The Effect of a Kinesthetic Curriculum on the Mathematics Achievement of Elementary English-Language Learners

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Abstract

There is a rapidly changing demographic of school-aged children in the United States. From 2003-2013 the percentages of English-language learners (ELL) in public schools grew from 8.7% to 9.2% (Ross et al., 2012). By 2025, one out of every four public school students will be an ELL (National Clearinghouse for English Language Acquisition, 2010). A growing field of research focuses on identifying best practices that support ELL’s in the classroom. Through best practices, teachers are able to meet the complex learning needs of ELL’s. The purpose of this study was to examine the effect of a kinesthetic curriculum on the mathematics achievement of fourth-grade ELL’s. After evaluating the effectiveness of the kinesthetic intervention, teachers had the opportunity to use best practices for ELL’s. A significant increase in mathematics achievement levels occurred following kinesthetic interventions. This could further help ELL’s to succeed in the classroom and on critical standardized achievement tests.

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The Effect of a Kinesthetic Curriculum on the Mathematics Achievement of Elementary English-Language Learners

English-language learners (ELL) across the United States confront many challenges when it comes to progressing in mathematics within the educational system. Teachers strive each day to implement best practices to meet the learning needs of ELL’s in all academic areas. Duffy, Furner, and Yahya (2005) noted that the increased diversity of students in the classroom expands each day. Therefore, teachers need to continually examine the research and keep abreast of diverse teaching strategies to reach all students. On a national level, the challenge for educators is to meet the demands of the No Child Left Behind Act. According to Zehr (2008), virtually all states continue to struggle in meeting the No Child Left Behind Act’s academic targets for ELL’s in mathematics and reading. Limitations in learning and achievement occur for ELL’s because cognitive work involves the use of a second language (Bresser, Melanese & Sphar, 2009). This second language barrier provides researchers and teachers reason to explore new and innovative ways to meet the needs of ELL’s.

Review of Literature

Educational Reform

The roots of standards-based educational reform lie in the educational philosophies of Benjamin Bloom and his work on taxonomy of educational objectives in 1956 (Fuhrman, 1993). The reforms that emerged from Bloom’s work gained momentum during Ronald Reagan’s presidency with the induction of federal objectives and goals highlighted in a report by the National Commission on Excellence in Education (1983) called A Nation at Risk. Since the publication of this report, expectations of student achievement progressed with the arrival of new reforms such as No Child Left Behind and the Race to the Top agenda (Ravitch, 2010).

These reforms completely changed the level of accountability within the present-day educational system. Educators had to create a new set of standards to encompass a complete framework makeover of the educational system (Mathis, 2010). Although state and federal governments mandated many changes, the task of constructing new frameworks for educators to work within resided with the school district. Furthermore, along with current reforms and accountability,
teachers had to create new constructs within the classroom to keep up with the demands and unrelenting focus on standardized achievement scores. With all of these mandates in place, it is imperative to equip teachers with current research, strategies, and interventions allowing them to focus on instructional practices to increase student achievement.

**Effect of Reforms on the Mathematics Achievement of ELL’s**

One group of students in particular most affected by the changed expectations for student performance on standardized mathematics testing is the ELL’s. Studies consistently find that among ethnic minority students in general, performance in mathematics achievement is significantly poorer than that of the majority population (Gross, 1993). Gándara and Hopkins (2010) found that ELL’s, especially those who live within states not accustomed to meeting their instructional needs, show lower academic achievement and lower graduation rates. Calderon, Slavin, and Sanchez (2011) suggested that students no longer labeled as ‘limited English proficient’ still struggle with different aspects of The English language, which affects their ability to succeed in academic subjects. Therefore, the problem ELL’s face with language proficiency affects all aspects of their academic life.

**Problems Facing ELL’s in the Classroom**

Researchers suggest several reasons why ELL’s continue to underachieve in the area of mathematics.

| Language barriers |

One reason for underachievement is the strong correlation between children’s English proficiency and mathematics performance (Schleppegrell, 2007). Students acquire conversational language skills much more quickly than mathematics language (Coggins, Kravin, Coates, & Carroll, 2007). According to Borgioli (2008), ELL’s who are in an English-speaking-only mathematics class will struggle with many mathematical problems that require a proficient understanding of the English language. Commonly attributed to learning deficiencies, the reality is a lack of understanding of the English language.

| Low socioeconomic status |

Another problem facing ELL’s involves their socioeconomic status. Understanding the backgrounds and experiences of ELL’s in any setting is important to their survival and success rate (National Council of Teachers of English, 2008). Although poverty is a factor underlying achievement for all
student groups (Aikens & Barbarin, 2008), regardless of ethnicity or primary language, its greater prevalence is in homes, schools, and communities in which ELL’s live and learn. This suggests a potential interaction of socioeconomic status with language and underlies achievement trends of language-diverse groups. Students and the exposure they encounter outside of the classroom could possibly affect the direct translation of their abilities to learning.

**Lack of modalities used**

In line with the language barrier issue, Lee, Lee, and Jiménez (2011) noted that mathematics uses a verbal form of communication, possibly limiting the learning of ELL’s in mathematics. Many educators believe that an understanding of the language of numbers is necessary for attaining proficiency in mathematics. As a result, students do not need proficiency in the English language to perform mathematics (Janzen, 2008). However, Schleppegrell (2007) showed that a strong correlation existed between the level of a student’s English proficiency and his or her mathematics achievement, thus verifying that ELL’s do need instructional interventions and instructional strategies to help them understand the meaning behind mathematical concepts, skills, and vocabulary. Lee et al. (2011) suggested that mathematics teachers of ELL’s should be acutely aware of their instructional strategies and the effects that they have on their students. Some students may show outward emotional signs of difficulty, but others may show no signs until asked to perform. Being proactive, as opposed to reactive in the academic realm of ELL’s is imperative to helping them succeed.

**Closing the Achievement Gap**

Studies continue to find very wide achievement gaps between those who are ELL’s and those who are able to speak the English language, thus signaling a need for interventions for both ELL students and the teachers (Calderon et al., 2011). The U.S. Department of Education reported that, in fourth-grade mathematics, there was a 21-point gap between Hispanic and White students (Ross et al., 2012). Educators must continue to be aware of deficiencies and disparities between the two groups in order to close the achievement gap.

To meet the needs of a diverse population, and in order to close the achievement gap between groups, it may be necessary to reformat the curriculum and the entire school. In the 1990’s, a program entitled ‘Success for All’ restructured the entire school (Calderon et al., 2011). Most effectiveness studies use this approach as a model in how to restructure a school for effective learning (Calderon et al., 2011). Language and literacy development, tutoring programs, staff development, and parental involvement can also aid in closing the achievement gap (Calderon et al., 2011).
Werner (2001) found that the reason why ELL’s were not performing well in mathematics was their lack of vocabulary comprehension and time allotment during standardized test taking. Werner (2001), along with Skoning (2010), Carter (2004), and Pica (2009) suggested that ELL classrooms using movement to teach mathematics could help ELL’s succeed. Skoning (2010) noted that a kinesthetic approach to academics allows teachers to meet the diverse needs of all students by enabling students to connect the academic language with movement.

Block, Parris, and Whiteley (2008) investigated the effects of adding a kinesthetic learning aid to increase third-grade students’ reading comprehension and metacognition in phonics, vocabulary, and fluency. The experimental group reported a mean score on the Stanford Achievement Test–9 of 77.1 (SD = 4.4). This figure was significantly higher than that of the control group at 73.6 (SD = 6.7) (Block et al., 2008). This suggests that kinesthetic intervention can have a significant effect on student learning. However, the study did not provide any evidence of improvement in mathematics, nor were there any data describing the effects that it had on ELL’s as a subgroup. Although the data do provide clear evidence that kinesthetic interventions can improve academic progress, as determined by the standardized assessment mentioned above, the information lacks any indication as to its ability in mathematics or for ELL’s.

Gardner (1983) sought to answer the following question: Is intelligence a single thing or various independent intellectual faculties? In the introduction of his classic work called *Frames of Mind*, Gardner (1983) refuted the ideas of the psychometric and behaviorist eras, wherein intelligence was seen as a single entity. On the contrary, Gardner pointed out the following:

> Nowadays an increasing number of researchers believe that there exists a multitude of intelligences, quite independent of each other; that each intelligence has its own strengths and constraints; that the mind is far from unencumbered at birth; and that it is unexpectedly difficult to teach things that go against early “naïve” theories that challenge the natural lines of force within an intelligence and its matching domains. (p. 13)

Keeping in mind Howard Gardner’s idea that a multitude of intelligences exist, it could be possible that movement allows for different intelligences to manifest within a kinesthetic curriculum. Through a kinesthetic curriculum, students experience what they learn by way of movement, thus opening a possible doorway for providing ELLs with the tools needed to strengthen their intelligences and academia. Barron (2010), a dance choreographer, stated that these different ways to be smart represent ways of looking at the world that can become doorways to understanding when teachers consciously include differentiated learning strategies in the classroom.
Theoretical Framework

Although some interventions may be working, gaps between ELL’s and non-ELL’s, in both mathematics and language arts remain statistically significant (Zehr, 2010). As Zehr (2010) noted, the 2009 fourth-grade data of the National Assessment of Educational Progress indicated that only 7.5% of ELL’s scored proficient in reading, whereas 35.5% of non-ELL’s were proficient. This disparity suggests that curriculum and instructional design alterations are necessary in order to benefit ELL’s. Within the classroom, kinesthetic interventions could be an alternative to meet some of the needs of the individual ELL’s who are struggling to meet the standards across the United States.

With little to no increase in the fourth-grade ELL’s mathematics standardized achievement scores at the research school, this study sought to focus on students’ independent intelligence with a kinesthetic approach to learning mathematics. The average fourth-grade ELL’s mathematics proficiency rate on the state standardized assessment at the research school had remained stagnant for three years at 67%. More recently, the proficiency rate decreased an additional six percentage points to 61%.

The following research questions guided this study: (1) what was the effect on mathematics achievement for ELL’s who used a kinesthetic approach to learning as compared to their peers who did not, as measured by the EASYCBM? (2) How did a kinesthetic mathematics curriculum affect the differences between male and female ELL student performance, as measured by the EASYCBM? (3) How did a kinesthetic mathematics curriculum affect the differences between ELL’s from low socioeconomic backgrounds when compared to their peers who are not from low socioeconomic backgrounds, as measured by the EASYCBM?

Methodology

Participants

Participants were fourth-grade students ages 9 and 10, in a large suburban elementary school in the southeastern United States. The experimental group consisted of 20 ELL’s (10 females and 10 males) who received a kinesthetic curriculum through a pullout program where they received mathematics instruction using only a kinesthetic approach. The control group consisted of 20 ELL’s (10 females and 10 males) who received only traditional mathematics instruction. Both the control and experimental group were matched based on gender. Two certified teachers provided instruction. One provided regular mathematics instruction and the other provided kinesthetic-based mathematics instruction.
The ELL’s in the sample were of Hispanic, Asian, Black, and Latino descent. With the fourth-grade ELL’s already set up in inclusive classrooms, the researcher chose to use a convenience sample. The researcher distributed and collected signed permission forms from parents who gave permission for their children to participate in the research. The English proficiency levels of ELLs in the study identified through a language proficiency test as Non-English Speaking (NES), Limited English Speaking (LES), or Fully English Proficient (FEP). The ELL’s different levels of English proficiency may have affected the internal validity of the research.

Instrument

Data from the EASYCBM assessments were inclusive of algebra and math number operations for the fourth-grade ELL’s sampled. The ‘Curriculum Based Measures’ (CBMs) assess the degree to which students master the skills and knowledge critical at each grade level (Farley, Irvin, Fei Lai, Saven, & Wray, 2009). A passing score on the EASYCBM is 60. The school district in which the study took place uses EASYCBM to assess growth and achievement during the academic year. It also determines if a student is below or at grade level.

Procedures

Design

The intent of this study was to compare an experimental group who received kinesthetic-based mathematics instruction to a control group who received nonkinesthetic-based mathematics instruction over a 16-week period. After the Institutional Review Board approved the research proposal, the researcher submitted a letter to the superintendent of the school district and the principal of the research school seeking permission to conduct the study. The researcher implemented a quasi-experimental design. Data was compared between the experimental and control group. The experimental group received kinesthetic interventions during mathematics instruction that occurred in the same setting and at the same time twice a week. The two groups received the same instructional program with the exception of the experimental group who received kinesthetic-based lessons. Lessons developed and taught to the experimental group aligned with the school district’s mathematics curriculum and the Common Core Standards. Skills taught during this period were inclusive of operations and algebraic thinking, number and operations in base ten, and number and operations-fractions.
Data Analysis

The researcher collected data from the EASYCBM mathematics assessment scores at the beginning of the study. Upon receiving results from the assessments, the researcher completed statistical analysis through descriptive statistics and developed three hypotheses from the data set. Research Question 1 sought to determine if there had been an increase or decrease in mean achievement scores between the experimental and control groups by examining EASYCBM data and inferential statistics.

Research Question 2 sought to determine if there were any gender-related changes in scores between those receiving kinesthetic intervention and those who did not through the examination of EASYCBM data and descriptive statistics. Research Question 3 sought to determine if there were any increases or decreases in scores, as determined by socioeconomic status, between the control and experimental groups by examining EASYCBM data and descriptive statistics.

Results

The researcher completed an $F$-test to determine if the variances between the experimental and control groups were equal before completing the $t$-Test. Data from the $F$-test indicated that the variances were homogenous, $p > .05$. The researcher applied an unpaired $t$-Test assuming equal variances to determine if the posttest data was significant. A statistically significant difference existed between the groups posttest scores, $p < .05$.

All students in the experimental group (100%) showed an increase in mathematics achievement as measured by the EASYCBM. Nine of the students (45%) in the control group showed an increase in mathematics achievement as measured by the EASYCBM. Three of the students (15%) in the control group did not increase or decrease in achievement level as measured by the EASYCBM.

Upon examination of the data, the experimental group pretest mean (60.6) and posttest mean (80.1) showed an average increase in achievement level of 19.5 points (See Table 1). Data also revealed that the control group pretest mean (69.5) and posttest mean (72.2) had an average increase in achievement level of 2.7 points (See Table 1).
Further analysis of the data showed that both groups made mathematical gains in achievement. However, the experimental group on average made greater gains. In addition, the data revealed was statistically significant $t(38) = 2.28$, $p < .05$, with the experimental group average increase of 16.8 points more than the control group after the 16-week kinesthetic curriculum implementation. Both female and males took a pretest before the implementation period and a posttest at the conclusion of the implementation. Data revealed the male experimental group pretest mean (64.2) and posttest mean (82.9) differed by 18.7 points. The male control group pretest mean (74.5) and posttest mean (73.6) differed by .9 points. The female experimental group pretest mean (57) and posttest mean (77.3) differed by 20.3 points. The female control group pretest mean (64.5) and posttest mean (70.8) differed by 6.3 points. Data revealed that both female groups increased their achievement between pre- and posttest assessments.

The female experimental group pretest mean (57) and posttest mean (77.3) differed by 20.3 points. The female control group pretest mean (64.5) and posttest mean (70.8) differed by 6.3 points. Data revealed that both female groups increased their achievement between pre- and posttest assessments.

The low SES experimental group pretest mean (56) and posttest mean (78.3) indicated an increase of 22.3 points. The low SES control group pretest mean (64) and posttest mean (67) indicated an average increase of 3 points. Thus, the low SES experiment group had an increase in achievement scores, which was on average 19.3 points greater than the low SES control group. The non-low SES experiment group pretest mean (67.5) and posttest mean (82.9) revealed an increase of 15.4 points from pretest to posttest. The non-low SES control group pretest mean (77.6) and posttest mean (79) indicated an average increase of 2.3 points. Upon examination of the data between students of low socioeconomic status and non-low socioeconomic status indicated that all groups increased in achievement levels. However, the low SES experiment group increased on average by 22.3 points, while the non-low SES experiment showed a smaller increase of 15.4 points. Data from the low SES control group showed an increase of 3 points, while the non-low SES control group also showed a smaller increase of 2.3 points.

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<td>Experimental Group</td>
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Note: Passing score on the EASYCBM is 60.
Discussion

Results of the study indicated that the experimental group’s average achievement scores after the posttest was higher compared to those of the control group. This is consistent with Block et al.’s (2008) study, which assessed the effect of kinesthetic learning aids on students. Furthermore, results were similar to those found by Carter (2004), which suggested students had higher achievement levels when movement was part of the curriculum. The experimental group, which received the mathematics kinesthetic curriculum, showed achievement across the spectrum, with not a single student decreasing or remaining stagnant in achievement.

These results suggest that a mathematics kinesthetic curriculum may help students to perform better. Students participating in the experiment participated in academic activities more when they included movement. Furthermore, students in the experimental group may have had higher self-perceptions of their mathematics ability, which improved their mathematics aptitude and ability to perform better than the control group on the EASYCBM assessment. McGraw, Lubienski, and Strutchens (2006) found a difference in achievement by gender, with males outperforming females on both pretest and posttest measures.

Borgioli (2008) also noted that males have a slight advantage in mathematics achievement in Grades 3 to 5. However, the data did reveal that the females in the control group had an increase of 6.3 points on average, whereas the male control group actually decreased in points on average by .9 points. This could be because male ELL’s are complacent within the traditional mathematics curriculum, they are not motivated to learn because of the presentation of material, or the interventions that the teachers are using are not working with male ELL’s in mathematics.

The results of the study were consistent with those of Aikens and Barbarin (2008) that noted lower achievement in the low SES group. In this study, students in the low SES group of ELL’s scored an average of 13 points lower than the non-low SES group of ELL’s. However, findings suggest that when kinesthetic interventions occur, low SES students can make just as many gains as non-low SES students. Gains made by the low SES experimental group were on average 6.9 points higher than those made by the non-low SES group were. After the posttest, the disparity between the low SES and non-low SES experimental groups had closed from 11.5 points to 4.6 points. These results are similar to those of Borgioli (2008). Lessons taught with kinesthetic interventions provide ELLs the opportunity to improve academic achievement regardless of gender or SES.
Conclusion

A kinesthetic-based approach to mathematics affords students considerable benefits. Use of such methods provides a different way of learning mathematical concepts and skills. These benefits are inclusive of mathematics enrichment, social academic experiences, learning through a different part of the brain, and supplementing the existing mathematics curriculum in an enjoyable manner. The benefits of kinesthetic-based approaches to mathematics may extend beyond ELLs to other groups of students having trouble with mathematics.

References


