al state that: “embedding movement-based learning across mathematics had a significant positive effect on children’s enjoyment and engagement without compromising the quality of learning”. (Riley et al., 2017, Abstract). It can be deducted that the use of movement in the classroom can promote a ‘can do’ positive attitude and therefore produce better learning outcomes.

There have been studies that have not found any significant change when using kinesthetic strategies in their instruction to elementary students. Rachel Metzler studied the effects of kinesthetic movement with multiplication in a third-grade class. She used kinesthetic movement with multiplication fact acquisition. She used two groups of third grade students. One group was taught using kinesthetic movement and another group was taught with more traditional methods (staying at desk with pen and paper). This study was done on both male and female students and students with and without IEPs. Metlzer states that: “There was no significant difference in the post-test multiplication scores of the kinesthetic instruction group” (Metzler, 2016, p. ii).

Britiney Fife, in a study of first-grade children and their recall memory, used active learning in mathematics. Fife’s study retained a null hypothesis that there was no significant effect on the memorization of addition facts. There was no significant difference between the use of a traditional method and the use of an active method. However, the experimenter noticed enthusiasm of children participating in the experimental method. The researcher also noticed unenthusiastic responses to the controlled method. Fife suggested further research using active learning of math facts in the classroom.

Method

Overview of the Study

The study took place at a magnet school in Long Island hosting elementary grades from kindergarten to 4th grade. An educational research sample of 16 students was used for the math experiment and an educational research sample of 5 students was used for the ELA experiment. The treatment groups and the control groups were the math and ELA classes before and after treatment. Students in the first grade in-person math class were taught using regular instruction for two weeks. Following the two-week period of regular instruction, students were administered a pretest consisting of a 15-item quiz which contained mixed addition and subtraction problems.

Regular instruction in the first grade in-person math class followed the curriculum-based instruction, based on the pacing guide for first grade. Students sat at their desk while the teacher delivered instruction. Students also completed independent work at their desks as part of regular instruction.

The innovative method in the math class was used during a two-week period succeeding the regular instruction period. The treatment consisted of using kinesthetic strategies during instruction. The kinesthetic strategies used for the math class, consisted of using math floor mats. The math floor mat used for this study was a Math & Movement© 8’ by 8’ 100 number charts. Students were able to walk and hop in the mat. Students were able to count by ones and by tens using the mat. Students practiced addition and subtraction problems using the mat. While they used the mat, students were encouraged to say the numbers out loud. Each exercise was modeled for the students. The researcher worked with the students as a whole class, in small groups and individually. Following instruction, the math floor mat was left on the floor for students to use while they did independent work. Students were administered a posttest after the two-weeks of treatment. Scores ranged from 0 to 15.

For the ELA virtual kindergarten class, the researcher taught using regular instruction for the duration of a two-week period. Following the two-week period of regular instruction, students were assessed using a 26-item lower-case recognition BAS assessment.

Following the two-week period of regular instruction and pretest, the treatment method was used during instruction for another two weeks. Following the two weeks of treatment, students were administered a posttest.

Regular instruction for the ELA group consisted of the letter-sound recognition drill using Fundations© picture cards. During regular instruction, students saw the Fundations© picture cards on the shared screen during the Google meet. The researcher said the name of the letter, the keyword on the card associated with the sound of the letter and sound the letter makes. The students repeated what the researcher said.

During the treatment period, the same Fundations© picture cards were used. However, the students were taught how to do the letter using their bodies while simultaneously repeated what the researcher said. Students also danced to Jack Hartmann's alphabet workouts. Students danced and moved doing specific movements while repeating the letter, keyword and letter. The innovative method added body movement and song to the phonics exercises.

After the two -week period of treatment, students were assessed again using the same instrumentation used for the pretest, which consisted of the 26 lower-case letter part of the BAS assessment. For each lower-case letter that each student named correctly in English, the student were awarded one point. Scores ranged from 0 to 26 points.

Setting

The setting for the research was an elementary school which fosters grades K to 4. The school is a magnet school, the first magnet school in the district and the newest addition to the district. The school opened its doors in 2003. The school focuses on providing opportunities for students to explore their world first-hand. This school is set in the heart of Nassau County in Long Island. The demographics of the population for this district are mixed. According to The New York State Education Department (NYSED), the school's demographics comprise 18% Black or African American, 67% Hispanic or Latino, 11 % White and 3% Multiracial students. In addition, 20% of the students are English Language Learners, 12% of the students are students identified as students with disabilities, 1% of the students are homeless and 68% are economically disadvantaged.

Research Designs

The researcher used a quasi-experimental research method. The study investigated the differences in participant scores between regular instruction and the use kinesthetic strategies during instruction. Testing occurred over a total period of four weeks. Data was collected in the form of pretests and posttests for later analysis using paired samples *t*-tests of significance between participant scores with regular instruction and participant scores with treatment. The sample was not stratified by gender or age.

Participants

The class where the research project for math was conducted was a first grade in-person general education class that hosts 16 students. This class had 7 females and 9 males. There were 7 students from a Hispanic background, two of which were Spanish-speaking also fluent in English, 2 African American students, 3 Multiracial students, and 4 White or Caucasian students.

The class where the ELA experiment was conducted was a kindergarten virtual class consisting of 5 students in a small group setting. This class had 4 male students, three of Hispanic background and one African American, and one female student of Hispanic background.

Sampling

The math sample and the ELA sample were both samples of convenience. The researcher worked in these classes and they were the only two classes available at the time for the research.

The math sample was the entire general education in-person math class in an elementary school. The math sample had 16 students. The sample was not stratified by gender or ability.

The ELA sample was the virtual kindergarten class in an elementary school. The ELA sample consisted of the 5 students in one of the small groups, representing a small sample of the 18 students in the ELA kindergarten virtual class. The sample was representative of the students that needed additional support in this kindergarten class. The sample was not stratified by gender or any other criterion.

Instrumentation

The instrument that was used for math was a one-page quiz containing 15 items. The items consisted of mixed addition and subtraction problems. The addition and subtraction problems contained both single-digit and double-digit addition and subtraction problems. The same quiz was used for the pretest and for the posttest.

The instrument that was used for ELA was a 26-item quiz. The quiz contained the 26 letters of the English alphabet in lower-case. The quiz was part of the lower-case BAS© assessment. The same assessment containing the 26 lower-case letters of the alphabet was administered as a pretest and as a posttest.

Procedures

The first-grade math students were assessed using a one-page quiz containing 15 mixed addition and subtraction problems which ranged from single-digit to double-digit. For each problem, if solved correctly, each student received one point. Scores ranged from 0 to 15 points. The same quiz was used for both the pretest and posttest. Students were administered a pretest following a two-week period of regular instruction. For the posttest, students were administered the same quiz following a two-week period of treatment. The quiz was administered in class and students did the quiz at their desks. The pretest and posttest were administered at the beginning of the math period. Students were be given 15 minutes to complete the quiz.

The kindergarten students in the virtual classroom group, were assessed on lower-case letter recognition. The instrument that was used to assess these students was a 26-item lower-case letter recognition assessment that is part of the BAS© assessment. For each letter they could name correctly in English, each student was awarded one point. Scores ranged from 0 to 26. The pretest assessment was administered at end of the virtual class ELA class period following a two-week period of regular instruction. Students were administered the same quiz at the end of a two-week period of treatment. The posttest was administered at the end of the virtual ELA class period. The pretest and posttest were administered online. The researcher shared the screen during the Google meet, showing one letter at a time. The letters were not in alphabetical order. Each student was assessed individually. If the student could name the letter correctly in English, the researcher marked it on the BAS assessment sheet and the student was awarded one point. If the student could not name the letter in English, even though they could name the keyword or sound, the student was not awarded any points. The researcher noted any substitutions made by the student. However, students were not awarded any points for substitutions. For example, if the student named the letter in Spanish or said the keyword or sound but could not name the letter correctly in English, the student did not receive points for that answer. The researcher explained the exercise to the student and told the student they could either name the letter they saw or say: “I don’t know it”.

Collection of Data

In the math class, data was collected using a 15-item quiz which was administered two weeks after regular instruction and two weeks following treatment. The 15-item quiz was graded on a scale of 0-15. The quiz was administered in-person during math class.

In the ELA class data was collected using a 26-item quiz. The quiz was administered two weeks after regular instruction and after a two-week period of treatment. The data was collected during ELA instruction using a Google meet platform. The results of the quiz were graded on a scale of 0-26.

Data analyses

Data analyses were conducted using the Statistical Package for the Social Sciences (SPSS, v. 23). Data analyses include distribution frequencies of scores obtained for both math and ELA pretests and posttests, means, median, simple scattergrams and paired samples *t*-test. The statistical test that was used to compare scores and test the hypotheses, is a paired samples *t* test using the scores obtained from the pretests and the posttests. Following the results of the paired samples *t* test, the results were analyzed. According to the probability of the results obtained, it was determined whether there was a significance and thus the Ho (Null Hypothesis) was rejected or whether there was no significance and thus the Ho was not rejected. The alpha level was .05.

A paired samples *t* test was used for the first-grade math class and a paired samples *t* test was used for the Kindergarten virtual ELA class.

Results

Overall Results

The descriptive, overall results or the data analyses are presented first. This is followed by a discussion of the results obtained.

Summary of Results

The math scores were measured using a 15-item quiz scale with possible scores from 0 to 15. The mean score from the pretest was M = 9.56, the mean score from the posttest was M =

10.69. (see *Table 3* and *Table 4*). The mean scores obtained from the posttest were higher when compared to the mean scores obtained from the pretest. However, the difference is not statistically significant (see *Figure 1*, *Figure 3.1.* and *Figure 3.2.*).

Dependent Variables: Math Scores

		Paired Differences							
					95% Confidence Interval of the Difference				
Variable	Mean	Std. Error	Paired Pretest-Posttest Mean	St. Deviation	Lower	Upper	*t*	*df*	Sig. (2-tailed)
Pretest (No Treatment)	9.56	1.132	-1.125	3.07	-2.763	.513	-1.464	15	.164
Posttest (Treatment)	10.69	.938	-1.125	3.07	-2.763	.513	-1.464	15	.164

Figure 1. Math pretest and posttest scores comparison based on paired samples t-test.

The simple scattergram for the math posttest shows that the scores from the math posttest are more distributed (see *Figure 3.2.*). The simple scattergram for the math posttest scores also shows a higher approximation to the normal curve. The variability of scores is higher in the pretest (see *Figure 3.1.*), than the posttest (see *Figure 3.2.*). The standard deviation from the pretest scores is (*sd* = 4.53) while the standard deviation from the posttest scores is (*sd* = 3.75).

The Null Hypothesis (Ho) for the math class states that there is no difference in math outcomes when using kinesthetic strategies for math instruction.

According to the results obtained from the pretest and posttest scores, the average math score increased from 9.56 (*sd* = 4.53) on the pretest to 10.69 (*sd* = 3.75) on the posttest. The difference between the two means is statistically not significant at the 0.05 level (*t* = -1.46, *df* = 15), therefore the null hypothesis (Ho) was not rejected for the math class. (see *Figure 1*)

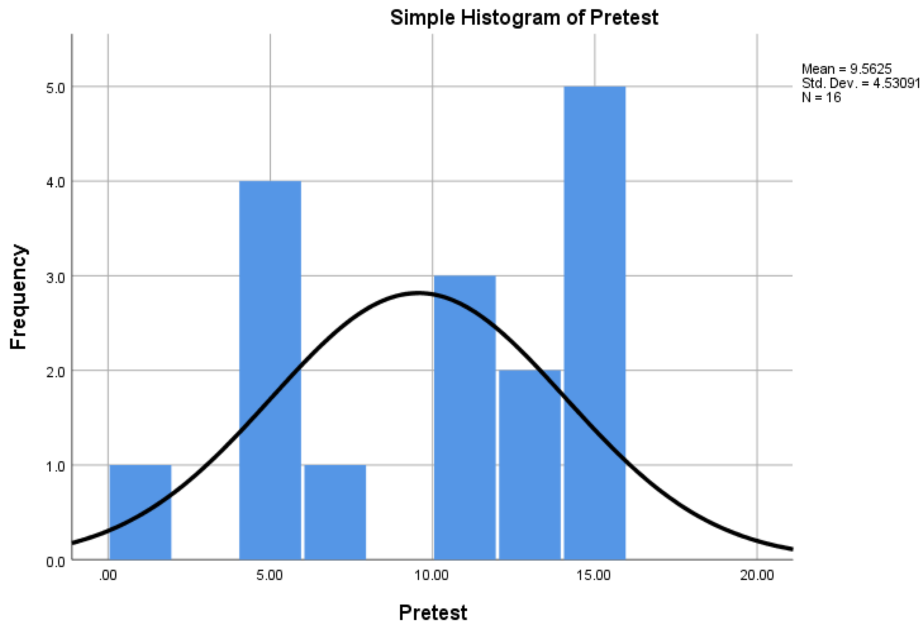

Figure 3.1. Simple Scattergram for Math Pretest Scores.

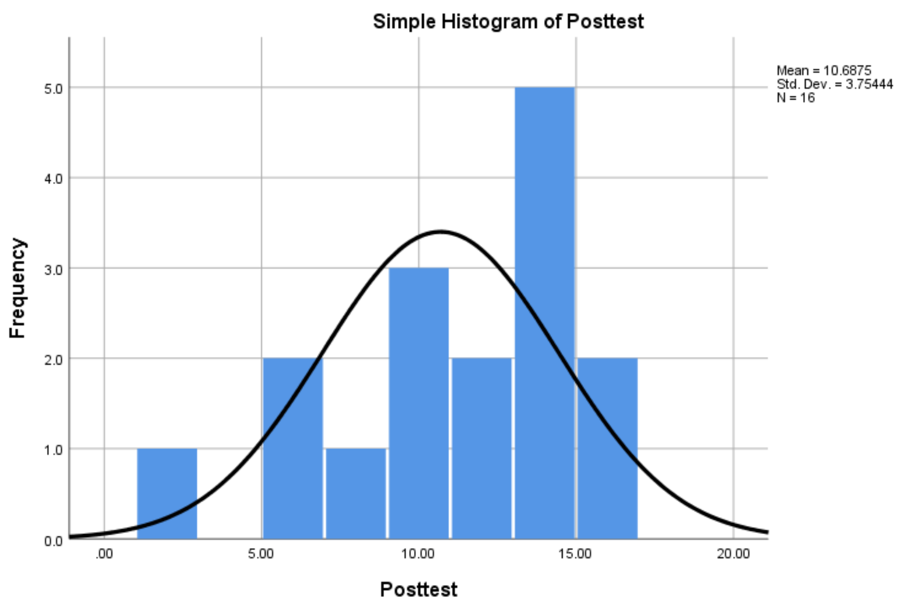

Figure 3.2. Simple Scattergram for Math Posttest Scores.

The ELA scores were measured using a 26-item quiz scale with possible scores from 0 to 26. The distribution number of recognized lower-case letters scores for the ELA pretest is highly skewed to the left with only one student out of the 5 recognizing 2 letters and only one student out of the 5 recognizing 12 letters. According to the scores obtained from the pretest, 3 out of 5 students recognized 0 lower-case letters, showing a mode of 0. The median number of recognized lower-case letters scores for the pretest is (*Mdn* = .00) and the mean (*M* = 2.80). The first quartile is (Q1 = 0) and the third quartile is (Q3 =7), showing that the is greater variability and the distribution of the scores is highly skewed. Because the distribution is highly skewed to the right, the mean is substantially higher than the median.

The ELA mean number of recognized lower-case letters score for the posttest is (*M* = 11.20). The distribution number of recognized lower-case letter scores from the ELA posttest is more symmetric. (see *Table 2*, *Figure 2*, *Figure 4.1* and *Figure 4.2*). However, the median is still higher than the mean (Mdn = 14.00). The standard deviation for the ELA posttest is (sd = 7.19) (see *Figure 4.2*), showing the scores variability is still high.

		Paired Differences							
					95% Confidence Interval of the Difference				
Variable	Mean	Std. Error	Paired Pretest-Posttest Mean	St. Deviation	Lower	Upper	*t*	*df*	Sig. (2-tailed)
Pretest (No Treatment)	2.80	2.33	8.40	6.11	-15.983	-.816	-3.075	4	.037
Posttest (Treatment)	11.20	3.22	8.40	6.11	-15.983	-.816	-3.075	4	.037

Figure 2. ELA pretest and posttest scores comparison based on paired samples *t*-test.

The simple scattergram for the ELA pretest (see *Figure 4.1.)* does not approximate the normal curve and is very skewed to the right. However, the simple scattergram for the ELA posttest (see *Figure 4.2.)* not only shows that the scores in the posttest went up, but it also illustrates the scores are more distributed and shows a higher approximation to the normal curve.

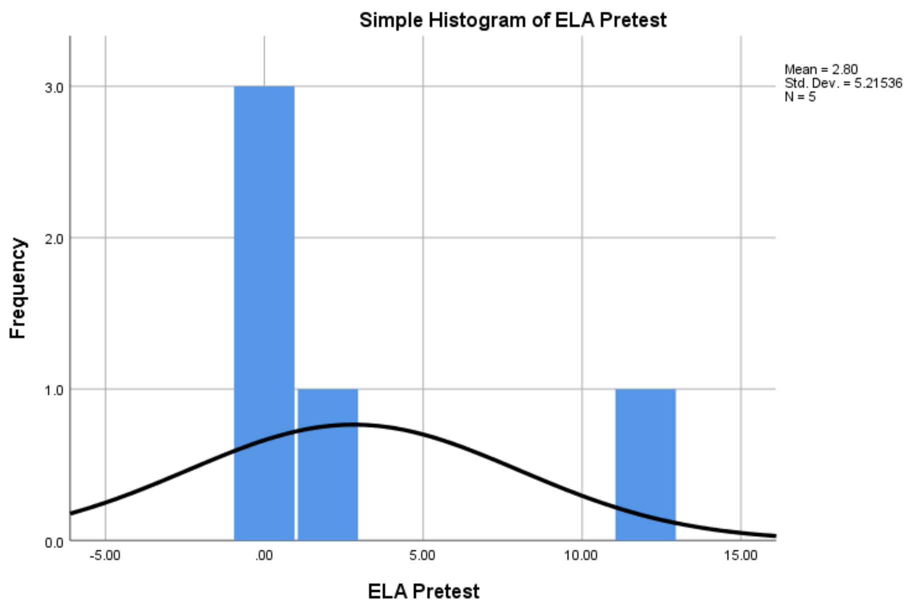

Figure 4.1. Simple Scattergram for ELA Pretest Scores.

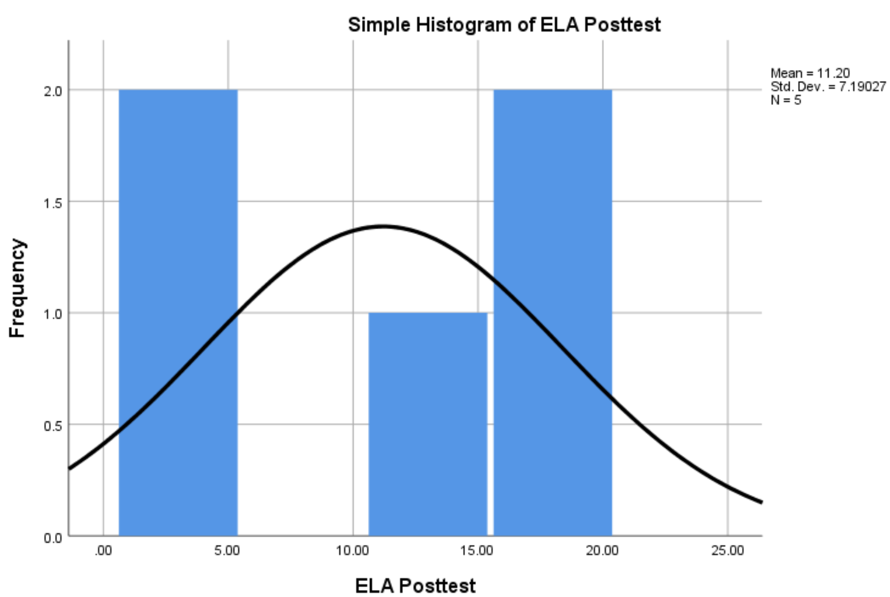

Figure 4.2. Simple Scattergram for ELA Posttest Scores.

The Null Hypothesis (Ho) states that there is no difference in ELA outcomes when using kinesthetic strategies for instruction.

According to the results obtained from the pretest and posttest scores, the average mean for ELA scores increased from 2.80 (*sd* = 5.22) on the pretest to 11.20 (*sd* = 7.19) on the posttest. The difference between the two means is statistically significant (t (4) = -3.08, p = < .037), therefore the null hypothesis (Ho) was rejected at the .05 level.

Discussion of Results

According to the paired samples t-test, there is no statistical significance between the two means for the math class. However (see Table 1), most students with lower scores in the pretest, obtained a higher score in the posttest. The scores from the pretest and posttest show that a significant number of students, including students that had obtained a perfect score of 15/15 in the pretest, obtained a lower score in the posttest. It is difficult to assess what caused the drop in scores in the posttest.

When the researcher examined the posttest in detail, she found some students who made little to no mistakes in the pretest, had made sloppy mistakes in the posttest, such as not reading the problems correctly. For example, some students had mistaken (-) with (+). Students were given 10 minutes before instruction began to complete the quiz. The researcher wonders if scores would have been higher if students had been given more time to complete the test.

It is difficult to assess the impact the kinesthetic treatment had on the students in the math class due to the short duration of the treatment. Furthermore, students were assessed at their desks. Students were not assessed using the floor mat used for the treatment.

The treatment, according to the results obtained from the data, made an overall difference in the math class, even if small and statistically not significant.

In contrast, the scores obtained from the ELA posttests are much higher than the scores obtained in the pretests (see Table 2). The results obtained from the paired samples t-test for the pretest and posttest in ELA are statistically significant, showing that the use of treatment made a difference. However, the highest score obtained was 18/26. Two students who obtained a score of 0/26 in the pretest, obtained a score of 3/26 and 4/26 respectively. The most significant difference was found in two students. One student who obtained a score of 0/26 in the pretest, obtained a score of 14/26 in the posttest; and another student who obtained a score of 2/26 in the pretest, obtained a score of 18/26.

According to the paired samples t-test, there is statistical significance between the two means for the ELA class. It can be concluded that the treatment was effective. The effectiveness of the treatment was measured by the scores obtained in the pretest and posttest. The scores obtained in the posttest are significantly higher.

Implications

According to the results obtained from both pretests and posttests, it can be concluded that kinesthetic strategies can be effective in ELA instruction to help students with letter recognition and letter-sound correspondence. All students in the ELA virtual class obtained a higher score in the posttest. However, the sample was small, consisting of only 5 students. Furthermore, the sample was not stratified.

Despite the increase in scores, two out of the 5 students only recognized 3 and 4 letters, respectively. This class was taught virtually and not all students were in class for all sessions. The virtual component made it difficult to teach on some days due to internet connection problems. Background noise also presented a challenge.

It can be concluded that kinesthetic strategies can have a positive impact on young students during ELA instruction. It can be implied that the use of kinesthetic strategies during ELA instruction can help students obtain the letter-sound recognition that is needed to gain reading fluency.

The scores obtained from the math posttests, in general, were higher than the scores obtained in the math pretests. However, some students with higher scores in the pretest, obtained a lower score in the posttest. It is difficult to assess what caused scores to drop in the posttest.

The most significant fact is that most students with lower scores in the pretest, obtained a higher score in the posttest. The study was made with the struggling learner in mind. Therefore, it can be concluded that despite the fact the paired samples *t*-test showed that the difference between the two means is statistically not significant at the .05 level ($t = -1.46$, $df = 15$), the scores obtained in the posttest show that the treatment made a difference in those students with lower scores in the pretest. It can be concluded the treatment was effective for some students. It can be implied that the use of kinesthetic strategies during math instruction could potentially help those students who learn better with the use of non-linguistic representations.

Recommendations

Based on the results of the paired-sample t-test for the ELA classroom, it is recommended that teachers incorporate kinesthetic strategies during ELA instruction in kindergarten.

Furthermore, it is suggested that more research be done using a more purposeful and larger sample across the kindergarten grade, including in-person classes. It is also recommended that the duration of the study be longer.

Based on the results obtained from the study, it is recommended that more research be conducted on kinesthetic strategies during math instruction, specifically the use of math floor mats. It is suggested the sample includes more than one classroom in the first grade and the duration of the treatment be extended to obtain more precise information. In addition, it is recommended that further research includes strategies to help students transition from desk to floor mat to desk.

During the data collection process in the in-person math class, students were assessed at their desks using a 15-item quiz in the pretest and posttest. However, during instruction with treatment, the floor mats were left on the floor during independent practice. Students were able to get up, explore, and go back to their desks to solve problems. It is recommended that future research incorporates the same strategy that is used for instruction, during the data collection process.

References

Baroody, Arthur. (2006). Why children have difficulties mastering the basic number facts and how to help them. Teaching Children Mathematics. 13. 22–31. 10.5951/TCM.13.1.0022.

Block, C. C., Parris, S. R., & Whiteley, C. S. (2008). *CPMs: A kinesthetic comprehension strategy*. The Reading Teacher, 61(6), 460-470. doi: 10.1598/RT.61.6.3.

Brabec, K., Fisher, K., & Pitler, H. (2004). Building Better Instruction: How Technology Supports Nine Research-Proven Instructional Strategies. *Learning and leading with technology*, *31*, 6-11.

Centers for Disease Control and Prevention (2018) Strategies *for Classroom Physical Activity in Schools*. Atlanta, GA: Centers for Disease Control and Prevention, US Dept of Health and Human Services. Retrieved from: https://www.cdc.gov/healthyschools/physicalactivity/pdf/2019_04_25_Strategies-for-CPA_508tagged.pdf

Cook, S. W., Yip, T. K., & Goldin-Meadow, S. (2010). Gesturing makes memories that last. Journal of memory and language, 63(4), 465–475. https://doi.org/10.1016/j.jml.2010.07.002

Corcoran, B. (2018, December 27) *Ever feel Just 'Average'? Think again, SAYS Todd Rose* - Edsurge News: Digital Learning in Higher Ed [EdSurge.com]. Retrieved from: https://www.edsurge.com/news/2017-06-12-ever-feel-just-average-think-again-says-todd-rose

Culp, B., Oberlton, M. & Porter, K., (2020) Developing Kinesthetic Classrooms to Promote Active Learning, Journal of Physical Education, Recreation & Dance, 91:6,10-15, DOI:

10.1080/07303084.2020.1768178. Retrieved from ResearchGate: https://doi.org/10.1080/07303084.2020.1768178

Curtis, K. C. (2019). Teacher Perceptions of Kinesthetic Learning during Literacy Instruction [ProQuest LLC]. In ProQuest LLC.

Dean, C. B., Hubbell, E. R., Pitler, H., & Stone, B. J. (2012). Classroom instruction that works : Research-based strategies for increasing student achievement. ProQuest Ebook Central https://ebookcentral.proquest.com

Dweck, C. S. (2006). *Mindset: The new psychology of success***.** New York: Random House.

Fife, B. M. (2003). A Study of First Grade Children and Their Recall Memory When Using Active Learning in Mathematics. Retrieved from: https://search-ebscohost-com.ezproxy.nyack.edu/login.aspx?direct=true&db=eric&AN=ED479328&site=eds-live

Fountas, I.C. & Pinnell, G.S. (2010). *[Irene C. Fountas and Gay Su Pinnell]. Fountas & Pinnell benchmark assessment system 1©. Grades K-2, levels A-N. Portsmouth, NH :Heinemann,*

Goral, M. G. (2009). Take Time for Action: From Kinesthetic Movement to Algebraic Functions. Mathematics Teaching in the Middle School, 14(7), 388–391. https://doi.org/10.5951/mtms.14.7.0388

Gonzalez, J. (2020, October 5). *To Boost Learning, Just Add Movement*. Cult of Pedagogy. Retrieved from: https://www.cultofpedagogy.com/movement/

Hall, B. S. (2019) "The Effect of Music and Movement Interventions on Elementary Students' Classroom Transition Times and Engagement". Honors Theses. 1124. Retrieved from: https://egrove.olemiss.edu/hon_thesis/1124

Hartman, J. (2018, January 15) Workout to the Letter Sounds | Version 2 | Letter Sounds Song | Phonics for Kids | Jack Hartmann [YouTube.com]. Retrieved from: https://www.youtube.com/watch?v=VFa0b_IIRac

Hill, McGraw. (2019, January 4). A Research-Based Approach to Math Fact Fluency That Also Promotes A Love of Mathematics! Medium, Inspired Ideas. Retrieved from: medium.com/inspired-ideas-prek-12/a-research-based-approach-to-math-fact-fluency-that-also-promotes-a-love-of-mathematics-31f9d7e8099f.

Jastrow, M. (1903). A Dictionary of the Targumim, the Talmud Babli and Yerushalmi, and the Midrashic Literature and II (1) 421. London; New York: Luzac & Co.; G. P. Putnam's Sons.

Marzano, R. J., Gaddy, B. B., & Dean, C. (2000) What Works in Classroom Instruction. McREL, Aurora, CO. Retrieved from: http://www.peecworks.org/peec/peec_research/I01795EFA.3/Marzano%20What_Works.pdf

Math and Movement (August 2020) *BDNF on the Brain: Movement-Based Learning* [mathandmovement.org]. Retrieved from: https://mathandmovement.com/bdnf-on-the-brain-movement-based-learning/

Metzler, R. (2016) T*he Academic Effects of Kinesthetic Movement With Multiplication Fact Acquisition Instruction for Students in Third Grade*. Graduate Program in Education. Goucher College.

Mindset Works (2017) *Decades of Scientific Research that Started a Growth Mindset Revolution.* Retrieved from: https://www.mindsetworks.com/science/

Moats, L. C. (2006, Summer) Overcoming the Language Gap: *Invest Generously in Teacher Professional Development*. Academic Language Therapy Association [ALTA]. 3-4.

Murphey, D & Sacks, V. (2019) *Supporting Students with Adverse Childhood Experiences:* How Educators and Schools Can Help [aft.org]. Retrieved from: https://www.aft.org/ae/summer2019/murphey_sacks

New York State Education Department [NYSED], (n.d.) *New York State Education at Glance*. Retrieved from https://data.nysed.gov/

Powell, S. R., & Fuchs, L. S. (2012). Early Numerical Competencies and Students with Mathematics Difficulty. Focus on exceptional children, 44(5), 1–16.

Rath, T. & Gallup. (2007). StrengthsFinder 2.0. Amsterdam University Press.

Riley, N., Lubans, D., Holmes, K., Hansen, V., Gore, J., & Morgan, P. (2017). Movement-Based Mathematics: Enjoyment and Engagement without Compromising Learning through the EASY Minds Program. *EURASIA Journal of Mathematics, Science & Technology Education*, *13*(6), 1653–1673.

Rose, T. (2016). *The End of Average: How we Succeed in a World that Values Sameness*. San Francisco, CA, HarperOne/HarperCollins.

Rose, T. (2017). *The End of Average: Unlocking our potential by embracing what makes us different*. HarperOne, an imprint of HarperCollins Publishers

Schafer, E. D. (2019). Kinesthetic memory. Salem Press Encyclopedia of Health. (3) 1064-1067

Vocabulary.com. (n.d.). Retrieved from: https://www.vocabulary.com/dictionary/kinesthetic.

Wilson Cooper, C. (2003). The Detrimental Impact of Teacher Bias: Lessons Learned from the Standpoint of African American Mothers. Teacher Education Quarterly, 101-116. doi:https://files.eric.ed.gov/fulltext/EJ852360.pdf

Wilson Language Training Corporation© (2021) Fundations©. Retrieved from:

https://www.wilsonlanguage.com/programs/fundations/

Appendix

Tables

Table 1
Pretest and Posttest Math Scores

Participant Number	Pretest Score	Posttest Score
1	13	11
2	14	15
3	10	13
4	11	9
5	4	6
6	5	6
7	10	11
8	7	10
9	14	15
10	14	13
11	14	10
12	14	14
13	5	8
14	4	14
15	1	2
16	13	14
Total	*n* = 16	

Scores ranged from 0 to 15. The scores are based on a math quiz consisting of 15 items which contained mixed addition and subtraction problems, including one and two-digits. For each item, the student was able to solve correctly, the student received one point. If the student inverted the numbers, for example wrote'91' instead of '19', the student did not receive a point for that problem. If the student inverted a number, for example wrote 'p' instead of '9', the student did not receive a point for that problem. The sample was a sample of convenience and was made up of the 16 students in a first-grade class in an elementary school hosting k-4. The sample was not stratified by gender, ethnicity, or age.

Table 2

Pretest and Posttest ELA Scores

Participant Number	Pretest Score	Posttest Score
1	12	17
2	0	3
3	0	4
4	0	14
5	2	18
Total	n = 5	

Scores ranged from 0 to 26. The score 0 means that the student did not recognize any of the 26 lower-case letters in English. Students did not receive any scores for substitutions, letter sounds or answers in Spanish or another language. The student received one point for each lower-case letter the student was able to name correctly in English. The sample was a sample of convenience which included the 5 students in a small group setting. The sample was not stratified by gender, ethnicity, or age.

Table 3

Formatted Frequency Distribution of Math Pretest Scores for the Output in Figure 3.1.

Score (*X*)	*f*	%	Cumulative %
15	0	0.0	100.0
14	5	31.3	100.0
13	2	12.5	68.8
12	0	0.0	68.8
11	1	6.3	56.3
10	2	12.5	50.0
9	0	0.0	50.0
8	0	0.0	50.0
7	1	6.3	37.5
6	0	0.0	37.5
5	2	12.5	31.3
4	2	12.5	18.8
3	0	0.0	18.8
2	0	0.0	18.8
1	1	6.3	6.3
0	0	0.0	6.3
	n = 16	100.0	

The mean (*X*) for the scores obtained in the math pretest is *X* = 9.56. The most frequent obtained score in the upper quartile was 14 (31.3%) in the upper quartile. In the lower quartile, the most frequent obtained score was 4.5 (24.5 %).

Table 4

Formatted Frequency Distribution of Math Posttest Scores for Figure 3.2.

Score (*X*)	*f*	%	Cumulative %
15	2	12.5	100.0
14	3	18.8	87.5
13	2	12.5	68.8
12	0	0.0	68.8
11	2	12.5	56.3
10	2	12.5	43.8
9	1	6.3	31.3
8	1	6.3	25.0
7	0	0.0	25.0
6	2	12.5	18.8
5	0	0.0	18.8
4	0	0.0	18.8
3	0	0.0	18.8
2	1	6.3	6.3
1	0	0.0	6.3
0	0	0.0	6.3
	$n = 16$	100.0	

The mean (X) for the math posttest scores is $X = 10.69$. The most frequent obtained score in the upper quartile was 14 (87.5 %). The most frequent obtained score in the lower quartile was 6 (12.5 %).

Table 5

Formatted Frequency Distribution of Posttest ELA Scores for Figure 4.1.

Score (*X*)	*f*	%	Cumulative %
26	0	0.0	100.0
25	0	0.0	100.0
24	0	0.0	100.0
23	0	0.0	100.0
22	0	0.0	100.0
21	0	0.0	100.0
20	0	0.0	100.0
19	0	0.0	100.0
18	0	0.0	100.0
17	0	0.0	100.0
16	0	0.0	100.0
15	0	0.0	100.0
14	0	0.0	100.0
13	0	0.0	100.0
12	1	20.0	100.0
11	0	0.0	100.0
10	0	0.0	100.0
9	0	0.0	100.0
8	0	0.0	100.0
7	0	0.0	100.0
6	0	0.0	100.0
5	0	0.0	100.0
4	0	0.0	100.0
3	0	0.0	100.0
2	1	20.0	80.0
1	0	0.0	80.0
0	3	60.0	60.0
	n = 5	100.00	

The mean (*X*) for the ELA pretest scores is 2.8. The ELA scores obtained in the ELA pretest were very low. According to the scores obtained in the pretest, most participants recognized 0 letters. On the lower quartile, the most frequent score was 0 (60 %). On the upper quartile, the most frequent score was 12 (20 %).

Table 6

Formatted Frequency Distribution of Posttest ELA Scores for Figure 4.2.

Score (*X*)	*f*	%	Cumulative %
26	0	0.0	100.0
25	0	0.0	100.0
24	0	0.0	100.0
23	0	0.0	100.0
22	0	0.0	100.0
21	0	0.0	100.0
20	0	0.0	100.0
19	0	0.0	100.0
18	1	20.0	100.0
17	1	20.0	80.0
16	0	0.0	80.0
15	0	0.0	80.0
14	1	20.0	60.0
13	0	0.0	60.0
12	0	0.0	60.0
11	0	0.0	60.0
10	0	0.0	60.0
9	0	0.0	60.0
8	0	0.0	60.0
7	0	0.0	60.0
6	0	0.0	60.0
5	0	0.0	60.0
4	1	20.0	40.0
3	1	20.0	20.0
2	0	0.0	20.0
1	0	0.0	20.0
0	0	0.0	20.0
	n = 5	100.0	

The mean (*X*) for the ELA posttest scores is 11.20. The scores obtained in the posttest are much higher than the scores obtained in the pretest. This list is less skewed and more distributed than the list from the scores obtained in the ELA pretest. On the lower quartile, the percent is 3.5, on the upper quartile, the percent is 17.5.

Figures

Dependent Variables: Math Scores

		Paired Differences							
					95% Confidence Interval of the Difference				
Variable	Mean	Std. Error	Paired Pretest-Posttest Mean	St. Deviation	Lower	Upper	*t*	*df*	Sig. (2-tailed)
Pretest (No Treatment)	9.56	1.132	-1.125	3.07	-2.763	.513	-1.464	15	.164
Posttest (Treatment)	10.69	.938	-1.125	3.07	-2.763	.513	-1.464	15	.164

Figure 1. Math pretest and posttest scores comparison based on paired samples t-test.

Dependent Variables: ELA Scores

		Paired Differences							
					95% Confidence Interval of the Difference				
Variable	Mean	Std. Error	Paired Pretest-Posttest Mean	St. Deviation	Lower	Upper	*t*	*df*	Sig. (2-tailed)
Pretest (No Treatment)	2.80	2.33	8.40	6.11	-15.983	-.816	-3.075	4	.037
Posttest (Treatment)	11.20	3.22	8.40	6.11	-15.983	-.816	-3.075	4	.037

Figure 2. ELA pretest and posttest scores comparison based on paired samples *t*-test.

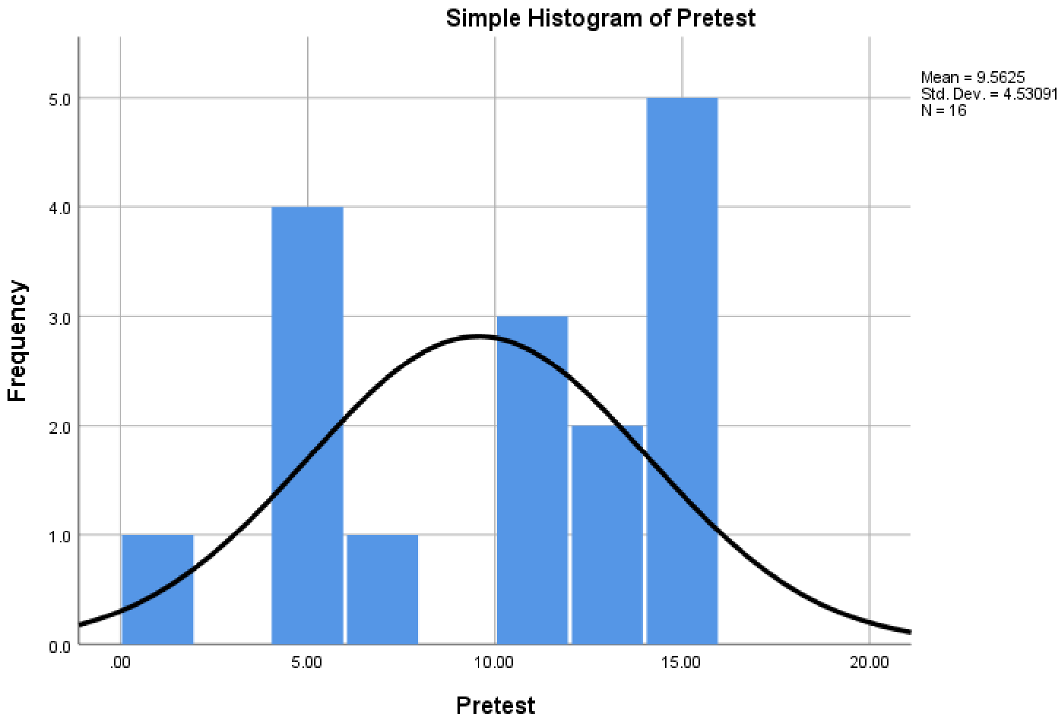

Figure 3.1. Simple Scattergram for Math Pretest Scores.

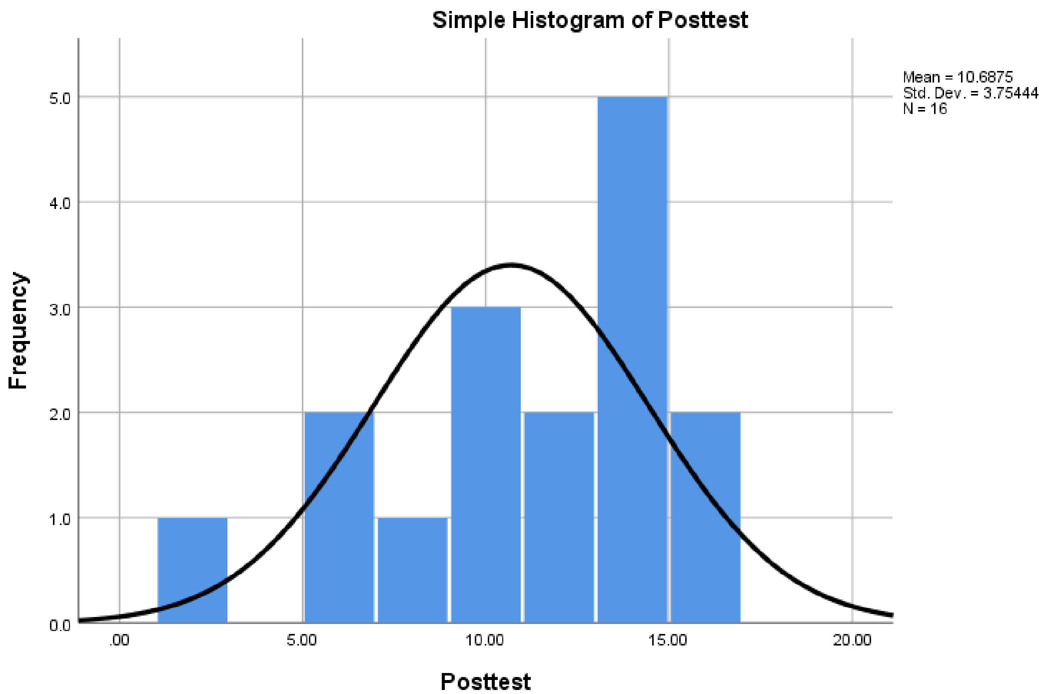

Figure 3.2. Simple Scattergram for Math Posttest Scores.

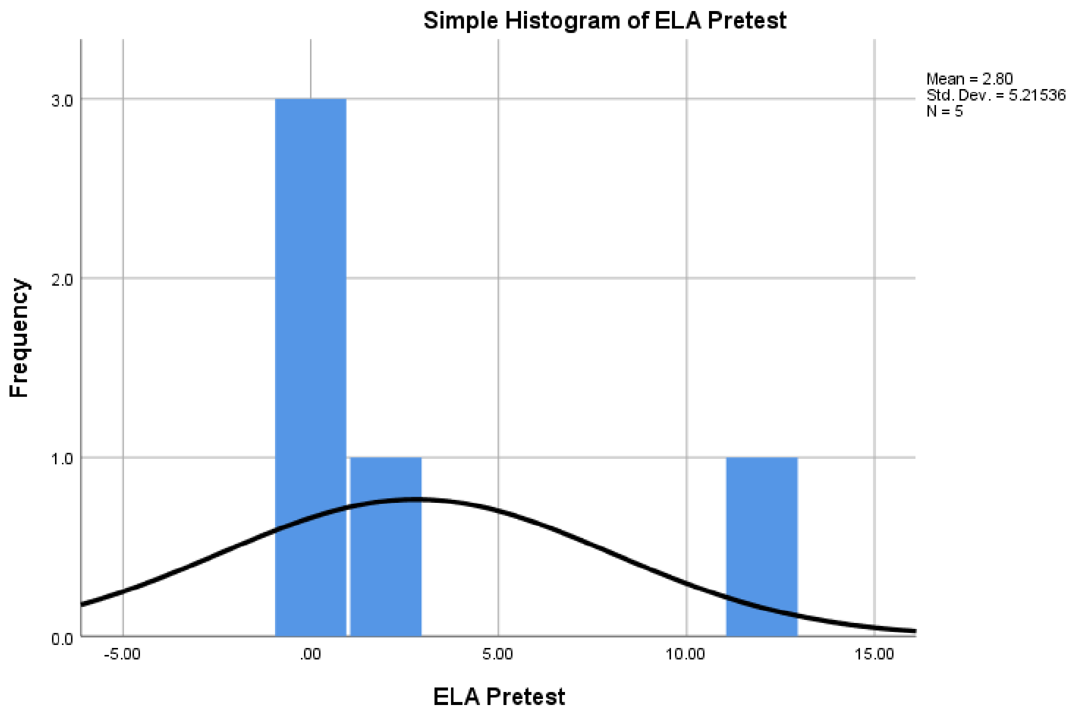

Figure 4.1. Simple Scattergram for ELA Pretest Scores.

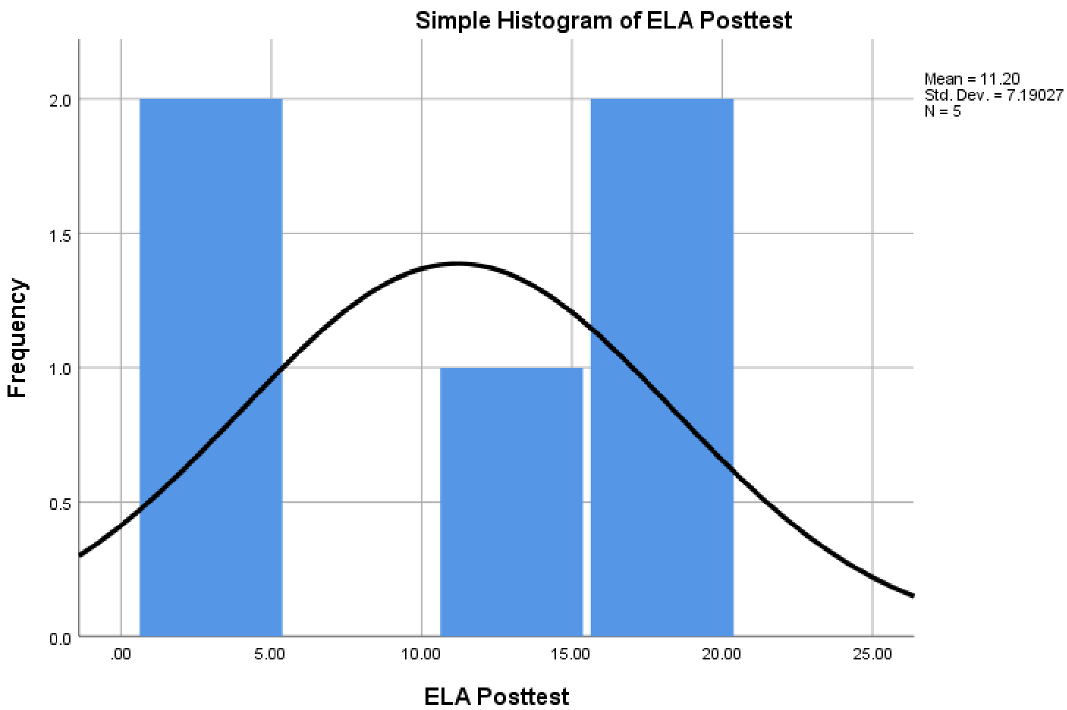

Figure 4.2. Simple Scattergram for ELA Posttest Scores.