

THE EFFECTS OF TAKING STRUCTURED MOVEMENT BREAKS ON THE
ALGEBRA ACHIEVEMENT OF GIFTED FIFTH GRADERS

A Thesis by

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The following faculty members have examined the final copy of this thesis for form and content, and recommend that it be accepted in partial fulfillment of the requirement for the degree of Master of Education with a major in Special Education.

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ABSTRACT

Students experiencing mental fatigue while pursuing high levels of achievement may refocus attention, gain cognitive benefits, and increase achievement by taking breaks from class work. In this quantitative study, two types of breaks, sedentary versus structured movement, were compared to determine whether one demonstrated greater efficacy for increasing the algebra achievement of gifted fifth graders. Daily ten-minute breaks were taken during math class across a six-week period. When algebra achievement data associated with structured movement breaks were compared to the data associated with sedentary breaks, results indicated that nine out of eleven students made their greatest individual growth during the structured movement break treatment.

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CHAPTER 1

INTRODUCTION

The No Child Left Behind Act (NCLB), enacted in 2001, has had a major impact on schools, teachers and students across the United States. Its emphasis on educational accountability, closing the achievement gap and the use of research-based instructional strategies has caused schools to change the manner in which they educate their students.

Teachers and students are under pressure to perform at ever higher levels academically, with the goal that 100% of students will demonstrate academic proficiency by the year 2014 (NCLB, 2001). Many schools are attempting to meet this goal by increasing instructional time in reading/language arts and mathematics.

A 2008 study published by the Center on Education Policy reported on the impact that NCLB has had on instructional time in 349 nationally representative school districts. It was found that as a result of NCLB, 62% of districts had increased instructional time in language arts and/or math. On average elementary schools added 141 minutes per week in language arts instruction and an additional 89 minutes per week in math instruction. In most cases the added instructional time for math and language arts meant reduced time for other subjects or school day activities. Most districts that increased time in language arts and math also decreased time spent in

learning science, social studies, art, music, or physical education, or at lunch and recess. On average, elementary schools reduced time spent in studying science and social studies by 151 minutes per week, art and music by 57 minutes per week, and physical education and recess by 90 minutes per week (Center on Education Policy, 2008). It is posited that this re-allotment of school day minutes and its resultant impact on language and math instruction will produce in every child the high academic achievement legislated by NCLB.

The effects of NCLB legislation are keenly felt in the large mid-western urban school district where I teach. The last eight school years have seen changes in mandated instructional time, especially in reading/language arts and math. The district now requires that all elementary school children receive 90 minutes of uninterrupted reading instruction daily, with an additional 60 minutes daily in writing instruction and in reading intervention or extension. Sixty minutes daily of math instruction, with an additional 30 minutes daily in math intervention or extension is also mandated by the district.

As a result of these strict instructional guidelines, many schools in the district have seen some increase in achievement level, but at what cost? Teachers and students appear stressed and fatigued. There is little or no time for activities that children have traditionally enjoyed at school, such as being read to for the sheer joy of sharing literature, creating unstructured

artwork, and playing with friends at recess. These activities are all but disappearing as teachers must instead teach additional lessons in an effort to improve **every student's academic performance** to the greatest degree possible.

Despite the constant demand for achievement, students become inattentive many times each day. When students are inattentive, they may fail to focus on the learning task, or they may fail to achieve, in spite of their best efforts to focus on their lessons. Numerous times I have observed in my own students this tendency toward inattentiveness and inability to achieve. This mental fatigue is usually noticeable by mid-morning and increases throughout the day.

In one elementary school situated in an upper-income neighborhood of the mid-western city, a group of gifted fifth-grade students study advanced math during the mid-afternoon. The classes are available to students identified as gifted, and they give an important advantage to those who intend to apply for the middle school Pre-International Baccalaureate (Pre-IB) program during their fifth-grade year. On the whole, students in the gifted program at this school come from families who insist on high achievement. Students feel pressure from many sources, and when the pressure is combined with the fatigue of the day, students show signs of inattention. Since it is unlikely that legislators, administrators, and parents

will withdraw their insistence on ever-increasing achievement, what can help students refocus and achieve when they are mentally fatigued?

CHAPTER 2

REVIEW OF THE LITERATURE

Probably every educator has noted the role of mental fatigue and inattentiveness in children's lack of academic progress. Educators, anxious **that their students should learn, attempt to combat students' inattentiveness by calling out children's names, scolding,** and teaching lessons in a dramatic fashion, usually to little avail. There comes a point for every student when the mind cannot absorb any more without rest, and the student experiences mental fatigue and the accompanying inattentiveness.

Breaks as Mental Fatigue Relief

It is common in the United States for teachers or parents to send children outside to "run off excess energy" or "blow off steam". Over the last approximately 135 years, British philosopher Herbert Spencer's theory that children in confinement accumulate and must disperse surplus energy has become widely-accepted as fact. However, in a study conducted by Evans and Pelligrini (1997), no evidence was found to support the "surplus energy" theory, but research has shown other important reasons for taking breaks.

Effects of Taking a Break on Attentiveness and Behavior

Studies indicate that there are benefits to students' attention and

behavior when they are allowed to take frequent breaks from class work. In 1995, Pelligrini, Huberty, and Jones studied children's ability to focus on academic tasks. Results showed that the longer the time before a break, the more inattentive the children became.

Studies have repeatedly shown that concentration and attention span are improved through physical activity (Caterino & Polak, 1999; Chomitz et al., 2009; Evenson, Ballard, Lee, & Ammerman, 2009; Grieco, Jowers, & Bartholomew, 2009; Mulrine, Prater, & Jenkins, 2008; Ridgway, Northrup, Pellegrin, LaRue, & Hightshoe, 2003; Shephard, 1997, as cited in Lau, Yu, Lee, So, & Sung, 2004; Taras, 2005). After breaks, students are more attentive and ready to continue with academic tasks. It is theorized that the increased ability to focus gained from a physical movement break leads to greater time on task and fewer incidents of inappropriate behavior, thus aiding the student in learning at a faster pace (Ahamed et al., 2007; Coe, Pivarnik, Womack, Reeves, & Malina, 2006; Grieco et al., 2009; Lau et al., 2004; Shephard, 1996, as cited in Taras, 2005; Sibley & LeMasurier, 2008; Tomporowski, Davis, Miller, & Naglieri, 2008). Researchers speculate that the ability to learn faster because of renewed concentration and on-task behavior may account for the well-documented finding that children whose instructional period is shortened by as much as one hour daily, with the time

replaced by movement breaks, do not fall behind academically, and may even excel (Ahamed et al., 2007; Coe et al., 2006; Henley, McBride, Milligan, & Nichols, 2007; Sallis et al., 1999; Sibley & Etnier, 2003; Taras, 2005; Trudeau & Shephard, 2008). An extreme example of this phenomenon **is the Three Rivers, Quebec, project in the 1970's which demonstrated that** even replacing up to 26% of the instructional minutes daily with physical movement did not cause the students to fall behind or struggle academically (Shephard et al., 1994, as cited in Sallis et al., 1999). Unfortunately, this project has never been published in a professional journal, so few details are known about how the experiment was carried out, nor the exact nature of the results. Nevertheless, the evidence indicates that giving students a break for physical activity will likely improve their attentiveness and behavior without compromising their academic achievement.

Effectiveness of Types of Breaks

Pelligrini and Davis (1993) (as cited in Pelligrini & Smith, 1993) concluded that there is value in taking a break during instruction. However, their research showed that the type of break has an influence on children's attentiveness to academic tasks after the break. The results of their study indicated that "vigorous play is negatively related to attention on a post-recess achievement task, while sedentary playground behavior was positively correlated with attention and negatively correlated with fidgeting"

(p. 58). Different results were found in studies by Coe et al. (2006), Grissom (2005), and Tomporowski et al. (2008), which showed that vigorous activity is associated with higher grades, and aerobic exercise is associated with increased cognitive ability and academic achievement. But Sibley and Etnier (2003) found that the type of exercise practice did not appear to matter. Resistance training, skills practice, physical education classes and aerobics programs all yielded an overall effect size of 0.32, indicating exercise to be significantly related to increased cognition.

Toppino, Kasserman, and Mracek (1991) (as cited in Pelligrini & Bohn, 2005) indicated that structured breaks may not produce the desired attentiveness because the student is still required to focus on instructions or some type of task. Other studies do not support Toppino's findings, however.

A 2004 study found that structured activity tends to result in more vigorous activity than unstructured breaks (Stewart, Dennison, Kohl, and Doyle, 2004), a result which may be beneficial since vigorous activity is associated with higher grades (Coe et al., 2006; Tomporowski et al., 2008).

In another study, researchers explored the effects of a classroom-based activity program on on-task behavior (Mahar, Murphy, Rowe, Golden, Shields, & Raedeke, 2006). Students participated in the moderately-to-vigorously-active *Energizers* program during one 10-minute break daily for 12 weeks. Results indicated an 8% improvement in the mean on-task behavior for the intervention group over the course of the study. While no

apparent attempt was made to measure any changes in cognition or achievement that may have resulted from an increase in on-task behavior, one may speculate that such a change could occur if the purpose of desiring to increase student on-task behavior is to increase learning and achievement.

Movement, the Brain, and Cognition

Recent research in the area of brain development and function indicates that physical activity brings about both chemical and structural changes in the brain. A Salk Institute study showed that when exercising, mice experience chemical changes in the brain, which increase both the number of neurons and the number of connections they make (Gage, 1999). Studies point to similar brain development in people as they exercise (Jensen, 2008; Sibley & LeMasurier, 2008; Summerford, 2001). There is further evidence that exercise builds cells in the hippocampus, which is an area of the brain that deals with learning and memory (Mulrine et al., 2008; Vaynman, Ying, & Gomez-Pinilla, 2004). In addition, exercise promotes the growth of a brain chemical called brain-derived neurotrophic factor (BDNF), which appears to facilitate communication between neurons (van Praag, Kempermann, & Gage, 1999, as cited in Sibley & LeMasurier, 2008). Mice with the highest levels of BDNF also had the best recall and the fastest

learning rate (Vaynman, Ying, and Gomez-Pinilla, 2004). There is reason to believe that BDNF functions similarly in humans.

In addition to neural and cell development, exercise increases oxygen and glucose in the brain, leading to better brain function (Friedland, 1990, as cited in Sibley & LeMasurier, 2008; North, McCullagh & Tran, 1990). Studies indicate that physically fit children have more cortex activity and can perform cognitive tasks more quickly. Vigorous aerobic activity has been associated with increased cognitive performance in tasks requiring creativity, planning, and evaluation of thoughts and actions (Tompson et al., 2008).

While exercise changes the structure of the brain, studies indicate that **exercise may also improve mental health by increasing the levels of “feel-good” brain chemicals serotonin and dopamine (Summerford, 2001; Tomporowski et al., 2008)**, by helping people cope with stress, anxiety, and self-image and by promoting clearer thought and improved memory (Chomitz et al., 2009; Mulrine, Prater & Jenkins, 2008). All of these exercise benefits may contribute to increased cognitive abilities and academic achievement.

Eric Jensen, well-known for his work in the field of brain-based education, explains in his book *Teaching with the Brain in Mind* (1998) that movement triggers memory. Nearly 80 studies "suggest strong links between the cerebellum [the area of the brain commonly associated with

movement] and memory...language, attention, ...and even decision making. These findings strongly implicate the value of physical education, movement, and games in boosting cognition" (p. 84). The likelihood of creating a strong movement-memory link can be increased if the limitations of brain function are respected. Waite-Stupiansky and Findlay (2001) indicate that a period of about ten minutes is the maximum length of time that the brain can maintain a constant, intense focus. Taking frequent activity breaks helps to put into long-term memory the new information learned just before the break, argues Jensen (1998). However, my 2010 research project, in which I studied the effects of unstructured breaks on academic achievement, did not support this conclusion. Conversely, the students demonstrated a greater ability to learn and remember material taught after a break, rather than material taught before a break.

Movement Breaks and Achievement

The research evidence shows that taking a movement break can trigger physiological changes that can improve cognition and help children refocus on academic tasks. There is, however, also some evidence that taking a movement break can actually go beyond improved attention and on-task behavior, and can help children learn. Pelligrini and Bjorklund (1996) (as cited in Waite-Stupiansky & Findlay, 2001) argue that "breaks

strategically placed during and between cognitively demanding tasks increase children's attention and may increase learning" (p. 185).

Results of studies on movement and academic achievement are mixed. Some indicate little or no correlation between exercise and academic achievement (Coe et al., 2006), but others give evidence that exercise can have a positive effect on academics (Ahamed et al., 2007; Coe et al., 2006; Grieco et al., 2009; Mulrine, Prater, & Jenkins, 2008; Sibley & LeMasurier, 2008; Taras, 2005). According to these studies particular aspects of achievement may be associated with exercise. Some studies indicate that problem-solving ability improves with exercise (Grieco et al., 2009; Lau et al., 2004; Mulrine, Prater, & Jenkins, 2008; Sibley & LeMasurier, 2008). Chomitz et al., (2009) contend that physical activity is associated with improvement in math. Other research has associated physical activity with reading and language achievement (Mulrine, Prater, & Jenkins, 2008; Tremarche, Robinson & Graham, 2007). Both math and reading ability increases were documented in several studies (Chomitz et al., 2009; Dwyer, Sallis, Blizzard, Lazarus & Dean, 2001, as cited in Lau et al., 2004; Shephard, LaVallee, Volle, LaBarre and Beaucage, 1994, as cited in Lau et al., 2004). At least three studies demonstrated a relationship between physical activity and an increase in overall achievement test performance (Chomitz et al., 2009; Sibley and LeMasurier, 2008; Tomporowski et al., 2008).

It is unclear why so many research studies on movement and academic achievement have had such different results, but perhaps one reason is that the terms *academic achievement* and *physical activity* are not concisely defined. Some of the studies used standardized test scores as the measure of achievement, while others used grades as the measure. Some used self-reported grades from students. Similarly, the definition of physical activity was not consistent between studies, as some used specific measures of fitness or endurance or strength, while some only recorded the time spent in measured levels of activity. Some defined physical activity to mean participation in a P.E. class.

It is also possible that more factors are involved in producing academic achievement than just participating in physical activity. For this reason, studies often stopped short of claiming causation in the exercise/achievement relationship, instead describing the relationship as one of association or correlation. Possible factors that could affect this relationship include age, size, socio-economic status, adult expectations, and personal motivation of each student.

One result that many of the studies agree on, however, is that regardless of the working definitions used and the myriad of individual student characteristics, taking time for movement breaks, even as much as **an hour a day, will not compromise the students' academic performance**. In study after study, it was found that students who participated in increased

physical activity during the school day, though it resulted in less academic instruction, did not lag behind the control group nor struggle to keep up. Increasing the time spent in physical activity by reducing the time spent in academic instruction does not negatively affect the level of academic performance (Ahamed et al., 2007; Coe et al., 2006; Henley et al., 2007; Sallis et al., 1999; Sibley & Etnier, 2003; Taras, 2005; Tomporowski et al., 2008; Trudeau & Shephard, 2008).

Even though research indicates the value of movement in relation to attention and possibly academic achievement, schools do not currently seem to give much credence to the research. Schools continue to reduce the number of minutes that once were used for breaks such as recess, perhaps because it seems counter-intuitive to suggest that a similar or greater degree of achievement might be realized through physical activity than through higher expectations and increased instructional time. Given the high-stakes nature of education in the 21st century, it seems worthwhile to continue to study whether and how movement breaks might affect academic progress. Structured activity breaks that incorporate moderate to vigorous movement may be of special interest in the study of achievement.

In this study of how structured activity breaks affected academic achievement, the term *academic achievement* referred to a student's acquisition of algebra concepts and skills, as measured by the scores earned on formative and summative quizzes. The term *structured activity break*

referred to a ten-minute period during math class when the students participated in teacher-led *Energizer* exercise (Mahar, Kenny, Shields, Scales & Collins, 2006a).

In an effort to work smarter, rather than harder, I posed the following research question: How would gifted fifth grade **students' math achievement** be affected by physical participation in *Energizer* activities during the first ten minutes of algebra class?

CHAPTER 3

METHODOLOGY

The purpose of this study was to discover whether participating in a ten-minute exercise break daily during math class would increase the accuracy with which a group of gifted fifth-graders learned algebra. As a comparison, data was gathered regarding **the students' learning** accuracy following sedentary breaks.

Participants

School Demographics

The participating school is located in the largest school district in a midwestern state. Though the school is certainly urban by location, it is situated in the midst of an old and wealthy neighborhood. Most children from the neighborhood attend the school, and because the school is an international studies magnet school, other children from all over the city attend, as well. The two-story school building was built in the 1930's and is a stately example of fine craftsmanship. Its hardwood floors, high ceilings, large windows, cloakrooms and archways lend a studious air of high expectation to the school. The school is not, however, behind-the-times when it comes to technology and other amenities. The students' parents tend to be very active in giving their time and attention to the needs of the

school. There is a very high attendance rate at every school function, and many parents volunteer at the school on a weekly or even daily basis. The parents expend a great deal of effort on raising additional funds for the school to use as needed, even going so far as to raise funds for and then oversee the construction of a gymnasium/cafeteria for the school.

The school currently has 295 students enrolled. Approximately 57% of the students are male and 43% are female. About 66% of the students are considered economically advantaged and 34% are considered economically disadvantaged. Regarding ethnicity of students, 67% are White, 13% are African-American, 4% are Hispanic, and 16% identify with other ethnic groups.

Classroom Demographics

The participants in this study were a class of 11 gifted fifth-graders who were ten or eleven years old. Students were selected for participation in this advanced level class based on superior grade-level math assessment scores (above 90%). Study participants were those students who met the grade-level assessment score criteria and also had parent permission. All of the students were Caucasian, except for one boy who was African-American. With one exception, the students all had stable home-lives and lived with both of their parents. The parents were all professionals, placing the students and their families in the middle to upper SES category. Nine of the

participants had been identified as gifted, while two were in the process of being tested for giftedness.

Since I taught all of these students last year, I was familiar with the dynamics of both the class and the individuals. All of the students were capable of high achievement. There was little evidence of underachievement among the students, and in general, they put pressure on themselves to achieve. Though these students were motivated and able to learn easily, they often hit an academic wall which made learning difficult. Two of the students in the class had ADHD and took medication for the condition at lunch. By late morning, the students became easily distracted and in turn, often distracted others, further hampering their ability to learn.

Procedure

For six weeks the students participated in a 10-minute break at the beginning of their math enrichment class where they studied creating and solving algebraic equations, based mostly on word problems. The lessons included learning to use negative numbers, the distributive property, and ratios and proportions in algebraic equations (see Appendix A). While this level of math work is not generally part of the fifth grade curriculum, these students had a history of high math achievement. That, combined with their giftedness, means that they were likely to have encountered math skills and concepts that most fifth-graders had not. I chose creating and solving

algebraic equations as the academic content for this study because the students had very little familiarity with these skills.

During the first three weeks of the study, the daily break consisted of quiet, sedentary activities, such as reading silently, drawing or just resting. During these breaks the students sat quietly at their desks in order to control for variables such as socializing or moving around the room, which could unintentionally affect the results. Following the ten-minute break, class resumed for 20 minutes of instruction and practice. In order to be certain that students were not accessing outside resources that would invalidate the study, students were required to leave all of their work in the resource room.

During the final three weeks of the study, the ten-minute break consisted of the entire class participating in a teacher-led classroom physical activity program called *Energizers* (Mahar, Kenny, Shields, Scales & Collins, 2006a). See Appendix B for sample *Energizer* activities.

Research has shown the *Energizers* program to be effective in increasing post-break on-task behavior (Mahar et al., 2006b), which may lead to increased post-break learning. The *Energizer* break was followed by 20 minutes of algebra instruction and guided or independent practice.

Instruments and Data Analysis

The week before the study began; the students took a pretest over the material to be covered (Appendix C). Throughout the study, in order to more exactly measure achievement, a table of skills necessary to solve each algebraic problem was used to score each task for each child (Appendix D). Each time that a **student's written work demonstrated** correct completion of one of the skills listed on the table, that student received a tally mark. The tally total was compared to all of the possible tallies for that equation and a percentage found. In addition to allowing for comparison of equation solutions that required different skill sets, generating a raw score with the skill table and translating it into a percentage allowed for the measurement of small increments of achievement.

A brief formative quiz parallel to the pre-test and the summative tests was given at the end of each week. Summative tests identical to portions of the pretest were given at the end of Weeks Three and Six. The Week Three summative test consisted of items #1-5 from the pre-test. The Week Six summative test consisted of items #6-10 from the pre-test.

The score from the pre-test established a baseline for each student. **Each student's weekly quiz was** scored using the skills table, and the percentage was analyzed for trend. A comparison was made between each **student's pre-test** scores and his or her summative scores. Special attention was given to the cluster of scores that resulted during the three-week period

when the students participated in sedentary breaks. Likewise, the cluster of scores generated in the second three-week period, when the students participated in *Energizers*, was **analyzed. In each case, each child's** individual progress during each three-week period was found by comparing individual baseline data from the pre-test with each summative score separately. The improvement between the pre-test items and the identical summative test items was measured by percentage points and analyzed. In addition, the mean of the **class's weekly quiz scores** was graphed and analyzed for trend. The class **mean resulting from each treatment cluster's** formative and summative tests was also analyzed to see if students scored better under one treatment or the other.

Results

Individual

The results of this study indicated that a program of structured movement breaks may be more efficacious in learning algebra than sedentary breaks. In this study every student's algebra achievement scores rose dramatically between the pretest and the two summative tests, taken at the end of Week Three and the end of Week Six. Both summative tests showed that all of the students had learned a great deal regardless of the type of break they had participated in during the three weeks prior, but most children earned higher scores at the end of Week Six, after the *Energizer*

break treatment, than at the end of Week Three, after the sedentary break treatment.

Individual students' **scores** as shown in Tables 1 and 2 were attained by analyzing the way that the student completed each equation. Each child earned points whenever he or she demonstrated correct use of the skills required to solve the equation. The points earned in each equation were recorded on a table of skills, and a percentage score of correct skill usage was derived from the raw point score. They were recorded in Table 1.

TABLE 1
INDIVIDUAL STUDENT TEST PERCENTAGE CORRECT WITH SEDENTARY BREAKS

	Student										
	1	2	3	4	5	6	7	8	9	10	11
Pretest Items #1-5	0	15	0	11	6	0	0	0	6	0	6
Week 1 Formative	80	100	80	60	60	100	70	50	100	90	90
Week 2 Formative	62	88	88	92	77	88	96	92	92	92	67
Week 3 Summative	42	80	94	62	65	48	28	54	97	85	34
Sedentary Break Individual Range	80	85	94	81	71	100	96	92	91	92	84
Sedentary Break Individual Mean	46	71	66	56	52	59	49	49	74	67	42

TABLE 2

INDIVIDUAL STUDENT TEST PERCENTAGE CORRECT WITH **ENERGIZER** BREAKS

	Student										
	1	2	3	4	5	6	7	8	9	10	11
Pretest Items #6-10	7	5	2	1	1	5	1	2	19	2	0
Week 4 Formative	84	84	68	84	80	72	68	84	76	96	88
Week 5 Formative	62	90	76	94	60	86	66	96	54	35	74
Week 6 Summative	85	87	95	88	81	94	88	91	100	88	70
Energizer Break Individual Range	78	85	93	93	80	89	87	94	81	94	88
Energizer Break Individual Mean	60	67	60	67	56	64	56	69	62	55	58

Comparison of Figures 1 and 2, along with Tables 1 and 2, shows a benefit for the majority of the class when utilizing **Energizers**. However two students (Students #3 and #9) demonstrated their greatest individual growth in the first three-week period when they participated in sedentary breaks. This was indicated by a comparison of their pre-test scores of questions #1-#5 to their summative test score over the same questions and finding the range, 94 and 91 respectively. The remaining nine members

showed their greatest individual growth in the last three-week period when the class participated in *Energizers*. Students' second summative test scores were compared to their scores on identical pre-test questions #6-#10, with the range as their measure of growth, as shown in Table 2.

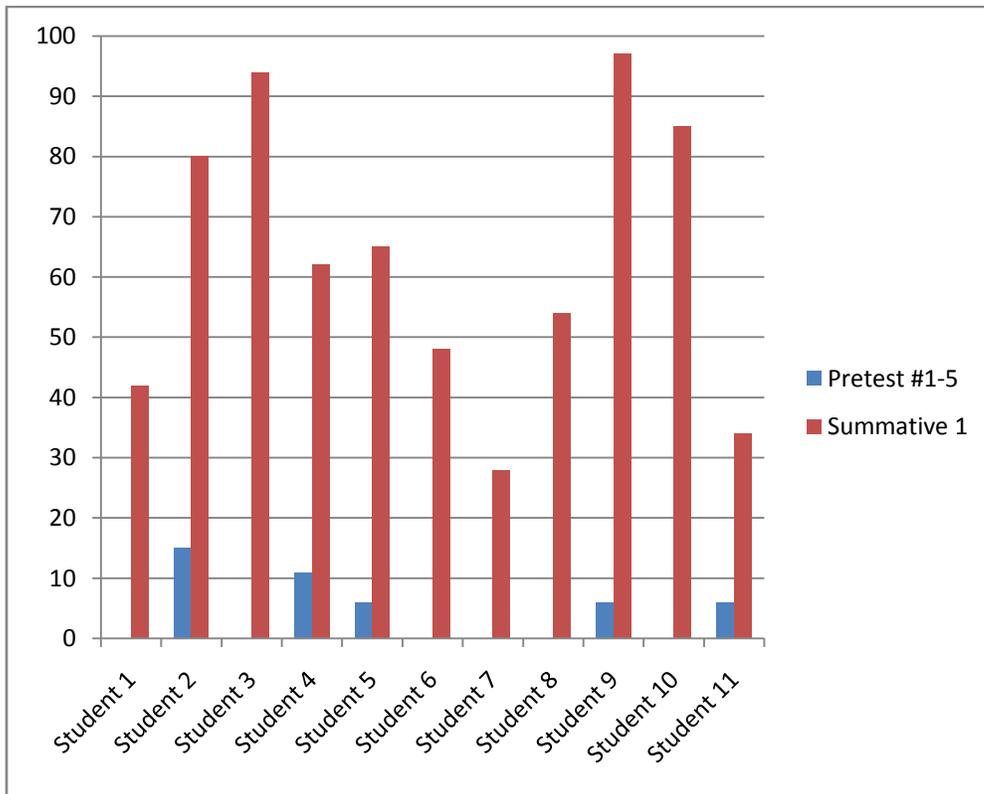


Figure 1. Individual growth between pre-test and summative #1 in percentages following sedentary breaks.

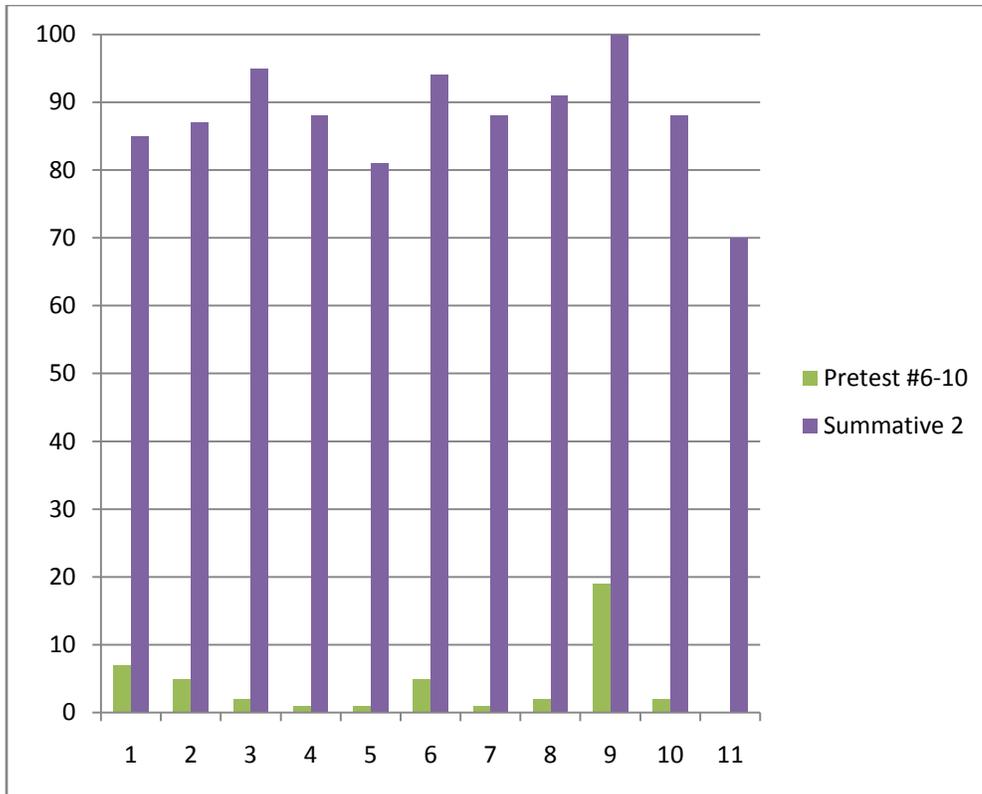


Figure 2. Individual growth between pre-test and summative #2 in percentages following *Energizer* breaks.

When each **child's individual scores** were analyzed (see Appendix E), the results were mixed. Comparison of **students' lowest and highest scores** of the study, as shown in Table 3, showed that during the three-week period when students were participating in sedentary breaks, eight students scored their lowest score of the entire study. Three students earned their lowest scores during the *Energizer* break time frame. (One student scored the same lowest score twice, once under each intervention type, thus accounting for a 12th score.) Regarding highest scores, students were equally split, with six

earning their highest scores during the sedentary break portion of the study and the other six scoring highest during the *Energizers* break portion (Again, there are twelve scores since one student had two identical highest scores, one of which occurred in each half of the study.) In this breakdown of scores, the *Energizer* break still appears to better facilitate algebra learning since fewer children had poor test scores during the structured movement break phase of the study.

TABLE 3
INDIVIDUAL STUDENT LOWEST SCORE BY PERCENTAGE AND BREAK
TYPE

Lowest Score for Each Student	Student Number	Type of Break When Lowest Score Was Earned
28	7	Sedentary
34	11	Sedentary
35	10	<i>Energizers</i>
42	1	Sedentary
48	6	Sedentary
50	8	Sedentary
60, 60	5	Both
60	4	Sedentary
68	3	<i>Energizers</i>
76	9	<i>Energizers</i>
80	2	Sedentary

TABLE 4
INDIVIDUAL STUDENT HIGHEST SCORE BY PERCENTAGE AND BREAK
TYPE

Highest Score for Each Student	Student Number	Type of Break When Highest Score Was Earned
100, 100	9	Both
100	6	Sedentary
100	2	Sedentary
96	10	<i>Energizers</i>
96	7	Sedentary
95	3	<i>Energizers</i>
94	4	<i>Energizers</i>
92	8	Sedentary
90	11	Sedentary
85	1	<i>Energizers</i>
81	5	<i>Energizers</i>

TABLE 5
NUMBER OF TEST SCORE EXTREMES ASSOCIATED WITH EACH BREAK

	Individual Students' Lowest Score of the Study	Individual Students' Highest Score of the Study
Scores Earned During Sedentary Break	8	6
Scores Earned During <i>Energizer</i> Break	4	6

Class

The class mean test score increased by 25 percentage points on the Week Six summative test as compared to the Week Three summative test. Because the third week summative test mean was by far the lowest of any of the weekly tests, the fact that the Week Six summative test class mean was increased by 25 percentage points may only indicate that there may have been factors involved that produced a low score during the third week that did not truly represent the skill of the students.

When the class mean of each weekly formative and summative test are separated out, the data showed a fluctuating trend each week, see Figure 3, with the highest class mean score during the sedentary break intervention occurring in Week Two, and the highest class mean score during the *Energizer* intervention taking place in Week Six. These two high class mean scores, 84% and 87% respectively, differed by only three percentage points, though that data still indicates that structured movement breaks facilitated greater growth in fifth grade students learning algebra. When all formative and summative quizzes were considered, the class mean during the first three-week period was 76%, and the class mean during the second three-week period was 80%, a difference of 4 percentage points, again indicating that structured movement breaks may assist some students in learning.

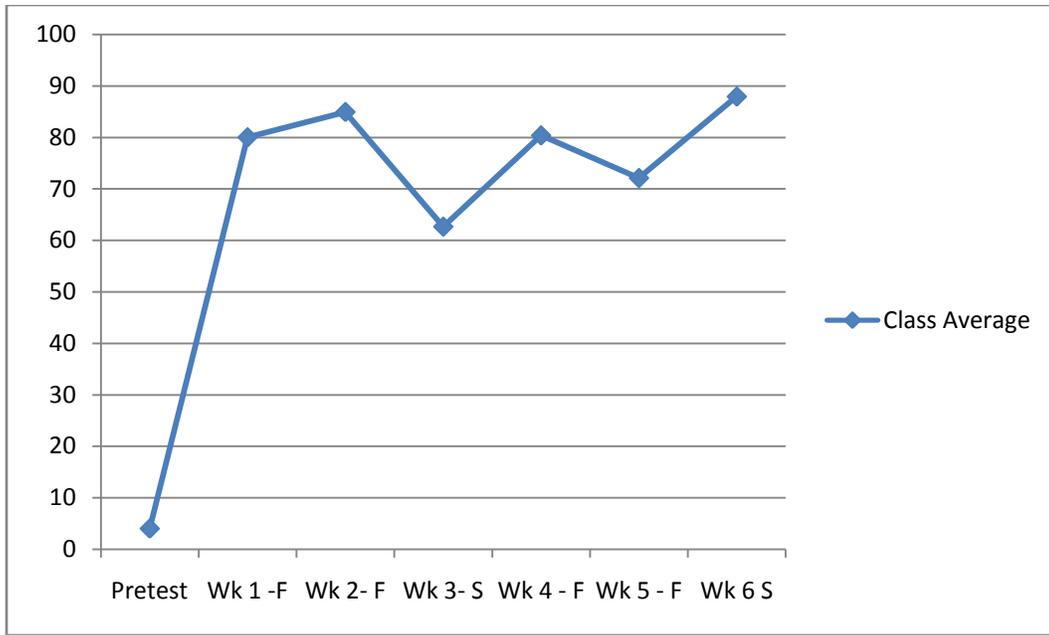


Figure 3. Class average on weekly tests in percentages.

Discussion

The results of this study generally supported the theory that structured physical exercise breaks can help increase academic achievement. Though supporting evidence in my study was not strongly conclusive, the results do show that movement breaks were associated with higher grades and may be associated with improvement in math (Chomitz et al., 2009). It is difficult to know whether movement breaks were associated with improvement in math in this study since achievement was not measured in other academic areas. However, comparison of math achievement under two treatments reveals that nine out of eleven students scored higher when they participated in movement breaks, thus establishing some support for the theory that movement breaks are associated with improvement in math.

My study also supported previous research which has shown conclusive evidence that physical activity restores concentration and improves attention span ((Caterino & Polak, 1999; Chomitz et al., 2009; Evenson, Ballard, Lee, & Ammerman, 2009; Grieco, Jowers, & Bartholomew, 2009; Mulrine, Prater, & Jenkins, 2008; Ridgway, Northrup, Pellegrin, LaRue, & Hightshoe, 2003; Shephard, 1997, as cited in Lau, Yu, Lee, So, & Sung, 2004; Taras, 2005). It is theorized that the focus gained through physical activity leads to greater time on task, improved behavior, and increased learning speed (Ahamed et al., 2007; Coe, Pivarnik, Womack, Reeves, & Malina, 2006; Grieco et al., 2009; Lau et al., 2004; Shephard, 1996, as cited in Taras, 2005; Sibley & LeMasurier, 2008; Tomporowski, Davis, Miller, & Naglieri, 2008). The high-test scores of the children in my study lend credence to the conclusions from other research. Though I made no attempt to measure improvement in attention or in learning speed, it seems likely that steadily improving algebra test scores could be indicative of improved learning skills, such as concentration, and learning speed.

In regards to student behavior, off-task behavior actually increased during the first three days of the implementation of the structured movement break, perhaps giving support to a study by Pelligrini and Davis (1993) (as cited in Pelligrini & Smith, 1993), which showed that vigorous movement may actually increase off-task behavior, while sedentary play tends to increase on-task behavior. While a few of my students misbehaved

out of good-natured exuberance, other children misbehaved out of self-consciousness in performing the movements in the presence of their peers. While these misbehaviors tapered off, some children continued to feel embarrassed and did not move vigorously, perhaps skewing the research results. The fact that these children increased their algebra achievement despite their resistance to the movement program may indicate that gaining the physiological benefits of exercise is not contingent on enthusiasm about any particular type of movement and that more moderate play may have greater benefits than vigorous exercise.

Some studies, such as those by Coe et al. (2006), Grissom (2005), and Tomporowski et al. (2008) show that vigorous exercise is associated with higher grades and academic achievement. In this study, five students exercised vigorously on most occasions. **When each individual's** test score mean from both the sedentary break and structured movement break are compared, two of these students scored higher, and apparently benefited more, throughout the movement break, and the other three students scored higher during the sedentary break, thus likely demonstrating a greater benefit from the sedentary break. Of the six students that resisted sustained vigorous exercise, one benefited most from the sedentary break, and five appear to have benefited most from the *Energizers* break. However, of the four test scores of 100% that were earned during this study, three occurred during the sedentary break treatment, demonstrating

perhaps that different types of breaks work for different people and that no intervention works well for everyone. Regarding the effects of vigorous or moderate exercise on academic achievement, some studies have found little or no correlation between physical exercise and academic achievement (Coe et al., 2006), but the results of this study indicated enough of an association between exercise and higher grades, in math particularly (Chomitz et al., 2009), to merit further study. It seems significant that only two students who participated in vigorous exercise achieved their greatest growth during the *Energizer* break, while five students who exercised moderately made their greatest gains during the *Energizer* movement breaks.

TABLE 6
ASSOCIATION BETWEEN VIGOROUS EXERCISE AND ACHIEVEMENT IN
INDIVIDUAL STUDENTS
(N=11)

	Students who exercised vigorously	Students who did not exercise vigorously
Excelled in sedentary break	2, 9, 10	3
Excelled in exercise break	1, 11	4, 5, 6, 7, 8

Notes: The determination of which students exercised vigorously is generalized and is based entirely on teacher observation.

The students took a two-question survey after the study had concluded. They were asked which type of break they had liked the most

and which type of break they thought had helped them learn the most. Nine children indicated that they liked the sedentary breaks best, while two preferred the *Energizer* breaks. Nine children also said that they thought the sedentary break helped them learn the most, and two said that *Energizer* breaks had helped them to learn most. Every child but one chose the same type of break in response to both questions.

Two students in the class have ADHD. It was anticipated that these students would prefer the *Energizers* break and would learn algebra more quickly when taking that type of break. This turned out to be true of only one of the students. Of the two students, one preferred the sedentary break and thought that it helped the most. The data of Student #3 proved that the **student's perception was correct. The other of these** students preferred the *Energizer* break but reluctantly answered that the sedentary break had probably helped the most in learning. This student was not correct, as can be observed in the data of Student #1. This student actually learned more through the *Energizer* breaks, which he liked so much. Four other students who took the survey were incorrect in saying that the sedentary break had helped them learn the most.

In this study, there were many factors that may have caused or been an effect of the **students'** increased learning, but these effects must be deduced **based on the students' scores because** I do not have the knowledge and resources to measure change in **a student's** concentration,

attentiveness, cognition, or problem-solving ability (Grieco et al., 2009; Lau et al., 2004; Mulrine, Prater, & Jenkins, 2008; Sibley & LeMasurier, 2008). Nor could I measure brain chemical and structural changes (Jensen, 2008; Sibley & LeMasurier, 2008; Summerford, 2001), nor oxygen and glucose levels (Friedland, 1990, as cited in Sibley & LeMasurier, 2008; North, McCullagh & Tran, 1990). Because I have seen some academic results when my students took structured movement breaks, I know, based on scientific studies, that it **is likely that the students' brain structures and brain** chemicals are growing and changing and that their cognitive abilities are improving.

In my Spring 2010 study I conducted research concerning the efficacy of allowing children to take breaks periodically throughout the school day. I discovered that I could fully support the work of Pelligrini and Bjorklund (1996) (as cited in Waite-Stupiansky & Findlay, 2001). **"Breaks strategically placed during and between cognitively demanding tasks increase children's attention and may increase learning"** (p. 185).

It seems counterintuitive to believe that giving children breaks from schoolwork may actually increase their ability to learn, and giving them breaks for movement may be especially valuable. While no single type of break will work for everyone, there is clear evidence that taking time for movement breaks, even as much as an hour a day, will not compromise the **students' academic** performance (Ahamed et al., 2007; Coe et al., 2006;

Henley, McBride, Milligan, & Nichols, 2007; Sallis et al., 1999; Sibley & Etner, 2003; Taras, 2005; Trudeau & Shephard, 2008). The results from this study showed that structured movement breaks may even help.

Implications for Practice

Research has substantiated the value of taking occasional breaks throughout the school day to relieve mental fatigue, refocus and renew attention, and to aid students in increasing achievement. It seems certain that best practice would dictate that all students should have regular breaks **in their schedules. What isn't so clear is whether breaks should follow a** certain format in order to gain the greatest efficacy in helping children achieve academically. The research has had mixed results and, therefore, mixed conclusions on this topic. Regarding movement breaks specifically, however, the research has come to one consistent and reliable conclusion. **Taking a movement break will not compromise any student's academic** achievement even when the children lose instructional time.

This is where practice should begin. Research shows that giving students movement breaks cannot hurt them and appears to even help them. Beyond this, personal experience with the students, as well as trial and error should guide practice. By observation educators know when students are fatigued and need a break. Likewise, observation will indicate when students are refreshed, attentive, and ready to work following a break.

If academic achievement is the goal when students are given movement breaks, there are questions regarding taking breaks that must be answered before best practice can be determined. For example, additional study, both formal and casual, must take place on the question of whether taking breaks, and particularly movement breaks, can reliably increase **students' achievement. If so, is there a formula of time and frequency and activity that brings optimal achievement for every student?** Until specifics are known, perhaps best practice is to give students frequent movement breaks and observe what happens with their achievement.

Limitations

As with most studies, the research design in this study contains inherent flaws. The participant sample was purposive rather than randomly chosen, and the sample was rather small. The participants demonstrated little diversity regarding ethnicity, gender, exceptionality, ability level, life experience, and SES level. Because of this, any comparisons made between groups of children would have likely been invalid.

Another limitation was difficulty with scheduling. It was not possible to schedule the study for six complete and consecutive weeks, owing to the Labor Day holiday followed by an in-service day. The best solution that I found was to begin the study on Thursday, August 26, so that the first week of the study had only two days, off-setting the two vacation days. The two-

day partial week commencing August 26, when joined with the three-day partial week following Labor Day, comprised a full week, while making the schedule such that all other weeks of the study were complete and consecutive weeks. One implication of this limitation was that the apparent effects of the sedentary break treatment may in actuality have been a **reflection of students' four-day school absence.**

Another limitation is that the students did not particularly care for the *Energizers* structured movement program, though there were some activities that they did enjoy, such as Silent Signs (Appendix B). Perhaps a different exercise program would have produced a different result. It may just be that no exercise program would have produced a different result because the students preferred the sedentary break. It is not often that they are given ten minutes to read, draw or rest and it seemed luxurious to them.

It could be, as well, that the study could not elicit the full effects of vigorous exercise because we were limited in both space and time. Perhaps exercising in a larger space, across a longer period of time would have encouraged all of the students to enthusiastically participate in the *Energizers* and would have produced a different result regarding the effects of exercise on academic achievement.

Additionally, only twenty minutes each day was set aside for algebra class. While the children learned a great deal in that brief time, perhaps a

longer period of algebra daily would have increased the learning exponentially.

Two irregularities caused me to rearrange the planned structure of the research. Well into the first three-week session and just before the first summative test, I discovered that question #4 on the pre-test and first summative was actually a poorly written equation. It was possible for the students to guess at the answer without using any algebra, so I removed that question from the first summative test. I did not re-evaluate the pre-tests with #4 removed simply because the children had been unable to solve the equation on the pre-test and it would have made no difference in their scores.

The second irregularity came at the end of Week Five when it became obvious by the formative test that the children had not adequately learned to use the distributive property to solve algebraic equations. I decided that I would have to re-teach this skill during Week Six and forgo my other plans. However, after teaching only one additional lesson from Chapter 5, the students had learned the skill so well that I decided to return to Chapter 6 and continue with my plans. Perhaps the *Energizer* breaks helped the children to learn quickly the same material that they had found so difficult just three days before.

Since math builds on itself, it is also important to be cautious about making any claims regarding data gathered during the final three weeks, the

structured movement break phase of the study. Though the focus skills in each chapter were new each week, the children relied on prior knowledge to help themselves learn new knowledge. All achievement made by the children was built on knowledge from other times and places, including the knowledge gained during both the sedentary and the *Energizer* phases of this research. It is difficult to say how and where the children learned all of the skills they needed in order to achieve so highly in algebra.

Implications for Future Study

Further study on the topic of movement breaks should be conducted to confirm which types of movement can facilitate renewed concentration, **on-task behavior, and increased academic ability. Does a student's enthusiasm** for a particular movement or sport make a difference in the achievement? Does the length of the break change how effective a particular break is? Does the length of the class before or after the break change the effectiveness of movement breaks? Are there specific subjects in which students achieve after having a structured movement break?

In the future, perhaps research can be done to simultaneously **measure many aspects of a person's response to mental fatigue and** inattentiveness, of taking a structured movement break, and of refocusing. Gathering additional data by measuring glucose and oxygen levels, as well as brain chemicals, all while a person is taking a structured movement

break, could gain valuable new knowledge. I anticipate that with enough manipulation of the variables, some of these basic questions about how the body and mind work together will be answered in the future.

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APPENDIXES

APPENDIX A
RESEARCH STUDY LESSON PLANS

Using Real World Algebra: Understanding the Power of Mathematics by Edward Zaccaro

Prior to Week 1 – pretest (also used as summative tests during Week 3 and Week 6)

Week 1 sedentary break

Day 1- Introduce “Chapter 1: The Language of Algebra”. Read pages 1-3 in character parts. Demonstrate how words are turned into math language. Match word problems with expressions pg. 5.

Day 2 – Review turning words into math language. Finish page 5 and begin on page 6 (Level 1).

Day 3 – Review how to write more complicated expressions (Level 2). Complete selected Level 1 and Level 2 problems.

Day 4 – Introduce “Chapter 2: Solving Equations”. Read pg 9-12, emphasizing the three steps of algebra and the rule of equal treatment. Demonstrate each step.

Day 5 – Formative: similar to pretest #1 question. Review the algebra rules. Solve together a couple of the problems on pg. 13. Students solve the remainder.

Week 2 sedentary break

Day 1 – Review rules for algebra and introduce new skill of adding or subtracting to eliminate numbers (pg. 14). Review turning words into math language. Students solve problems pg. 15.

Day 2 – Introduce reciprocals on pages 16-17. Demonstrate skill and practice on desk. Solve equations pg. 18.

Day 3 – Review reciprocals and algebra rules. Complete pg. 18.

APPENDIX A (continued)

Day 4 – Introduce the concept of subtracting n 's from both sides.

Solve several of the equations on pg. 19 together, then students solve them alone.

Day 5 – Formative –similar to pretest #2. Do selected problems from Level 1 and Level 2.

Week 3 sedentary break

Day 1 – Introduce “Chapter 3: Using Algebra to Solve Problems”.

Read pgs. 25-28. Groups work together to write and solve equations pg. 29.

Day 2 – Read pg. 30 and review algebra used in problems. Review correct form. Students solve selected Level 1 and Level 2 word problems.

Day 3 – Students continue working on Level 1 and Level 2 problems (pg. 31-32).

Day 4 – Introduce Chapter 4: Negative Numbers. Read pg.35-36. Act out negative numbers on human number line.

Day 5 - summative test for sedentary break treatment – pretest #1, 2, 3, 4, 5

Week 4 Energizers structured break

Day 1 – Introduce rules for working with negative numbers. Read pages 37-39 (adding and subtracting negative numbers). Do problems pg. 39.

Day 2 – finish doing problems pg. 39. Introduce Multiplying and Dividing Negative Numbers.

Day 3 – Review multiplying and dividing negative numbers. Students do pg. 42 equations.

Day 4 – Groups do selected Level 1 and Level 2 problems pg. 43-44.

Day 5 - Formative: similar to pretest #6. Individuals do selected Level 1 and Level 2 problems pg. 43-44.

APPENDIX A (continued)

Week 5 *Energizers structured break*

Day 1 – Introduce Chapter 5: The Distributive Property pg. 47-50. Relate to Hands-On Algebra.

Day 2 – Review Distributive Property. Students solve equations pg. 51.

Day 3 – Introduce cross-multiplying pg. 52-53. Practice equations pg. 53 together.

Day 4 – Review pg. 54 and do equations.

Day 5 –Formative: similar to pretest #7. Introduce Chapter 6: Algebra and Proportions. Read pg. 55-56. Work through pg. 57 problems together.

Week 6 *Energizers structured break*

Day 1 – Review ratios and discuss setting them up on pg. 58. Work through pg. 59 problems together and individually.

Day 2 – Review other uses for proportions in algebra pg.60-62 and work some of the problems individually.

Day 3 – Introduce problems that require change of measurement. Pg. 63-64. Work through them together.

Day 4 – Students do selected Level 1 and Level 2 problems from the unit to review for test

Day 5 - Summative test for *Energizer* break treatment – pretest #6, 7, 8, 9 10.

APPENDIX B

SAMPLE *ENERGIZER* EXERCISES

Name of Activity: **Factor It In**

Grade Level: 4-5

Formation: Students are divided into 4 groups and each group is sent to a corner of the room.

Equipment: 4 pieces of scrap paper labeled 2, 3, 4, and 5

Rules/Directions:

1. Teacher labels each corner of the room with one of the pieces of scrap paper.
2. Teacher calls out a number that is a multiple of 2, 3, 4, or 5.
3. Students who are in a corner that is a factor of that number will move to another corner.
4. Movements include:
 - Jumping
 - Skipping
 - Walking
 - Hopping on one foot
 - Marching
5. Example - If teacher calls out 6, students in corners labeled 2 and 3 will move to another corner.

Variation:

1. Have students move to a corner labeled with a factor of the number called. If a prime number is called, have students move to center of room.

Name of Activity: **California Dreamin'**

Grade Level: 3-5

Formation: Standing at desks

Equipment: None

Rules/Directions:

1. Teacher leads the class on a virtual tour of California. Students move at least 30 seconds for each of the actions listed below.
 - March across the Golden Gate Bridge
 - Surf in the Pacific Ocean
 - Climb up a Redwood Tree
 - Pretend you are an actor and wave to all your fans

APPENDIX B (continued)

- Flex your muscles like Arnold Schwarzenegger, the governor
- Stomp the grapes
- Pick oranges
- In line skate on the boardwalk
- Ski on the Sierra Nevadas
- Climb Mount Whitney, the highest peak in the continental US
- Crawl through the Death Valley Desert
- Hit a homerun at Pac-Bell Park
- Shoot a foul shot at the Staples Center

2. Teacher may use same concept with any state.

Variation:

1. Teacher can use a wall map to point out specific landmarks or attractions.

Name of Activity: **Silent Signs**

Grade Level: 4-5

Formation: Standing at desks

Equipment: Map

Rules/Directions:

1. Teacher chooses 1 student to go to the map.
2. Teacher chooses location (state or country) and tells everyone in the class except the student at the map (can write location on board or piece of paper).
3. Class uses movement without talking to guide the student to the correct location.
 - East: knee lifts
 - West: jumping jacks
 - North: raise the roof
 - South: squats
4. Repeat with new location and new student.

Variation:

1. Post the direction that corresponds to each movement on the board.

APPENDIX C
ALGEBRA PRE-TEST

Name _____ Date _____

1. A math book weighs 2 pounds more than a science book. Write expressions for the weight of each book.
2. If a hat and coat together cost \$185 and the hat cost n dollars, write an expression for the cost of the coat.
3. $4n - 9 + 2n - 6 - 7n = 6n - 36$
4. $\frac{n}{2} = \frac{2}{n}$
5. Four consecutive numbers add up to 154. What is the smallest number?
6. $-8 \times 5n = 80$

APPENDIX C (continued)

7. A football player carried the ball 5 times during a game. He gained 15 yards on the first play, gained 11 yards on the second, lost 22 yards on the third carry, lost 9 yards on the fourth and had no gain or loss on the fifth carry. What was his total amount of yardage for the game?

8. $\frac{2}{5} = \frac{5}{n + 8}$

9. If a 10-foot stick casts a shadow of 8 feet, how tall is a tree that casts an 82 foot shadow?

10. The amount of a certain medicine that a patient needs is dependent on the weight of the patient. If a 140 pound person takes 28 mg. of the medicine, what would the proper dosage be for a 200 pound patient?

APPENDIX D

SKILLS EVALUATION FORM

Name		
Pg. #		
Problem #		
Problem Steps	Possible points	Student points
1. Name smallest unknown as the variable.		
2. Create related algebraic expressions using correct operations.		
3. Write as an equality.		
4. Collect like expressions.		
5. Isolate the variables.		
6. Find value of the variable.		
7. Use correct computation.		
8. Use negative numbers correctly.		
9. Use distributive property correctly.		
10. Create ratios and proportions correctly.		
11. Treat both sides of the equation equally.		
12. Correctly solve the equation.		
13. Interpret the solution to answer the question.		
TOTAL POINTS		
PERCENTAGE OF POSSIBLE POINTS EARNED		

Chapter 1 questions will be graded using steps 1 and 2.

Chapter 2 questions will be graded using steps 1, 2, 4, 5, 6, 7, 11 and 12.

Chapter 3 questions will be graded using steps 1, 2, 3, 4, 5, 6, 7, 11, 12 and 13.

Chapter 4 questions will be graded using steps 1-8 and 11-13, as required by individual problems.

Chapter 5 questions will be graded using steps 5, 6, 7, 9, 11, and 12.

Chapter 6 questions will be graded using steps 1-13, as required by individual problems.

APPENDIX E

INDIVIDUAL TEST SCORES

Student 1	4	80	62	42	84	62	85
Student 2	9	100	88	80	84	90	87
Student 3	1	80	88	94	68	76	95
Student 4	5	60	92	62	84	94	88
Student 5	3	60	77	65	80	60	81
Student 6	3	100	88	48	72	86	94
Student 7	1	70	96	28	68	66	88
Student 8	1	50	92	54	84	54	91
Student 9	14	100	92	97	76	96	100
Student 10	1	90	92	85	96	35	88
Student 11	2	90	67	34	88	74	70
Class							
Average	4	80	84.90909	62.63636	80.36364	72.09091	87.90909
	Pretest	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6
				Summative			Summative