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Improving Understanding of Mathematics Concepts in Kindergarten Students through Movement Integration

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Capstone Project: An Action Research Project

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Abstract

This action research project stemmed from the noticeable benefit of movement woven throughout the Wilson Fundations curriculum in developing early phonemic awareness. Knowing that kindergarteners have a natural inclination to move, this project aimed to determine whether similar benefits of movement could be garnered in mathematics instruction by boosting number sense and fact fluency. Participants completed an end-of-unit assessment and then received instruction with movement integration for the following unit before completing its end-of-unit assessment. Assessment scores were converted into the school's grading scale of M, W, or B, and a chi-square test of association was used to determine statistical significance. Findings revealed a significant association between movement integration in kindergarten mathematics instruction and improved assessment scores. The research was conducted in hopes of improving teaching practices in kindergarten mathematics through use of movement integration, and the findings indeed impact both teaching and learning by affirming movement integration as a useful intervention strategy.

Keywords: kindergarten, movement integration, mathematics instruction, number sense, fact fluency

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Introduction

Researchers have long agreed that in early childhood and elementary classrooms, "learning can benefit from movement" (Shoval et al., 2018). The types of movement and learning, as well as the specific benefits, however, vary by age, grade, and content area and can be influenced by several factors such as duration of movement integration and environment. Therefore, honing in on a specific grade level and content area proves to be an effective way to identify more clearly whether learning benefits from movement integration and, if so, in what ways. In an article examining the effects of movement integration in elementary school classrooms, for instance, researchers concluded that "10-minute and 20-minute MI [movement integration] breaks were enough to obtain improvements in students' performance in math" (Goh et al., 2018). The elementary grades, however, encapsulate anywhere from five to seven grades depending on the school, so tailoring research specifically to kindergarten lends itself to a more targeted approach in identifying the type of movement and strategies for integration that lead to optimal benefit.

For years, the Wilson Fundations curriculum has provided early childhood and elementary students with an approach to learning early literacy skills using "multi sensory activities meant to heighten phonemic awareness" (Florida Center for Reading Research, 2015). This multi sensory approach remains useful because it provides students with an opportunity for a "visual and kinesthetic demonstration of learning" that allows learners more than one mode of making sense of and demonstrating an understanding of new information (Shoval et. al., 2018). In other words, the kinesthetic component capitalizes on the inclination of children to move around by tying the learning to the movement itself. While plenty of research exists backing up

the benefits of movement integration in literacy instruction such as the Wilson Fundations curriculum, similar research in mathematics instruction is scarce. The problem, therefore, is that kindergarten students have a desire—and need—to move, yet weaving structured, productive movement into a classroom setting can lead to a management and overall counterproductive struggle if not done effectively. Harnessing the benefits of movement is possible, as Wilson Fundations has shown, but translating and applying similar research as well as realistic strategies in mathematics instruction is necessary.

The purpose of this action research is to determine whether or not integrating movement into kindergarten mathematics instruction will boost student engagement and, consequently, understanding of content. Knowing that the five and six-year-old body naturally seeks frequent movement throughout the day and especially during periods of concentrated learning, this research aims to apply the same methodology that informs the incorporation of kinesthetic learning to boost phonemic awareness to mathematics instruction in hopes of improving number sense and fact fluency. This research benefits educators seeking ways of helping students develop solid number sense and fact fluency in kindergarten through movement that contributes to sustained engagement during lessons.

Movement integration in any kindergarten lesson has the potential to be highly useful because it allows students the opportunity to "use their bodies to represent key academic terms and ideas, as well as demonstrate their understanding of those ideas" at a crucial developmental stage in which they are acquiring more bodily awareness (Lindt & Miller, 2017). It therefore provides an interdisciplinary method of instruction that, in addition to strengthening learning itself, contributes to students' recommended physical activity for the day as well as "boosts

interest levels, which supports greater sustained attention to lessons, allowing them to learn more effectively and commit concepts more easily to long-term memory" (Lindt & Miller, 2017). Additionally, this intervention lends itself particularly well to easy integration in any classroom, as adaptations and accommodations for diverse learners are not only easy but also likely benefit the needs of such learners.

This action research project will compare student assessment scores from units taught with and without movement integration to determine whether or not movement impacts engagement and understanding. Using data from student assessments as well as qualitative data analysis, this study will unveil the positive impact of incorporating movement into mathematics instruction using simple movements such as jumping jacks, clapping, rolling, tapping, and stepping. In doing so, this project will aim to draw parallels between existing, acknowledged benefits of movement integration in literacy instruction and new mathematics teaching strategies rooted in movement.

Though researchers and educators both seem to acknowledge that benefits of movement integration exist, conclusions about specific benefits and how to acquire them most productively are lacking. That being said, some curriculums have made use of these benefits by adapting them to specific subject areas, such as Wilson Fundations, though these are largely literacy-based. The literature review will explore benefits of movement, math instructional strategies in kindergarten, and learning needs of kindergarten students to connect all of these areas together in a way that foregrounds the action research to show the effectiveness of incorporating movement in kindergarten mathematics instruction for improved engagement, understanding, and fundamental number sense and fact fluency.

Review of the Literature

Children need opportunities for physical movement throughout the day. Instead of causing a disruption to learning and creating a classroom management issue, however, movement can be intentionally integrated into elementary lessons to enhance instruction. Ample research has been conducted on benefits of movement in elementary classrooms, and this literature review seeks to highlight some of the more general benefits as well as more widely acknowledged impacts of movement, such as increased interest in content and attitudes towards school. Because this action research project aims to delve specifically into kindergarten mathematics, this literature review also reveals substantial research pointing to fine motor development, increased interaction with academic content, and ways in which kindergarten students benefit uniquely from movement integration in mathematics instruction as opposed to their older, elementary-aged peers. Looking first at movement in general elementary classrooms and then moving to kindergarten mathematics, this literature review aims to create a foundational understanding of movement integration and the goals of kindergarten mathematics instruction before painting a clearer picture of why movement and multimodal instruction instruction are especially suited for the kindergarten classroom and lead to developmental growth.

Movement Integration in the Elementary Classroom

Integrating movement into elementary education teaching practices has long served as a strategy for effective content delivery because its purpose is simple—kids like to move. In other words, young learners have a desire and need to move, so finding ways to build movement into otherwise long periods of seated instruction offers a needed reprieve. Besides satisfying this urge to move, however, are several scientific and research-backed reasons supporting movement

integration in elementary school classrooms including heightened interest, increased motivation, and improved test scores in classrooms relying on frequent movement during instruction (Lindt & Miller, 2017).

In a study examining the effect of movement on student interest towards content, Lindt and Miller (2017) compared outcomes of movement and non-movement lessons in second and third grade math classes taught by four different teachers. After being trained in movement integration as well as in rating student interest levels using direct observation and retrospective videos, the four teachers employed strategies such as dancing to learn information, applying movement to content assessment, and station rotations. Results showed "significantly more" excitement, engagement, and sustained focus from students in lessons that incorporated movement (Lindt & Miller, 2017).

In addition to improving interest, motivation, and focus, movement can lead to higher levels of academic achievement. Indeed, in a study looking at the effects of GoNoodle Brain Breaks on reading fluency in elementary classrooms, researchers determined that physical activity serves as the necessary link for "improving reading fluency, accuracy, and comprehension in the classroom and closing the widening achievement gap" (Wold et al., 2023). Participants in this study included 384 students in either second or third grade among 16 classes from four different Title One public elementary schools in the American West. After breaking the classes into two groups—eight using brain breaks and eight not engaging in intentional movement—researchers administered the DIBELS reading assessment following reading instruction and, in the movement group, following a GoNoodle Brain Break. Notable conclusions included "pronounced effects" on reading fluency measures immediately following

physical activity as well as improved brain function and executive cognitive processes (Wold et al., 2023). Such effects include improvement in the three areas that researchers assessed following the movement including words read per minute, reading accuracy, and words retold, and improvement in executive cognitive processes supports the notion that movement can impact developmental growth as students become more adept at processing new information (Wold et al., 2023).

Studies have also sought to compare the efficacy of physical activity breaks with breaks from learning that offer a reprieve from instruction but do not target physical activity. Even then, however, breaks including physical activity yielded greater effects on academic achievement than academic-based breaks or periods of free time in the classroom. One such study analyzed the reading achievements of 460 third through fifth grade students that were broken into groups depending on whether their classrooms relied on physical activity during learning breaks or simply allotted for free time or structured academic breaks. Researchers Fedewa et al., (2018) discovered “small to moderate effect sizes (ES)” indicating gains in reading achievement in classrooms using aerobic-only movement breaks. They looked specifically at reading achievement, which had an ES of 0.13, which qualified as a larger gain in reading achievement than participants who did not engage in physical activity brain breaks (Fedewa et al., 2018). Though both the study conducted by Wold et al., (2023) as well as that of Fedewa et al., (2018) express findings rooted in literacy and reading, their results nonetheless offer a starting point for similar research in how such benefits can be garnered in math using similar movement strategies.

Benefits of movement integration in learning in elementary classrooms exceed academic achievement. Though academic performance consistently improves with movement, empirical

evidence points to improved physical and mental health, executive functioning, memory, and on-task behavior as additional areas that benefit from physical activity in the classroom and during instruction (Savina et al., 2016). This evidence proves to be significant because improved physical and mental health lend themselves to strong academic performance over time by decreasing absences due to illness or interferences with learning, and executive functioning, memory, and on-task behavior are all vital elements necessary for success in elementary school. Several more studies were consulted to explore these areas and look for not only additional benefits of movement but potential connections between academic achievement, motor development, and social-emotional competency gains when movement integration occurs within elementary instruction (Mariana et al., 2023; Moon & Webster, 2019; Shah et al., 2018; Vetter et al., 2020).

Kindergarten Mathematics

Mathematics instruction in kindergarten classrooms is specific and nuanced, unlike the early elementary grades that follow it and share commonalities. For example, kindergarten math typically revolves around the ten frame and developing fact fluency to five as well as secure early number sense and identification. In contrast to first grade and beyond—grades that delve into topics like place value and simple addition and subtraction—kindergarten math aims to instill a sense of fluency and automaticity in number recognition as well as foundational skills for the years to come. With that being said, the teaching practices that support successful kindergarten mathematics instruction are tailored to these specifics, and looking at those strategies that have proven to be especially useful is helpful when identifying which, if any, movements may yield a better understanding (Bottia et al., 2014; Deringöl et al., 2021).

In a large-scale study involving over 15,000 kindergarten students across the country, for instance, researchers Bottia et al., (2014) sought to understand how kindergarten teachers' instructional practices differentially affected the mathematics achievement of kindergarten students' math academic readiness. Using a series of multilevel modeling techniques using data from the Early Childhood Longitudinal Study (ECLS-K), researchers worked with teachers across the country to incorporate 46 curriculum variables in kindergarten mathematics instruction. Among these variables were movements such as jumping jacks, clapping, patting, and stepping, all of which were integrated into instruction in different ways depending on the needs of the given class, i.e. some movements were integrated during instruction, while others took place during learning breaks (Bottia et al., 2014). Conducted over six moths and in three stages meant to allow for pre-testing, experimentation, and post-testing, researchers ultimately concluded that movement can be especially beneficial when implemented at the whole group level as opposed to small groups or individuals. Given the scale of this study, the findings are broad and difficult to parse through to identify specific data points related to this action research other than providing support for movement at the whole group level (Bottia et al., 2014). Therefore, further analysis into kindergarten mathematics instructional practices provides insight into how exactly movement benefits learners at this age and grade level.

Other studies involving mathematics instruction at the elementary level have focused less on the teaching strategy and more on the grade level itself, as the foundation of mathematics instruction often proves to be predictors of future success in the subject. One study, conducted by Clarke et al., (2022), sought to test the efficacy of a Tier 2 kindergarten mathematics intervention program (ROOTS), honing in on not only the intervention but also the grade level. Researchers

assigned 62 classrooms to either participation in the ROOTS program or to the control group entailing mathematics instruction as normal and relied on a pretest and post test to evaluate effectiveness. ROOTS intervention consisted of 50 lessons throughout the school year that took the place of the standardized curriculum being used in both the experimental and control group classrooms (Clarke et al., 2022). In other words, all classrooms used the same math curriculum, and the ROOTS program served as an intervention component of the curriculum that could be used to supplement lessons for struggling learners. Statistical analysis revealed a 0.08 difference in Hedge's g values between treatment and control conditions, ultimately indicating significant positive effects related to targeted intervention math instruction in kindergarten (Clarke et al., 2022).

Similar to the benefits of targeted intervention are the positive results accompanying early math assessments aimed at proactively addressing specific learning needs in kindergarten. Whereas ROOTS intervention seeks to compensate for learning gaps, the early math assessments discussed in a study conducted by McDonald et al., (2021) aimed to identify where kindergarten students fell along a "developmental continuum of mathematical understanding" in an effort to tailor instruction to student needs so as to ensure they leave kindergarten with a strong foundation in mathematical concepts. Unlike the ROOTS intervention study, however, this study spanned three school years and therefore provides more nuanced and comprehensive data supporting this strategy. A different cohort served as the participants in each year of the study, though all three cohorts were comprised of 25 kindergarten classes from eight schools and anywhere from 50 to 60 educators. Two assessment tools were used—the Give-N Task and the Numeracy Screener—both of which are reliable and valid assessments meant to evaluate

students' numerical magnitude processing and spatial reasoning (McDonald et al., 2021). Between the two assessments, students completed four tasks on number comparison, number ordering, shape composition, and mental rotation, and educators recorded answers in assessment booklets.

The results showed that on average, 20% of kindergarten student participants were identified as not yet having achieved a level of numerical understanding and spatial reasoning that would allow them to move through a kindergarten math curriculum with ease and sufficient understanding (McDonald et al., 2021). This information is helpful because it identifies students needing support in math instruction. Whereas the ROOTS intervention study highlights an effective intervention method, this study suggests a helpful framework for identifying those students who would benefit from such intervention and advances the argument for the importance of specific, targeted math instructional strategies for kindergarten students.

Kindergarten Movement and Multimodal Instruction

Though the positive impacts of movement vary across the elementary grades and may include benefits such as greater sustained attention and interest, academic achievement is at the forefront of those in kindergarten. In a study conducted by Shoval et al., (2017), researchers sought to "challenge" the separation between movement and academic learning that often occurs during research on movement by instead integrating body movement in a learning environment that allows the children to choose their own movement activities. The study consisted of 160 kindergarten students from independent kindergartens within the same district, and participants were divided into three groups differing by learning conditions. The first group consisted of 61 students and incorporated mindful movement, the second group consisted of 54 students and

employed movement for its own sake, and the third group consisted of 54 students and served as the control group (Shoval et al., 2017). In both of the experimental groups, students participated in 90 minutes of movement activity. Teachers in the first group—the mindful movement group—integrated mindful movement with academic learning across 90 minutes of instruction. The second group offered students several activity options to choose from for 90 minutes including socio-dramatic and academic learning workshops with movement integration, i.e. writing numbers on shelves of climbing equipment and obstacle courses. The control group participated in the 45 minutes of unstructured free play outside that is standard for kindergarten classes across the district and spent the rest of the day focused on academic learning (Shoval et al., 2017).

In contrast to this study, Shimek (2020) researched kindergartners' multimodal transactions with a nonfiction picture book to determine how multimodal movement impacts learning in kindergarten. Using Rosenblatt's transactional theory of reading and a social semiotic approach to multimodality, Shimek used observation and video recordings to track student interaction with read aloud text. Though not rooted in intentional physical movement like other studies, this research is, nonetheless, significant because it highlights the natural inclination of young learners to engage in movements while taking in new content. The study looked at a kindergarten classroom comprised of 20 students and one teacher and aimed to trace the physical movement interactions during nonfiction read alouds and independent reading using interviews with students and the teacher, photos, document collection, field notes, and methodological memos. Shimek (2020) details how interactions such as the following were flagged during data analysis for further analysis: "quick and staccato pointing with his right hand on the image of the building" with "his head nodding up and down and his exclamation" as well as "ways the boys

used their bodies as a part of their negotiation of understandings" through "gaze, gesture, and proxemics."

Despite the considerably different subject matters of Shoval et al., (2017) and Shimek (2020)'s studies, the findings and discussions share striking similarities. Shimek's research is largely rooted in observation as opposed to numerical, quantitative data but comments on how all of the kindergarteners observed read books with their bodies, meaning they interacted with the text using some form of movement rather than simply reading the text aloud with their voices. This interaction, Shimek (2020) suggests, underscores a behavior that is "often overlooked as an essential part of the curriculum" and "the importance of mind and body connection in learning." These findings corroborate those of Shoval et al., (2017), which support the claim that mindful movement environments stimulate more academic thinking. Researchers used a one-way ANCOVA on the MAT test to determine a significant learning condition effect wherein the children in the mindful movement group—those who integrated structured movement into their academic learning scored higher than the other two groups on both the reading achievement and sequencing assessment tests. Researchers then discussed how the children exposed to mindful movement reached significantly higher achievement levels and improved overall in assessment scores, aligning with Shimek's (2020) conclusions about the necessity of connecting the mind and body during the learning.

Developmental and Motor Benefits of Movement

Benefits of movement integration may look different across grades and affect different areas of achievement, but, regardless of elementary grade or age, the research also suggests that such integration has developmental and motor benefits. Goh et al., (2018), for instance, looked at

on-task behavior in elementary students during movement integration and sought to determine whether on-task behavior increases with movement integration, implying developmental growth in the ability to sustain attention during learning. The participants in this study came from four elementary schools and were comprised of 233 students from 11 different classrooms ranging from first to sixth grade. This study sticks out among others because of collaboration between researchers and the schools' physical education teachers to provide training to classroom teachers on movement integration prior to data collection to ensure all teachers were adept at integrating movement and doing so uniformly during collection (Goh et al., 2018). Participating teachers integrated one 15 minute physical activity during the day for four weeks in the classroom, and five trained observers recorded on-task behaviors using systematic observation methodology. Movement integration began after a four week period of baseline data collection. Using two-way repeated measures ANOVA, researchers determined that students' on-task behavior during baseline lessons decreased by 8.7% by the end of the lesson, whereas no significant change occurred during the lessons with movement integration, indicating notably greater sustained on-task behavior (Goh et al., 2018).

A similarly conducted study shared equally positive results but highlighted how physical activity can promote working memory and motor competence in young learners. Researchers studied four classes of preschool-aged children—two classes received 12 weeks of physical activity intervention during academic instruction, and the other two classes went about their daily routine as normal—and used the 1-back task and Movement Assessment Battery for Children, second edition to measure both working memory and motor competence before and after the 12 weeks of intervention (Zhang et al., 2022). Results showed that working memory, manual

dexterity, aiming and catching, and global motor competence all improved after the the implementation of physical activity (Zhang et al., 2022). Conversely, however, Kercood et al., (2007) honed in on the effects of fine motor movement and tactile stimulation on students with attention problems and found no significant difference in achievement or on-task behavior with movement integration. The scope of the study was limited though, as researchers only looked at four nine-year-old students in fourth grade that had ADHD. All four students participated in general education classrooms and, through the study, received a 20 minute session of physical activity for four sessions before completing an assessment that was compared to baseline data. Two of the four students performed better on fine motor and tactile stimulation tasks, improving by 55% and 45% respectively, while there was no notable change in the other two students. Additionally, researchers did not find any data showing either an increase in on-task behavior or decrease in off-task behavior following physical activity intervention (Kercood, 2007). This study contrasts the findings of several of the aforementioned studies but is also the only one to look specifically at students with ADHD.

Finally, researchers have also looked for a connection between movement integration and social-emotional competency. This link could be significant because an increase in social-emotional competency in kindergarten can improve students' perceptions of themselves as learners and ability to approach difficult tasks in school with a developmentally appropriate mindset. In other words, a kindergartener struggling in math may develop feelings of dislike for school or negative opinions of his ability to succeed if his social-emotional competency is lacking. Researchers Moreira et al., (2023) explored the relationship between the physical activity and motor and social-emotional competence by measuring and comparing the motor

skills and social-emotional characteristics of children from two different kindergarten classrooms, one with physical activity integration during instruction and one without intentional movement. Motor competence was measured with the motor competence assessment (MCA) and social-emotional competence was gathered through pro-social behavior, peer problems, and externalizing behaviors described on a questionnaire completed by parents (Moreira et al., 2023). MCA scores were nearly 70% higher for children attending the kindergarten with physical activity integration, but social-emotional competency proved to be unaffected by physical activity. That being said, there was no evidence suggesting that social-emotional competence declined or was correlated with motor competence, so researchers concluded that it is not harmful, though more research on the subject would be necessary for a better understanding (Moreira et al., 2023).

Methodology

This action research study sought to answer the following research question: how can movement integration be employed as a strategy for boosting student engagement and understanding in kindergarten math lessons? To answer this question, research unfolded in a kindergarten classroom where the entire class served as participants. The setting for this action research is a kindergarten classroom at a private preschool through grade 12 school in the American Northeast. The kindergarten is comprised of 87 students separated into five classes with two teachers, all of which follow the same curriculum. The classrooms are set up similarly and conduct math lessons for the same amount of time at the same time each day. The classroom being used in this study has a large open seating area in front a SmartBoard that students sit in front of during mathematics lessons before returning to their tables that seat groups of three to

five students for independent or group work. This open areas allows for ample unrestricted movement.

The participants included 18 kindergarten students, nine girls and nine boys. 14 of the students came from the school's preschool program, which uses the same math curriculum as well as has a heavy emphasis on movement through its music and movement program. Careful consideration is given during placement to ensure an even distribution of gender, birth month, academic strength, and sibling order among the five kindergarten classes, so this class of 18 students represents an evenly distributed group of learners in each of these categories. All 18 students are physically able to participate in the movement activities without support. Three students receive mathematics intervention for twenty minutes three times per week, and nine of the students receive academic support for literacy skills through the school's developmental learning program. At this point in the school year, fifteen students are six years old, two are five years old, and one is seven years old.

The independent variables in this study are the math and literacy curriculums being used as well as the movement woven into instruction. The school uses Illustrative Mathematics and Wilson Fundations, respectively, and the movements used in this study include jumping jacks, clapping, patting the ground, and stepping side to side. Further, the length of mathematics instruction, assessments, and research methods are uniform across the five kindergarten classes at the school in which the research is being conducted, as is the movement integration. Math lessons take place for 60 minutes each day, with 35 of those minutes entailing direct instruction and 25 minutes entailing either independent or group work. Dependent variables would be student performance on assessments and length of student engagement and sustained attention

during instruction as well as prior education of students in the class, physical ability of students (for the movement portion), language and literacy skills, and gender, age, and intellectual intelligence, though these three variables are often made uniform across the classes during placement.

The math skills assessed for the final trimester of kindergarten are summarized in thirteen objective statements listed on the final report. These statements come from the learning goals provided by the end of year assessment from Illustrative Mathematics. The statements and skills assessed are as follows:

- counts verbally to 100 beginning from any given number within this range;
- counts backward from any given number within this range 0-20;
- identifies and writes numerals in the range 0-20;
- counts a set of 20 or more objects with 1-to-1 correspondence;
- given a set of up to 20 objects, can answer the question, “How many are there?”;
- compares the numbers of objects in two groups or two written numerals in the range 1-10;
- understands numbers 11-19 as 10 ones and some more ones;
- adds and subtracts within 10 using objects or drawings to represent the problem;
- fluently adds and subtracts within 5;
- sorts the same set of objects in more than one way;
- describes and compares measurable attributes, such as length or weight;
- names basic shapes regardless of their orientation or size; and

• classifies shapes as two-dimensional or three-dimensional (Illustrative Mathematics, 2021).

The intervention in this study is the movement integrated into instruction. As opposed to sitting on the carpet and watching and listening as a lesson unfolds, students engage in intentional movements chosen specifically to boost engagement and reinforce concepts. For example, when learning about teen numbers, instead of trying to conceptualize the abstract idea of a teen number being "ten and some more," students perform ten jumping jacks and then switch to clapping for the remaining ones. Doing so forces them to develop both number sense and counting fluency. The movements are controlled and structured; this integration is not meant to be a freestyle brain break or strain on classroom management but, rather, a purposeful blending of movement with instruction intended to support concepts being taught. Motor and cognitive development exist as a "positive relation" with "motor skills being necessary for learning and later academic performance," so weaving movement into kindergarten math instruction not only adds the motor skills component necessary for learning but also lays an important foundation for future academic success (Padial-Ruz et al., 2022).

Data Collection

Data collection revolved around student assessment scores. Students completed the end of unit assessment for unit five from Illustrative Mathematics, a unit they received standard instruction on, i.e. sat on the carpet as normal and did not integrate movement during any lessons. For the duration of unit six, students received instruction as they have with other units but with movement integration. Lessons were taught according to the curriculum, and no other conditions differed other than the addition of movement during each lesson. It is important to

note as well that these two units were chosen because they cover the same content, and unit six is simply a continuation of addition and fact fluency within 10 that began in unit five. Therefore, there are no concerns about assessments from each unit being different and skewing results. The end of unit assessment scores from unit six serve as a point of comparison to test for a difference in understanding when lessons incorporate movement. Therefore, the end of unit assessments serve as the measurement instruments and are both reliable and valid because they are standardized, provided by the curriculum, and designed to match and assess the specific content from the lessons.

Students completed the end of unit assessments in two parts. The first part of the assessment was done independently in a whole group setting. Students spread out to assigned areas across the room so as not to be influenced by others' work and completed the questions as they were read aloud by a teacher. The second part of the assessment was completed one-on-one with a teacher because the questions required step-by-step reading, and kindergarteners were not equipped to read the questions on their own yet. The assessments were then scored by the teacher and converted into an M, W, or B scale, meaning "meeting," "working towards," or "below" grade level expectations. For this study, the unit five and six assessments qualify missing two or less questions as M, missing between three and seven questions as W, and missing eight or more questions as B. IRB exemption applies because the students receive instruction and complete the assessments under normal school conditions and are not put in any harm or at risk at any time. The timeline for this data collection spanned two weeks. Students completed the unit five assessment on a Friday, received instruction on unit six for the following nine school days, and completed the unit six assessment on the tenth day, two weeks after the the unit five assessment.

As for data storage and security, the school math specialist securely keeps all scored assessments and enters assessment data into the school's math data wall. Student assessments are then shredded when the student leaves the division after completing second grade.

Data Analysis

The class of 18 students that served as the participants in this study completed the end-of-unit assessment for the fifth unit of kindergarten mathematics as they had done with the previous four units. Twelve students received a score of M or W, meaning they were either meeting or working towards grade level expectations for student scores. The other six students received a B, meaning they were below grade level expectations in their understanding of the content. Following the intervention of movement integration into daily mathematics instruction for two weeks, students completed the next end-of-unit assessment for unit six. These two units, units five and six, were chosen because they covered the same material and shared the same end-of-unit assessment skills, so differences between the assessments were not a concern. The unit six assessments revealed that 16 students scored at meeting or working towards grade level expectations, and only two scored below grade level expectations.

Table 1

Units Five and Six Participant Scores

Student	Unit 5 Score	Unit 6 Score
1	W	W
2	M	M
3	B	B

Student	Unit 5 Score	Unit 6 Score
4	M	M
5	M	M
6	W	M
7	B	W
8	W	M
10	B	W
11	M	M
12	B	W
13	B	W
14	W	M
15	B	B
16	M	M
17	M	M
18	W	W

Table 2

Chi-Square Test of Association Calculations

	Meeting or Working Towards Grade Level	**Below Grade Level**	**Marginal Row Totals**
Before	12 (14) [0.29]	6 (4) [1]	18
After	16 (14) [0.29]	2 (4) [1]	18
Marginal Column Totals	28	8	36 (Grand total)

Table 1 lists the letter-assigned score of all 18 students based on their numerical scores on both the unit five and unit six assessments. The numerical scores were converted into the standard letter scoring system used by the school consisting of either M, W, or B and are reflected in the chart. These scores were then converted back into numbers based on the number of students that received each score for the purpose of the statistical test. In other words, the B's in the Table 1 Unit 5 Scores column were converted to a six because six students received a B; this six was input into the statistical test, and the same procedure followed for the M's and W's.

Data analysis occurred using the chi-square test of association to determine whether there was a statistically significant difference in assessment scores following the intervention of movement integration. Results of the chi-square test of association indeed revealed a significant difference, X^2 (1, N = 18) = 2.5714, p =.109. Students were more likely to meet or effectively be considered as working towards grade level expectations on end-of-unit math assessments when movement integration took place during daily math lessons. The data categories are the M, W, or

B scores, and the numerical values are reflected in Table 2, which lists the calculations used in the chi-square test of association to determine whether statistical significance was present or not. Using a p-value of 0.5 and a frequency table of scores before and after the movement integration intervention, scores were analyzed to check for significant differences before and after the movement integration intervention. Because the results of the chi-square test of association were X^2 (1, N = 18) = 2.5714, p =.109, the data supports movement integration as an effective intervention for boosting understanding of mathematical concepts as evidenced through improved scores.

As previously noted, the M and W scores were combined into one numerical value to simplify the test by having only two categories to compare. While four students improved from a B to a W, it is also important to note that three additional students improved from a W to an M. Though the jump from W to M is not as significant as the improvement in score required to go from B to W, their improvement nonetheless further advances the data revealed in the chi-square test of association supporting the benefits of movement integration.

When considering what this data indicates about the number of questions missed, one can see better the gains in understanding achieved through movement by reviewing the numerical equivalents for the M, W, and B scores. Students receiving an M missed two or less questions, while those receiving a W missed between three and seven questions. Students scoring below grade level, or B, missed eight or more questions. With these values in mind, one can then see that four of the six students scoring a B on the unit five assessment improved, at the very least, by missing seven instead of eight questions, though most made even greater strides. Similarly, the three students who progressed from W to M completed the unit six assessment by missing

only two or less questions as opposed to the potential seven they could have previously answered incorrectly.

Because students improved across all categories, going from B to W and W to M, the data suggests that the movement integration intervention can have positive effects on learners at all stages. In other words, the movement did not only help those struggling to score at grade level expectations but also helped advance three of the students working towards grade level expectations to meeting them. That being said, no student scoring a B on the unit five assessment scored an M on the unit six assessment, and two students scoring a B on the unit five assessment maintained their B on the unit six assessment. This data suggests that the movement integration intervention may be insufficient for getting students to progress beyond one scoring category, i.e. going from B to M as opposed to from B to W. It also indicates that movement integration is not a guaranteed method for getting students to achieve a score that meets grade level expectations because of the two students who scored a B on both assessments. However, no student scored in a lower category on the unit six assessment than the unit five assessment, so while the data may not provide an assured intervention for improvement, it does promise that the movement integration will not have harmful effects on student scores.

Ultimately, all but two student participants completed the unit six assessment scoring at or sufficiently working towards grade level expectations, which is a welcome improvement from the twelve who did so on the unit five assessment. Seven students progressed to the next scoring category, and no student regressed in scoring. This data suggests that movement integration provides an effective method for intervening in kindergarten math instruction to boost understanding of content and achievement on assessments. Further data analysis confirms a

significant association between movement and improved assessment scores. Not only does the improvement come from students progressing from the targeted B to W range, but it also comes from the W to M jump as well, indicating a range of potential growth through the intervention.

Discussion

Summary of Major Findings

The purpose of this action research was to determine whether or not integrating movement into kindergarten mathematics instruction will boost student engagement and, consequently, understanding of content. To answer this question, students completed an end-of-unit assessment provided by the math curriculum for unit five after receiving standard instruction throughout the unit entailing teaching practices and classroom conditions that were the same as all previous units of instruction. Students then received instruction on unit six under the same conditions; however, movement was incorporated into each lesson. Students used jumping jacks, clapping, patting, and stepping side to side while completing the activities during lessons in hopes of boosting engagement and thereby creating stronger number sense and fact fluency. The movements integrated were chosen because of their simplicity and the assurance that every student could complete them with ease; in other words, there was no data or research that went into selecting certain movements that may produce better results.

Following unit six's period of instruction, students completed the end-of-unit assessment, and scores were analyzed according to the school's reporting method of M, W, or B using the chi-square test of association. Data collected revealed that seven out of eighteen student participants improved their scores following the movement integration intervention, no students regressed, and four of the seven students who improved did so from B to W, the most significant

and desired increase as they went from performing below grade level expectations to working towards doing so. The findings therefore suggest that movement integration serves as an effective intervention for boosting engagement and, ultimately, understanding of mathematical concepts in kindergarten. Simply participating in the movements indicates engagement with the lesson and content, as doing so requires actively moving one's body, and the data supports the claim that understanding improved with the addition of movement integration.

Impact on Teaching and Learning

Despite the aforementioned limitations, this study still provides evidence of successful movement integration intervention. Therefore, the findings have the potential to impact teaching by providing a strategy to boost engagement as well as understanding in kindergarten mathematics instruction through movement. The literature review identifies several studies that support the use of movement in elementary education for benefits such as increased interest in content, motor and cognitive development, and kinesthetic learning experiences (Kercood et al., 2007; Lindt & Miller, 2017; Padial-Ruz et al., 2022; Vetter et al., 2020). It also names teaching strategies tailored to kindergarten mathematics instruction such as the use of manipulatives and read alouds (McGuire et al., 2021; Shimek et al., 2021). This study builds on both these categories by identifying a teaching strategy incorporating both the positive effects of movement and techniques accommodating the unique needs of kindergarten learners. The literature review identifies numerous studies that incorporated a variety of movement forms into lessons, some of which included group energizers, GoNoodle Brain Breaks, general physical activity, and unstructured movement time (Fedewa et al., 2018; Moon & Webster, 2019; Wold et al., 2023). This action research project used movements consisting of jumping jacks, clapping, patting, and

stepping side to side, though the variety of movement forms discussed in the literature review as well as data from this study suggest that any movement is better than no movement, meaning the there is an impact on teaching strategies by emphasizing the advantages of movement integration.

These findings then impact learning as well, as they provide an alternative method to visual or auditory learning that mathematics instruction may rely on and instead provides a way to engage kinesthetically with the material. Just as researchers have previously identified that curriculums like Wilson Fundations succeed because of the opportunity for a "kinesthetic demonstration of learning," this study suggests that mathematics learning can have a similar kinesthetic demonstration opportunity through movement integration (Shoval et al., 2018). Therefore, the impact on learning in this study largely stems from the parallels drawn between the benefits of movement in mathematics instruction as well as literacy. In other words, plenty of research as well as entire curriculums exist that purposefully integrate movement into literacy instruction, so this study provides data also supporting the use of it in mathematics instruction.

Limitations of the Study

This study has several potential limitations. The participant pool in this study is relatively small and does not reflect the entire kindergarten grade level at the school, as there are four other classes that did not participate. Further, the assessments used were provided by the math curriculum used by the school, and though they align directly with the taught content, do not necessarily test number sense or fact fluency directly. Both assessments evaluated these skills through problems that require these skills for success, but they did not assess these skills in an isolated manner. This study also only accounts for two units and roughly five weeks of

instruction, only two of which—the two weeks it took to get through unit six—included the intervention. Finally, as kindergarten is typically the first formal exposure to mathematics instruction, the limitation of developmental readiness exists as well. In other words, unlike an upper elementary student who has received mathematics instruction for a couple of years, there is the risk of kindergarten students, through no fault of their own, simply not being developmentally ready to take in and process instruction in mathematics, regardless of interventions (Mariana, et al., 2023; Padial-Ruz, et al., 2022; Savina et al., 2016).

Further Study

Though this action research yielded promising data supporting the use of movement as an effective intervention in kindergarten mathematics, the results also signal the need for further research on the topic. The participants all came from one classroom at a school with four other classes in the grade level, and the class only consisted of 18 students. Therefore, the results reflect a relatively small population, and, despite this action research project aiming to look specifically at the effects of movement integration in kindergarten classrooms, this topic could be researched in other elementary grade levels to increase the participant pool. Additionally, this study incorporated four different types of simple movements for the purposes of data collection, but further research could be conducted on the kind of movement used for intervention. Whether students benefit from vertical movement like jumping jacks or horizontal movement like stepping side to side could be worth considering as well as the positioning of their bodies, i.e. whether they are standing or on their stomachs, as looking into these topics could lead to more tailored movements aimed at improving the efficacy of movement integration. Previous

researchers have looked at movement integration progression frameworks—i.e., going from a simple jumping jack to longer, more intricate bouts of movement—across content areas as well as benefits of movements in areas such as social emotional competence, but specific research on mathematics instruction with various types of movement could be useful (Mariana et al., 2023; Moon & Webster, 2019).

This study also relied on the end-of-unit assessments provided by the school's chosen mathematics curriculum to assess the participants. While these assessments accomplished the necessary task for this study, developing a more standardized assessment that could be used to gauge the effectiveness of movement integration in any kindergarten classroom—not just those using this curriculum or associated instructional strategies—could also be helpful. Researchers have previously looked at the efficacy of early math assessments in kindergarten classrooms and concluded that they were informative for forming better teaching practices, so further insight into an assessment gauging growth in concept understanding with the addition of movement could have similar, positive effects (McDonald et al., 2021). Finally, further study may be conducted on what specific content areas improve with movement integration. For the purposes of this study, the assessments largely covered number sense and fact fluency within 10, as that is a large component of kindergarten mathematics as well as what the units of instruction covered. That being said, future research may look at effects of movement on more advanced topics within kindergarten—addition and subtraction within 20—or topics in upper elementary grades such as place value and multiplication.

Conclusion

Capitalizing on the natural instinct of children to move seems like an efficient method for balancing classroom management and academic instruction. Recognizing that unstructured movement allowances could lead to chaos, however, while still intrigued by the promise of increased understanding touted by literacy curriculums that blend movement into their teaching practices leaves one overarching question: can movement increase academic achievement? This question is broad, so the purpose of this action research project was to identify whether or not movement integration boosts engagement and understanding in kindergarten mathematics. The research suggests that it indeed serves as an effective intervention for increased engagement and understanding of content.

The efficacy of the intervention, however, lies in the implementation and the desired improvement. This study incorporated movement daily into lessons that were otherwise taught under normal, routine classroom conditions. Movements were simple and integrated with the purpose of forcing students to participate while offering a kinesthetic outlet for demonstrating their thinking. They were structured, and students treated the movements as learning tools, not a break or time for play. Further, the hope was that the movement intervention would improve the assessment scores of students performing below grade level by helping them to perform at "working towards" grade level expectations. This data indicates such improvement took place as well as additional improvements from students already performing at a "working towards" level who reached the benchmark of meeting grade level expectations.

The findings of this study are significant because they provide evidence for movement integration as an effective intervention in kindergarten mathematics. In addition to the support of

movement integration by literacy curriculums as well as researchers in child motor and executive function development, math instruction joins these other areas in benefitting from movement integration. Weaving in four different kinds of movement activities into daily mathematics lessons over the course of a unit which lasted around two weeks proved to increase the scores of seven out of eighteen participants while boosting the engagement and active participation of the entire class. Kindergarten mathematics provides a crucial introduction to foundational mathematics concepts and skills that can be understood more thoroughly when taught using movement integration.

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