Abstract

The purpose of this study was to determine the effects of movement via the NeuroNet program on the academic achievement of 18 second-grade students. The effects on student behavior and student engagement were also examined. Academic achievement was measured using pre- and posttests of the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) assessment, and the Dibels Math assessment. There was a statistically significant difference in the math numbers/operations algebra scores between the control group using tradition instruction (M = 9.71) and the intervention group using the addition of movement (M = 11.82, p = 0.00). There was not a significantly different increase in the scores for reading and math numbers/operations. Student behavior and engagement checklists showed an overall percentage increase of all traits observed. Movement through the NeuroNet program was found to have no increase in achievement in reading, but there was an improvement in math, behavior, and engagement.

Effects of Movement on Academic Achievement for Second-grade Students

New information from brain research regarding brain function suggests that adding movement to the curriculum may help students perform higher in the academic curriculum (Smith & Lounsbery, 2009; Taras, 2005). Policymakers desire students to learn at higher levels so they are prepared for college and careers. Current researchers found that only one third to one half of eleventh-grade students is reaching a high level of readiness for college. These numbers have caused concern at all levels of education (ACT, Inc., 2010).

Teachers are concerned that their students experience an excessive struggle in reaching the higher goals expected. Teachers are constantly looking for strategies that will help their students learn more efficiently and think at higher levels due to such issues as poor comparisons with international testing scores and increased pressure from rising curriculum standards (Darling-Hammond, 2009; ACT, Inc., 2010). Movement has been demonstrated to improve cognitive function; therefore, exploration of the relationship of movement to academic achievement is important.

While some elementary schools have continued physical education classes and recess, many have none, claiming the need for more instructional time. However, research indicated that physical activity increases cognitive function. For example, Ploughman (2008), in a commentary reviewing research on physical exercise and brain function, validated a positive correlation between academic achievement and exercise for school-aged children. Even when factors such as IQ and socioeconomic status were included, the following results were compelling. Students with reading difficulties increased their abilities in accuracy and phonemic skill after undergoing daily exercises (Ploughman, 2008, p. 170). The California Department of Education (2002) found that students performed higher on the SAT9 test when they tested

physically fit on the Fitnessgram (Blakemore, 2003). Many children require more than one method to retain information. Skoning (2010) stated that "using creative movement … is one way to reach many of these children who do not learn through more typical instructional formats" (p.170). Teachers have long experienced the difficulty of classroom management when students are unable to go outside for recess. Helgeson (2011) noted that movement in classroom activities improves the environment and helps with classroom management. Incorporating movement into classroom activities would benefit all students, particularly those who are negatively impacted by socioeconomic status.

The state of Georgia is similar in achievement to the Southeastern states in general. According to the 2009-2010 Report Card (Governor's Office of Student Achievement, 2010), fourth-grade students in Georgia scored 34% in math, which was slightly lower than fourth-grade students in the Southeast states who scored 36%. There were similar results in reading. Fourth-grade students in Georgia scored at 29% while fourth-grade students in the Southeast states scored at 30%. While second-grade students are not tested, the results show that by fourth grade the percentage of students meeting the state expectations for achievement was lower than 50%. The percentage of schools in Georgia that made Average Yearly Progress was 77.4%. While the percentage is closer to the goal of 100%, the score still does not meet the expectation.

The research site gives evidence of the same situation as the state of Georgia. When looking at a comparison of achievement by grade level between the school and the state, the percentages are similar. The Governor's Office of Student Achievement reported that for the year 2009-2010 (the latest year reported) 95% of second-grade students at the research school met or exceeded state expectations in math while 86% of students in the state met or exceeded expectations in math. In reading, 90% of second-grade students met or exceeded state

expectations while 95% of students in the state met or exceeded expectations in math. The research school is comprised of a significant amount of those considered economically disadvantaged (Governor's Office of Student Achievement, 2010).

Two of the goals listed in the School Improvement Plan in reading and math for the entire student body are the implementation of professional learning and best practices with teaching economically disadvantaged students in order to raise their academic achievement. While 86.7% of the students met or exceeded the goal in reading, the target was 91%. The same is true in math. Seventy-seven percent met or exceeded the goal, but the target was 85%.

Currently, the research school is focused on locating curriculum programs and strategies that will improve academic achievement. The use of graphic organizers, small groups, direct instruction, writing programs, and curriculum workshops are not only encouraged but mandated. These activities have been in place for several years, and test scores have improved for much of the population. However, the school still has not reached the goals specified in the School Improvement Plan. With the population comprised of a large amount of economically disadvantaged students and research showing that cognitive function of students is affected by this status, there is reason for exploring different methods of learning (Sastry & Pebley, 2010). The addition of movement to classroom activities may be an important component.

Surveying student scores after implementing movement to their activities will garner information valuable to the entire school as well as the parents in the community. The research school is considered a suburban school. Once the effects of curriculum programs and strategies on academic achievement are determined, school faculty are able to apply the benefits to their own students. Administrators and teachers use the programs and strategies to determine the impact on the achievement of their particular student population.

Literature Review

Kinesthetic and tactile methods of learning have long been studied. For over twenty years researchers have provided evidence that many students respond better to active and hands-on tasks (Honigsfeld & Dunn, 2009). These methods of learning are included as a part of a philosophy of instruction known as learning style. The learning style model identifies the way a person starts to focus on as well as process and retain new information as the learning style (Lister, 2005). Those who are proponents of the learning style model advocate tactile and active games and activities as the primary methods of instruction for those students who show a preference for the kinesthetic learning style (Rayneri, Gerber, & Wiley, 2006; Lister, 2005); Honigsfeld & Dunn, 2009). While the learning style research is well documented based on student-indicated preferences and achievement, there is research that has provided an organic reason for the inclusion of movement to enhance learning.

Over the past few years, as researchers were making exciting discoveries about brain functioning, other researchers were focusing on one particular aspect that held potential for education: movement. Movement was seen as an important factor in how the brain works. The general belief is that "whole-brain learning through movement repatterning, or learning to move in new ways, can help students to access those parts of the brain previously unavailable to them" (Tremarche, Robinson, & Graham, 2007, p. 1). Vagovic (2008) believed that all the areas of development were associated with each other. The social, emotional, and cognitive areas can be enhanced or hindered by the physical status. If movement could be included in the classroom environment, then it is possible the mind and body of students could be better integrated, and cognitive functions could become more focused and efficient.

In the past 15 years, researchers have investigated how the brain functions. Neuroscientists and educators have joined forces to discover how the knowledge of brain function can improve teaching methods. The discovery of mirror neurons has provided interesting information which suggests potential strategies for use in the classroom. In research performed on monkeys, researchers found that the ventral premotor cortex contains neurons that fire when a monkey does a particular action and when it sees someone make that same action (Kohler, Keysers, Umilta, & Fogassi, 2002). These neurons are called mirror neurons. Kohler et al. (2002) investigated whether neurons would fire if a monkey would not only make a gesture but also gesture when it heard the sound of the action without having seen the action. They found that there were mirror neurons they labeled audiovisual mirror neurons that would fire when just hearing the sound of the action. Most particularly interesting is that these audiovisual mirror neurons are located in what is called Broca's area in humans. This area is associated with the processing of language (Dobbs, 2006). The way these mirror neurons act suggests that movement may play an important part in how the brain learns. Frey and Fisher (2010) explained that experiences cause neurons to discharge, and if they fire over and over, there are actual physical changes. Since physical development affects other areas of development, and repeated experiences cause physical changes in neural connections, then repeated movements associated with cognitive activity might cause better connections in the brain. Therefore, cognitive, social, and emotional development may benefit.

Blakemore (2003) discussed several effects of physical activity on brain function. The effects include an increase of capillaries surrounding the neurons. The increase of capillaries caused higher levels of blood and oxygen which causes a higher speed of recall. Second, because of the higher number of capillaries, circulation is better which helps nutrients reach the brain.

Movements that utilize the hands and feet cause the production of a mood-enhancing neurotransmitter. Sometimes exercise causes the release of endorphins, and the release of endorphins causes a higher level of alertness. Greater brain function is caused by an increase in the growth of nerve cells. Ploughman (2008) explained that physical activity could cause higher neuronal activity which would lead to cells integrating into neuronal connections (p. 237). The research suggested that exercise raises serotonin and norepinephrine which helps the brain process information. Although the effects of physical activity can be impacted by IQ and socioeconomic status, the results of research are convincing according to Ploughman. Studies performed on both humans and animals show that areas that are linked with movement and learning are closely joined. Therefore, physical exercise might increase neural connections (Sallis et al.,1999).

Given the research indicating that movement may increase cognitive function, a relationship between movement and academic achievement can be suggested. A few studies have investigated the relationship between movement and academic performance. The results were suggestive rather than conclusive. For example, concentration seems to increase in the time immediately following physical activity, but it may not be enough to cause improvement in school achievement (Taras, 2005). Field, Diego, and Sanders (2001), in their study of high school seniors, discovered that exercise was related to improved relationships, lower depression, lower drug use, and higher grade point averages. Sallis et al. (1999) used the SPARK program in fourth and fifth grades to explore the effects of physical exercise on student performance on achievement tests. The researchers found that reading scores declined less in the experimental group than in the control group. However, language scores declined more in the experimental group than in the control group. The primary finding was that more time in physical education

classes was not harmful to academic performance on achievement tests. The results of this study were inconclusive and more research is needed to support its findings.

Teachers are finding a challenge in keeping their students' attention long enough for them to become engaged in academic tasks. Student attention is necessary for learning. Researchers have discovered that learning problems in math and reading are increased in children with Attention Deficit with Hyperactivity Disorder (ADHD). Cognitive delays in language development are more often found in children with attention and impulsivity issues (Stalvey & Brasell, 2006). The difficulties in attention affect not only the student, but also the rest of the students in the class. According to Beaudoin and Johnston (2011), "classroom behavior improved after fine motor activity" (p.84). Extra physical activity is likely to be important for students with problems in attention since those students who demonstrate well-developed motor skills also demonstrate better attention (Ericsson, 2008).

The brain takes in information through the senses. Kinesthetic learning uses the sense of movement. Even the tasks of reading and math are affected by movement. Linguists and speech pathologists have identified the exact movements that are used in producing sound. Sounds are not just heard but are felt through kinesthetic feedback. "Without this feedback a child may recognize and understand words, but not be able to divide them into separate sounds" (Weggelaar, 2006, p.147). Using manipulatives to teach phonological awareness taps the kinesthetic sense which increases the phonological skills for students who experience difficulty with the skill (Rule, Dockstader, & Steward, 2006). In math, researchers found that movement that was purposeful produced higher student scores and attitudes (Beaudoin & Johnston, 2011). Increased physical exercise along with motor training can increase scores on mathematics tests as well (Ericsson, 2008).

According to Smith and Lounsbery (2009), there are few studies that have explored the effect of physical education on academic performance. However, the research that has been completed, has provided support for further examination (Ericsson, 2008;Tomporowski, Davis, Miller, & Naglieri, 2008). For example, the results of cross-sectional studies suggested that cognitive tasks are achieved more quickly by children who are more physically fit than those children who are less physically fit (Tomporowski et al., 2008). Smith and Lounsbery(2009), stated that one conclusion is daily physical education appears to cause the rate of learning to increase. Physical education also appears to be related to increased academic achievement. In addition, physical activity with its related social benefits may be associated with academic success. While there is evidence indicating that movement may improve cognition, there is not theory that connects movement and achievement satisfactorily (Tomporowski et al., 2008).

Purpose Statement

The purpose of this study was to explore the effects of movement on academic achievement in reading and math in the second grade. Specifically, this study explored the effects of movement on second-grade students in an inclusion class.

Research Questions

Research question 1. Will achievement scores be higher for second-grade students using NeuroNet with an academic task compared with second-grade students engaged in tasks via traditional methods without movement?

Research question 2. Will the pairing of movement with an academic task via NeuroNet have a positive effect on student behavior?

Research question 3. Will the pairing of movement with an academic task via NeuroNet have a positive effect on student engagement?

Definition of Variables

Movement. The independent variable applied as intervention was the use of NeuroNet . Students participated in 15 minutes of exercises synchronized with learning tasks daily.

Achievement. Academic achievement is the students' success in completing math and reading tasks. It was measured by test scores.

Behavior. Student behavior is that ability to follow classroom rules and direction. It was noted by teacher observation and measured by frequency charts.

Engagement. Student engagement is the degree of participation and attention by students to math and reading instruction. It was measured by frequency charts.

Methods

Setting and Participants

The research school was considered suburban, as its location was just outside a small city. According to the United States Census Bureau (2011), the community had 13.1% living below the poverty level, and the median household income was just below $45,000. The school had an enrollment of 431. Of those enrolled, 67% were eligible for both free and discounted lunch (National Center for Education Statistics, 2010). The research school was designated a Title I school. There was little ethnic diversity as the students enrolled were predominantly White (93%). Of the 431 students enrolled, 2 were American Indian, 5 were Asian/Pacific Islander, 15 were Black, and 7 were Hispanic (National Center for Education Statistics, 2010).

According to the Governor's Office of Student Achievement (2009-2010), 76.67% of students in the second grade at the research school met or exceeded on the reading, English language arts, and mathematics subtests of the Criterion Referenced Competency Test (CRCT). The second-grade students at the research school achieved a lower percentage (76.67%) than the

second-grade students in the district (83.84%). There were too few students with disabilities to report the scores for the group. However, 88% of the students who were economically disadvantaged met or exceeded state expectations in reading, while 93% of the economically disadvantaged met or exceeded state expectations in mathematics. Yet in English language arts, only 77% of students who were economically disadvantaged met or exceeded state expectations. Class achievement scores are to be determined.

Table 1

Student Demographics

Demographic	Treatment Class *N* = 17	Treatment Class *N* = 17
Race		
White	15	15
Black	2	2
Gender		
Boys	9	9
Girls	8	8
Students with Disabilities	6	6

The control class was a second-grade inclusion class with instruction given by a regular education teacher and a special education teacher. The treatment class was the same group of students with the same teachers. A comparison of achievement scores was made between the control group which participated in traditional instruction prior to the intervention and the treatment group which participated in exercises combined with academic tasks. Demographic

information about the class is presented in Table 1. There were seven students with disabilities in the class (N = 18). All six students with disabilities were boys.

Before the intervention began, the teacher-researcher sent consent forms to participants' parents or guardians. The consent forms documented the research intervention and the types of data collection, and asked permission for student participation. In addition, participants were given student assent forms stating that participation was voluntary.

The teacher-researcher was a special education teacher in the inclusion class with 20 years of experience. The teacher-participant was a regular education teacher with 5 years of experience at various grade levels. The teacher-researcher implemented the intervention with the assistance of the teacher-participant. Both teachers made observations regarding student behavior and engagement in the form of checklists. The teacher-researcher collected data from computerized achievement tests and benchmark reading and math assessments.

Intervention

In this study, the researcher examined the effect of movement on students' level of achievement, behavior, and engagement. One group of students was used in the study during two different phases. The control phase consisted of a traditional format of instruction. The experimental phase consisted of the same traditional format of instruction with the addition of movement coupled with academic tasks. These movements were made in rhythm while performing an academic task.

One class of second-grade students participated in this study. A within-group time series design was used with the second-grade class. Pretest and posttest measures were examined before and after the intervention (Cresswell, 2012). During the first semester, the control phase, the class was instructed using the traditional format implemented by the research school. The

participants were placed in an inclusion class with two teachers present for instructional time. The teachers used the school-adopted curriculum to give instruction in reading and mathematics. The content was on grade level in mathematics. However, the special education students received accommodations such as extra time on assignments and instruction in small groups. Reading instruction, consisting of a reading program at their instructional level, was modified for students with learning difficulties. Math instruction was given 60 minutes each day, 5 days a week. Reading instruction was given for 90 minutes each day, 5 days a week. During the control phase, students were given the Dibels Math exam in November by the teacher-participant and the teacher-researcher to measure academic achievement in reading comprehension and math. Reading fluency was assessed in September using DIBELS. The DIBELS assessment was given by the school-appointed examiners.

During the intervention phase, the same class of second-grade students continued the traditional format of instruction in reading and mathematics during the second semester, but movement was added to their daily activities. The students were given additional Dibels Math and DIBELS assessments before treatment began to provide a baseline of achievement. Checklists and observation were used for one week before the intervention began to measure student behavior and engagement in order to provide a baseline.

During the intervention phase, the students engaged in specified exercises from the NeuroNet program (Rowe, n.d.) each morning. The students participated in the exercises for 3 or more days each week. The exercises were performed in rhythm while engaged in an academic task. Ramnani and Passingham (2001) studied subjects while they performed to a visuomotor rhythm. The subjects were more able to respond from memory more quickly. As mentioned earlier, Beaudoin and Johnston found that purposeful movement had an impact on students in an

algebra class. They physically moved a parabola to match the equation in the problem. After the posttest, the treatment group had scores had increased 84%. Research was performed on students who identified various learning style preferences. Instructional strategies were used that accommodated each learning style, and were gradually phased in to determine which strategies had the most effect. Achievement gains varied for those students who indicated no preference, while gains were higher for those whose environmental and mobility preferences were accommodated. A similar pattern was found for the group who indicated multiple learning style preferences (Braio, Beasley, Dunn, Quinn, & Buchanan, 1997). Learning style theory is based on student reports of preference, and has been validated. However, research on the brain has indicated that patterns are how the brain learns at the neuronal level. The cells respond in an automatic and synchronous method to things that occur close in time (Miller, 2006). Given that the brain is attuned to patterns, the importance of rhythm to human learning is stressed. "…rhythm plays a vital part in language acquisition and competent language use" (Tuan & An, 2010, p. 18). Further, according to Tuan and An, since rhythm is closely akin to physical activity, the use of body movement is an important instructional strategy. The NeuroNet program was deemed a worthwhile treatment since it used both rhythm and purposeful movements.

Each NeuroNet exercise was performed to a1-minute timing for a total of 15 minutes. For example, the students were asked to stand on small stools, swing their arms and clap, while saying the letter shown on the SMART Board. These movements were performed simultaneously in time to a rhythmic clock sound. Each exercise was continued for 1 minute. Another exercise consisted of students standing on stools, swinging their arms, and bumping their fists together in time to the clock sound. At the same time, they named the picture on the SMART Board and provided the beginning letter. Students were informed of the goal for each

exercise and the criteria to meet that goal. After the exercises, students continued the traditional format of instruction in reading and mathematics. The NeuroNet program was continued daily for 7 weeks. At the end of the 7 weeks, the students were given the Dibels Math test by the teacher-participant and the teacher-researcher. DIBELS assessments were administered by the teacher-participant and the teacher-researcher. These tests, as the posttests, were compared to the DIBELS and Dibels Math pretests. Checklists and observation were used during the intervention to measure student behavior and engagement at the end of each week.

Data Collection Techniques

Achievement tests. The reading and math data collection was assessed with two instruments.

Dibels EasyCBM Math. Data on math achievement was collected through the administration of the Dibels EasyCBM math assessment (DIBELS; Alonzo & Tindal, 2009). Internal consistency was established in 2009 (Alonzo, Tindal, & Anderson, 2009). The assessment was administered before and after the intervention to both the control and intervention groups. Three domains were assessed in the instrument. The domains were Numbers and Operations, Geometry, and Algebra. There were sixteen questions assessing each domain. Scoring was based on the number of problems correct. The raw scores were then reported as percentages. Numbers were used in place of student names for reported results. Data were analyzed using a paired one-tailed *t*-test. The scores were interpreted based on a comparison of pretest and posttest scores.

Dynamic Indicators of Basic Early Literacy Skills. Data on reading fluency was collected through the administration of the Dynamic Indicators of Basic Early Literacy Skills-Next (DIBELS; Good & Kaminski, 2002). This assessment was a requirement for all students.

Concurrent validity and alternate form reliability was established by an assessment committee for the publisher in 2002. The assessment was administered before and after the intervention to both the control and the intervention groups. To examine basic reading skills, the Oral Reading Fluency subtest was used. The Oral Reading Fluency subtest consists of a leveled reading passage. Students were asked to read each passage for 1 minute and then retell what they could remember. The scoring was based on the number of words correct per minute. The retelling of the passage was scored by counting the number of words the student recalled from the story. The retell score was also assessed for organization and number of details. The results were reported in raw scores that were converted to percentages. Numbers were used in place of student names for reported results. Data were analyzed using a paired one-tailed *t*-test. The scores were interpreted based on a comparison of pretest and posttest scores.

Student Behavior Checklist.(Appendix A) Student behavior was measured by a behavior checklist developed by the researcher. Data was gathered on students before and during the intervention at the end of each week. Both control and intervention groups were assessed with the checklist. The behavior checklist consisted of six characteristics commonly found in elementary classrooms. The characteristics were in the areas of organization, routines, amount of activity, conflict, preparation, and self-control. Scores were gathered by placing a check beside each student's name for the behavior observed. Numbers were used in place of student names for reported results. Data were analyzed using a paired one-tailed *t*-test. Interpretation of the data was based on a comparison of the frequency of observed behavior between the control group and the intervention group.

Student Engagement Checklist (Appendix B) Student engagement was measured by a checklist developed by the researcher. Data was gathered on students before and during the

intervention at the end of each week. Both control and intervention groups were assessed with the checklist. The student engagement checklist consisted of four characteristics commonly found in elementary classrooms. The characteristics were in the areas of attention, participation, time, and completion of tasks. Scores were gathered by placing a check beside each student's name for the characteristic observed. Numbers were used in place of student names for reported results. Data were analyzed using a paired one-tailed *t*-test. Interpretation of data was based on a comparison of the frequency of incidents of engagement between the control group and the intervention group.

Results

Data was collected to compare one second-grade class before using movement with academic tasks and after using movement with academic tasks via the NeuroNet program. Achievement data was collected using Dibels Next and Dibels Math. Data on student engagement and achievement was collected using observational checklists (appendix A and B).

In order to discover the effect of the NeuroNet program on academic achievement, the class was given a Dibels Next reading fluency and retell assessment. In addition, the class was administered a Dibels Math assessment. The tests were administered again as a posttest at the completion of the intervention. The class scores were averaged.

Means and standard deviations for Dibels Reading Fluency are given in Table 2. The difference in mean scores between the pretest and posttest scores for the Intervention group were not significantly higher ($t = 1.69$, $p = 0.40$) than the difference in mean scores of the Control group ($M = 17.24$). The students in the intervention group did not score significantly better than the students in the control group,

Table 2

Achievement on Dibels Next Reading Fluency Results

Class							Comparison of mean gains/losses	
		Pretest		Posttest		Gains/Loss		
	N	*M*	*SD*	*M*	*SD*	*M*	*t*-value	*p*
Control	17	68.29	39.35	85.53	42.29	17.24	1.69	0.40
Intervention	17	85.53	42.29	82.06	37.69	-3.47		

*$p < .05$

Table 3 presents the mean and standard deviation results from the Dibels Retell Fluency assessment. The mean score for the Intervention group was not statistically significantly higher (t = -1.69; $p = 0.43$) than the mean score of the Control group ($M = 5.71$). The students in the Intervention group did not score significantly lower than the Control group.

Table 3

Achievement on Dibels Next Retell Fluency Results

Class							Comparison of mean gains/losses	
		Pretest		Posttest		Gains/Loss		
	N	*M*	*SD*	*M*	*SD*	*M*	*t*-value	*p*
Control	17	21.53	10.96	27.24	14.86	5.71	-1.69	0.43
Intervention	17	27.24	14.86	28.06	14.04	0.82		

*$p < .05$

The means and standard deviations for the scores on the Dibels Math Numbers/ Operations are shown in Table 4. The mean score for the Intervention group was significantly lower (t = -1.69; p = 0.00) than the mean score for the Control group (M = 1.05). The students in the Intervention group scored statistically significantly lower than the Control group.

Table 4

Achievement on Dibels Math Numbers/Operations

Class							Comparison of mean gains/losses	
		Pretest		Posttest		Gains/Loss		
	N	*M*	*SD*	*M*	*SD*	*M*	*t*-value	*P*
Control	17	9.13	2.47	10.18	1.70	1.05	-1.69	0.00**
Intervention	17	12.53	2.07	12.53	2.07	0.00		

*p < .05; **p < .01

Means and standard deviations for the scores for the Dibels Math Numbers/Operations Algebra are shown in Table 5. The mean score for the Intervention group was statistically significantly higher (t = -1.69; p = 0.00) than the mean score for the Control group (M = 9.71). The treatment had a medium effect (d = 0.51). Movement via the NeuroNet program increased scores approximately 22%. The students in the Intervention group scored significantly higher than the students in the Control group.

Table 5

Achievement on Dibels Math Numbers/Operations Algebra

Class							Comparison of mean gains/losses	
		Pretest		Posttest		Gains/Loss		
	N	*M*	*SD*	*M*	*SD*	M	*t*-value	*P*
Control	17	8.43	3.01	9.71	2.39	1.28	-1.69	0.00**
Intervention	17	9.71	2.39	11.82	2.48	2.11		

*$p < .05$; **$p < .01$

The effectiveness of NeuroNet on student behavior was measured by an observational checklist. The checklist was administered prior to the beginning of the intervention and at the completion of the intervention. The percentage of gain or loss in student behavior is shown in Table 7. Five of the six traits observed increased from the beginning of the intervention to the end of the intervention. The students in the Intervention group increased in their ability to be organized, decrease over activity, lack of conflict, being prepared for class, and showing self-control.

Table 7

Student Behavior Results

Behavior Trait Percentages	Organization of Materials	Follow Directions	Decreased Over Activity	Lack of Conflict	Prepared for Class	Self-control
Pretest	62%	86%	68%	92%	82%	74%
Posttest	91%	85%	73%	95%	95%	88%

The effectiveness of NeuroNet on student engagement was measured by an observational checklist. The checklist was administered prior to the beginning of the intervention and at the completion of the intervention. The percentage of gain or loss in student engagement is shown in Table 8. The students in the Intervention group increased by 10% or more in every observational area.

Table 8

Student Engagement Results

Trait Percentages	Paid Attention	Participated	Timely Task Completion	Remain On-task
Pretest	51%	28%	69%	74%
Posttest	81%	75%	81%	84%
Gain/Loss	30%	47%	12%	10%

Discussion

Conclusions

Did the movement from the NeuroNet program increase achievement scores in second-grade students? A conclusion can be made that the use of movement along with traditional instruction can improve student scores in math. When looking at the scores in the Dibels math domain of numbers and operations in algebra, there was a significant increase in student performance. These students in the intervention group achieved a mean gain of 2.11. This gain was determined to be statistically significant ($p < .01$). However, there was not a statistically significant increase in scores in Dibels oral reading fluency, retell, or in Dibels math numbers and operations. These results are similar to the findings in the Ericsson study (Ericsson, 2008) in which physical exercise and motor training led to an increase in mathematics test scores.

However, Sallis et al. (1999) found that the effects of movement on achievement simply slowed the decline in scores in reading more than in language. The results were found to be inconclusive.

Will the pairing of movement with an academic task via NeuroNet have a positive effect on student behavior? Percentages in positive student behavior increased by as little as 5% in decreased over activity, and as much as 31% in organization of materials. There was a 1% decrease in following directions. Beaudoin and Johnston (2011) found that fine motor activity caused an improvement in behavior. Ericsson (2008) found that students who had well-developed motor skills had better attention. The results of these studies concur with the results of this study. The results from this study, however, may be different if another rater performed the observations.

Will the pairing of movement with an academic task via NeuroNet have a positive effect on student engagement? Percentages in positive student engagement increased from 10% to 47% according to observed traits. The highest increase was in the area of student participation. The second highest increase was in student attention. The lowest percentage of increase was in on-task behavior. Another study found that concentration seemed to improve after physical activity, but the effect was only suggestive of a comparable increase in achievement (Taras, 2005). However, as in student behavior, results may differ widely according to the observer.

Significance on Student Learning

Teachers have been concerned for years over the students' struggle to achieve increasing expectations on state tests. Many schools have gone so far as to remove recess periods in order to capitalize instruction time. According to the Governor's Office of Student Achievement (2010), student performance is less than 50% on state tests by fourth grade. School personnel have

frequently looked for methods and programs that will increase students' efficient and successful learning. This study shows that movement in the classroom may help students make greater gains on test scores. Movement through the NeuroNet program resulted in an increase in math numbers and operations/algebra. A comparison of the mean gain between the control group (M = 1.28) and the intervention group (*M* = 2.11) showed a greater significant gain in the group that used the NeuroNet program.

What may be of more significance is the improvement in student behavior and engagement. While the decrease in over-activity improved by only 5%, there was a greater improvement in organization, preparation for class, and self-control. These areas would likely end in better student learning. There was a slight decrease in the area of following directions, however, student performance in that area was already high.

Another area of possible significance to student learning is the improvement in student engagement. There was a 30% increase in student attention to teacher instruction. Students' participation in class instruction improved by 47%. The use of the NeuroNet program did positively affect student engagement, which could lead to more efficient learning.

Factors Influencing Implementation

There were factors influencing the results of this study. Students who participated three or more days per week in the exercises were counted in the results. The NeuroNet program recommends implementing the exercises five days a week. Since not all the students had the benefit of all five days due to absences or pull-out classes, the scores may have been negatively impacted.The class was also introduced to a new style of comprehension instruction. It included teaching the students to slow down and pay attention to what they read.This method of instruction may have influenced the slight decline in mean reading fluency scores (mean loss -

3.47). The teacher-researcher and teacher-participant gave the achievement posttests which is not usual at this school. Summative assessments are usually administered by other personnel than the classroom teacher. Students may have been influenced to do less than their best since the tests were not given by the usual administrators.

Implications and Limitations

The results of this study have indicated that movement coupled with academic tasks does have a positive impact on math scores, student behavior, and student engagement. Although there was not a significant increase in reading scores, the increase in student behavior and engagement suggests that increases in other areas of achievement are possible. If behavior and engagement are positively impacted, then student learning would likely be positively impacted as well. Since the math scores did increase, adding movement to the curricular tasks is a valid teaching tool. The results of this study will be shared with the school administrators as well as county office personnel.

There were several limitations to this study. Action research is not as rigorous as other research. The inclusion of a separate class as a control group might have given very different results. There is more room for researcher bias since action research is generally performed on familiar subjects. Student behavior and engagement may have resulted in less of an increase given an impartial researcher and different criteria. The inexperience of the researcher also likely influences the results. The control and intervention groups both had a large proportion of special education students. Given that special education students have an identified need for three to four times as many exposures to subject matter, the necessity of a longer implementation period is expected. This study implemented the intervention for seven weeks. It is likely that a longer implementation period may have a positive influence in other academic areas.

Further rigorous research is necessary to provide conclusive results. There are many studies that have provided results that are suggestive instead of conclusive. These findings are possibly inconclusive because there are as many different types of movement as there are research studies. Additional research would benefit focusing on one type of movement in one situation. Research that focused on how movement affects the special education population as opposed to the regular education population would be particularly useful as well. The findings of this study provide a suggestive use for other second-grade classrooms and schools. Other schools may desire to fund their own research on movement in the classroom.

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Appendix A

Student Behavior Checklist

Students Date:	Organization of Materials	Follow directions/routines	Decreased Over activity	Lack of Conflict	Prepared for Class	Self-control	Organization of Materials	Follow directions/routines	Decreased Over activity	Lack of Conflict	Prepared for Class	Self-control	Organization of Materials	Follow directions/routines	Decreased Over activity	Lack of Conflict	Prepared for Class	Self-control	Organization of Materials	Follow directions/routines	Decreased Over activity	Lack of Conflict	Prepared for Class	Self-control	Organization of Materials	Follow directions/routines	Decreased Over activity	Lack of Conflict	Prepared for Class	Self-control

Appendix B

Student Engagement Checklist

Date: Students	Paid Attention	Participate in Class	Timely Task Completion	Remain On-task	Paid Attention	Participate in Class	Timely Task Completion	Remain On-task	Paid Attention	Participate in Class	Timely Task Completion	Remain On-task	Paid Attention	Participate in Class	Timely Task Completion	Remain On-task	Paid Attention	Participate in Class	Timely Task Completion	Remain On-task