Brain Breaks: Will Added Physical Movement Breaks Affect Student Test Scores?

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Abstract

The purpose of this study was to see how brain breaks between academic learning may affect student end of the unit math test results. This study sought to see if time spent on brain breaks was effective or if that time could be used more productively as instructional time. Domazet, Tarp, Huang, Gejl, Andersen, Froberg, and Bugge theorized that physical activity and sports participation had a positive effect on performance on math assessments for sixth and seventh graders. The study *Brain Breaks: Will Added Physical Movement Breaks Effect Test Scores* compared data collected to see if there was a correlation between brain breaks and students’ end of the unit math assessment scores. As a result, the study found that participants who participated in exercises before given math assessments had a higher averaged performance than participants who did not participate in movement exercises.
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Introduction

Due to budget cuts in public school settings and time restraints, the general education classroom teachers have not had time to allow movement in the classroom and students had become used to a stagnant learning environment. Students were unable to get up and move around in a classroom and were expected to sit quietly for hours. Some teachers used ‘brain breaks’ to allow students to move around and exercise throughout the day. There was a trend in many schools across the nation in which teachers were teaching in shorter 5-12 minute increments. These shorter 5-12 minute lessons were called mini-lessons. In between these mini-lessons, brain research studies stated that students often needed movement or brain breaks to refocus and help them retain information. Brain breaks were 2-5 minute breaks in which students participated in a variety of movement exercises (Hruska, B., & Clancy, M. E., 2008, p.13). Many of these exercises included cross body movements (midline). According to Xu & Ke (2014), using movements in which students cross their midline helped with student learning.

In the past eight-year period, the researcher observed in her own classroom that students tended to focus better after a brain break. Based on the researcher’s experience students were more focused and engaged in classroom lessons after a brain break. Unfortunately, time restraints made it difficult for teachers to incorporate brain breaks into their daily schedules. In the researcher’s experiences, teachers were pressured by administrators to constantly be instructing students and not waste curriculum time in the classroom. Based on these experiences, the researcher found it was difficult to incorporate brain breaks without data. The researcher sought to answer if brain breaks
had an effect on students’ performance. This study sought to compare students’ performance based on the application of brain breaks.
Chapter I Problem to be Investigated

Purpose of the Study

The purpose of this study was to see how brain breaks affected student math test results. This study sought to determine if there was a difference in academic testing results from having participated in brain breaks or not. This study presented different exercises that allowed students to move in an otherwise stagnant environment. The exercises were developmentally appropriate and allowed students to feel successful in the classroom. Information from this study was shared with colleagues to help support good instruction.

Justification for the Study

This study could help determine best teaching practices for a second grade general education classroom. It could determine the level of importance of incorporating physical movement in a primary general elementary classroom or no need for such breaks. It may have had a positive effect on students’ academic testing, therefore, could benefit instruction in other general education classrooms. A by-product of this study was that students learned different exercises that helped them refocus throughout the day. Another by-product was that students may have become more physically fit.

Research Question

The research question for this study was “How will added brain breaks affect 2nd grade students’ end of the unit math test scores?” The researcher noticed in her experience of 8 years teaching, that students were more focused after recess. The researcher wanted to see if physical movement would affect academics as well as student
focus during instruction. End of the unit math tests were used as a way to measure the
effect of physical movement on testing scores as opposed to standardized testing because
second graders in the researcher’s district did not administer standardized testing during
the research period. Additionally, the researcher used unit math tests because unit tests
were given on different dates throughout the research period. Being that unit math
assessments were given on different dates; the researcher could eliminate any variables
that could have affected standardized test results. Variables that could have affected the
results of a standardized test given on a single date, could include; family dynamics, the
health of participants, sleep deprivation, nutrition, or the focus of the test taker. The
researcher hypothesized that brain breaks would increase achievement scores for 2\textsuperscript{nd}
grade students. The researcher also believed that the use of brain breaks in an elementary
setting would help engage students during instruction. Therefore, brain breaks could be
used to refocus students throughout the day. Dependent variables were the use of brain
breaks in the classroom and independent variables were the test scores that were
collected.
Definition of Terms

**Brain Breaks:**

Constitutive Definition: According to Watson Life Resources, “brain breaks” are mental breaks designed to help students stay focused and attend. The “brain breaks” are physical activities that get the students moving to carry blood and oxygen to the brain. The breaks energize or relax. The breaks provide processing time for students to solidify their learning. (Jensen) (adapted from Alison Newman).

Operational Definition: For this study, brain breaks refer to short, (3-5 minute), interval movement exercises that participants will complete before academic testing.

**Formative Assessment:**

Constitutive Definition: According to the Merriam-Webster dictionary, “formative assessment” is an ongoing assessment of pupil’s educational development within a particular subject area.

Operational Definition: In this study, “formative assessment” refers to a way of assessing the knowledge that students may have part way through a unit. In this study “formative assessments” will be collected to determine the effectiveness of Brain Breaks.
**Summative Assessment:**

Constitutive Definition: According to the Merriam-Webster dictionary, “summative assessment” is a general assessment of a pupil’s achievements over a range of subjects by means of a combined appraisal of formative assessments.

Operational Definition: In this study, “summative assessment” refers to a way of assessing the knowledge that students have learned over the course of a math unit. In this study “summative assessments” will be collected to determine the effectiveness of Brain Breaks.

**Student:**

Constitutive Definition: The Merriam-Webster dictionary defines “student” as “a scholar, learner, especially one who attends school.”

Operational Definition: For this study, students will refer to second graders that are enrolled at Alfred Elementary School.

**Test:**

Constitutive Definition: According to the Merriam-Webster dictionary, “test” is the means by which presence, equality, or genuineness of anything is determined; a means of a trial.

Operational Definition: In this study, “test” refers to formative and summative assessments students will take at the end of each math unit.
Chapter II Background and Review of Literature

There have been many studies on the human brain, such as (Brusseau & Hannon, 2015; Chaddock-Heyman, Erickson, Kienzler, King, Pontifex, Raine, Kramer, 2015; Guiney, & Machado, 2013; Harveson, Hannon, Brusseau, Podlog, Papadopoulos, Durrant, Kang, 2016; Hillman, Erickson, & Kramer, 2008; Phillips, Hannon, & Castelli, 2014). Scientists are constantly making new discoveries of how the brain works and what different factors affect memory and learning.

Discussion

According to Guiney and Machado (2012), studies have shown that physical exercise have effected brain development. Guiney and Machado (2012), stated that in older adults, exercise has effected the autonomy of parts of the brain that have been linked to executive and cognitive functions. Based on this evidence, exercise could positively effect cognitive and executive functions in young adults whose brains were still developing. Guiney and Machado (2012), recreated studies that had previously showed positive effects from exercise on the anatomy of the brain for both older adults and young children. According to Guiney and Machado (2012), long term aerobic exercises led to an increase in parts of the brain that have been linked to executive functioning in older adults. Guiney and Machado (2012), also evaluated a number of studies that looked at the effect of exercise on cognition. In these studies, Guiney and Machado (2012), recreated an evaluation of three areas: task switching, selective attention/inhibitory control, and working memory. Based on the literature on task switching, in which participants answered questions based on different rules that change throughout the test, information showed that adults who were sedentary did not perform
as well. This suggested that regular exercise benefited older adults with regards to task switching questions. According to Guiney and Machado (2012), who cited Elmer, Hommel, and Prinz (1995), “tasks that involve suppression of stimuli with proponent response links presumably rely more on motor inhibition than on selective attention” (p.74). Based on the literature Guiney and Machado (2012), found, that older adults who regularly exercise performed higher on the assessments, given that they tested selective attention tested the effect of exercise on selective attention and inhibitory control for young adults. Finally, Guiney and Machado (2012), evaluated studies that tested regular exercise on the working memory. Working memory tasks included participants holding information for a short amount of time and rapidly changing information based on what was given.

Limitations of this Study

There were many factors that could have effected the results of these studies. Factors may have included such things as how the consistency of the task switching questions could reflect the abilities of the working memory rather than the abilities of the executive functioning. Guiney and Machado (2012), stated that there was insufficient literature to suggest and effect on younger adults. Research was limited and showed inconsistent results for studies. Researchers found that there was a positive effect on older adults when they exercised regularly. Participants in these studies showed higher test scores on tests that looked at their executive functioning abilities. The research completed by Guiney and Machado (2012), lacked information for younger adults and mainly focused on the effect of exercise for older adults. More research is needed to show the
effect of exercise on younger adults and children on executive functioning, due to the inconclusive and limited literature that was found.

Discussion

Hillman, Erickson, and Kramer (2008) wrote a meta-analysis of literature on the effects of exercise on animals, older adults, and children. The literature review Hillman et al.’s (2008), completed, discussed a study that examined the effects of exercise on adult cognitive function and a study that examined the effects of exercise on adolescence cognitive function. Hillman et al. (2008), cited a study completed by Sibley, Etnier (2003), which found that physical exercise had a positive effect in eight measurement categories on children ages 4-18. The categories were perceptual skills, intelligence quotient, achievement, verbal tests, mathematical tests, memory, developmental level/academic readiness, and other.

In the same article mentioned above, Hillman et al. (2008), also discussed a study by Etnier (1997), that examined how physical exercise effected cognition in older adults. This study took sedentary adults who were 60 to 85 years old and had them participate in physical activities several times per week for several months to a year. Participants were given dual-task tests included being asked to respond to two questions on the same subject, so participants had to change their thinking based on the questions the researchers asked. Single-task performances only asked participants to complete one task. The study sought to see if adults who participated in these exercises would show higher gains in cognition compared to those adults who were sedentary. The study showed that adults who participated in the physical activities showed larger growth than
those who stayed sedentary. The adults who participated in the physical exercises showed significant gains in dual-task performances; however, when given single-task performances, there was no difference between the two groups.

**Limitations of this Study**

There were numerous factors that could have affected the studies compiled by Hillman et al. (2008), such as age, the rigor of exercise, cognitive ability, and the human factor, that could affect results of studies. Influential factors of their research were that they did not discuss research done on the effects of physical exercise on children. Other limitations in their research were that the researchers did not discuss how the studies were conducted, or other variables that might have affected the study’s findings. For example, the location where the studies took place, the unit of measure used in the studies, or the socio-economic status of participants as well as other variables that may have affected the results were not included.

**Discussion**

Harveson, Hannon, Brusseau, Podlog, Papadopoulos, Durrant, Hall, and Kang, (2016), executed a study on the effects of exercise and resistance on cognition in high school aged students. Researchers sought to see if both aerobic exercise and resistance training, (mostly weight lifting) effected cognition. Participants of this study included 94 participants who were boys and girls of the age 16, participants included 48 boys and 46 girls. Researchers used the Stroop test and the Trail-Making Test as a means to measure executive functioning. Researchers asked participants to do a variety of tasks from a test in order to get a baseline for each participant. Then 7 days later participants were
randomly put into an intervention group that either consisted of aerobic exercise, resistance exercise, or no exercise, (which was the control group). Aerobic exercises included walking and/or jogging that increased participants’ heart rate for 30 minutes on an indoor track. Resistance exercise included exercises in which participants would exert a resistance to force, (such as the use of weight machines), for 30 minutes with a 1 minute break between sets of 15 repetitions. The non-exercise group sat quietly for 30 minutes while watching a sports video without falling asleep or moving. Participants were then given the Stroop and Trail-Making Test.

Based on the results of these assessments the researchers were able to conclude that young adults who were 16 years old that participated in aerobic and resistance exercises performed better than those who did not complete any exercise on the test. They found that exercise, both aerobic and resistance improved the cognitive process of the participants tested. Areas of improvement also included response speed and accuracy, problem solving, goal-oriented action, and stages of information processing. Harverson et al. (2016), also stated that boys performed better than girls on the given assessments. These researchers theorized that it might have been because of the types of exercises participants completed.

**Limitations of this Study**

One limitation of this study was the attendance of the participants, in which participants were sometimes absent and therefore data was skewed based on attendance. Another limitation in this study was that no preexisting information was collected showing participants’ original health level. Finally, another limitation of this study was
the inability to measure the intensity of which exercises were completed by the
researchers. All of these factors could have had an impact on the results of this study.

Discussion

In the study completed by Van der Niet, Smith, Schederder, Oosterlaan, Hartman, and Visscher (2015), researchers sought to see how physical exercise influenced
cognition in elementary school age children. The focus of their study was to see if daily
physical exercise effected executive functioning in children. The study consisted of 80
children ages 8 through 12. Researchers measured the amount of active exercise that was
completed in a day by using accelerometer, (a tool that measured participants’
movements), for 7 days. Participants were then tested on inhibition, working memory,
cognitive flexibility, and planning ability. Each of the participants were given the same
test individually in order to compare their scores. The results showed that there was no
significant difference between boys and girls, but that boys spent more time doing
moderate to vigorous activities than girls. The study suggested that there was a negative
effect between sedentary behavior and academic testing scores, which supported the idea
of incorporating brain breaks in a school setting. It also showed that there was a negative
effect between sedentary behavior and executive functioning. Researchers found that
there was a positive relationship between physical activities and planning skills.
Researchers were unable to identify what type of physical activities effected these brain
functions, however were able to monitor whether activities were light, moderate, or
vigorous based on the results from the accelerometer.
Limitations of this Study

Factors that could have effected outcomes in this study may have been the validity of the accelerometer, (in that it did not measure all exercises, such as swimming and cycling), the sample size, and the location of the study. There could have been different results in different areas of the world. Future studies should focus on the effect of all types of exercise on executive functioning or cognition.

Discussion

Syvaoja, Tammelin, Ahonen, Kankaanpaa, and Kantomaa (2014), also sought to determine how physical movement and sedentary behavior effected cognition and learning for school aged children. The researchers used 224 children in 5 schools in Finland and measured participants physical exercise through and accelerometer. Then measured their cognitive functions through visual memory, executive functions, and attention. Participants wore accelerometers for 7 consecutive days, only taking them off for water activities. The accelerometers were worn on the hips of participants and these devices measured moderate to vigorous activities. Sedentary time was measured through questionnaires that were given to participants. The researchers found that there was no significant difference between genders and cognitive functioning. They also discovered that moderate to vigorous physical activities effected children’s reaction time and the speed of their response to visual test. The results of the research, however, found that subjects who had a fair amount of sedentary time did well on the sustained attention portion of the test. Finally, researchers also found that sedentary and physical activities did not have a significant effect on other cognitive functions.
Limitation of this Study

This study did not assess the effects of sedentary behavior on cognitive thinking and learning; therefore, researchers did not compare effects of physical activities to sedentary behavior on cognition. In order to determine how physical activities and to what extent these activities effect cognition and learning behaviors in adolescents more studies need to be done.

Discussion

Another study was conducted to investigate the effects of aerobic fitness on learning and memory. Rain, Lee, Saliba, Chaddock-Heyman, Hillman, and Kramer (2013), conducted a study that examined the effects of aerobic fitness on learning and memory in 9 and 10 year olds. This study involved 49 participants ages 9 to 10. Researchers asked participants to not be involved in any physical activity for two days of the experiment. Researchers then measured participants’ level of fitness by measuring their oxygen consumption and after vigorous exercise on a treadmill and also asked them to rate how tired they were. Participants’ fitness levels were recorded so researchers could track how their fitness levels effected their learning. Participants were taught new information based on fictional regions and were asked the next day to recall the names and locations of those regions. There were two ways researchers tested memory recall on this day. One was a free recall test and a cue recalled test. During the free recall participants were shown an unlabeled map and were asked to match the region’s names from memory. In the cued recall session, participants were given 10 region names to match with the blank map. This study found that there was no significant difference
between participants with lower physical fitness and higher physical fitness in the initial learning stage. However, participants with higher level of fitness had a greater accuracy of delayed recall on both assessments given for this study.

Limitations of this Study

The conclusions of this study did not take into consideration many variables such as participants’ learning strengths and their knowledge of the subject matter used in this study. Should another study be done to determine the effects of physical fitness on learning and memory recall, researchers should identify the participants’ learning styles in addition to assessing their physical fitness level.

Discussion

Fedewa and Soyeon (2011), completed a literature study in which they looked at the effect of physical activities on student testing scores, academic success, and cognitive abilities. Fedewa and Soyeon (2011), researched published and unpublished studies that were pertinent to physical activities effects on children’s cognition and/or academic success. 118 studies were used in research cited by Fedewa and Soyeon (2011). The studies used various designs, different physical activities, as well as different ways to measure the relationship. Studies also posed different research questions. Results of the researcher’s findings showed that in experimental designs, there was not a significant difference between academic scores when participants participated in physical activities. From the cross-sectional design research that Fedewa and Soyeon (2011), conducted they found that the child’s performance academically was related to their physical fitness. The
more physically fit participants were the higher cognitive abilities they had, which of course helped them achieve more academic success.

**Limitations of this Study**

This study had restrictions, such as the researchers were only able to find information from the same sample. Other studies that were researched were not included because they were single case designed or had insufficient information. Finally, Fedewa and Soyeon (2011), did not mention other variables that could have skewed the results of studies. Some of these factors include such things as economic status, physical activity participation, ethnicity, or gender. To determine how much these factors effected the results of this study, future studies must be done that take all of these variables into consideration.

**Discussion**

More studies were completed to test the effects of exercise on cognition. Hill, Williams, Aucott, Milne, Thomson, Greig, Munro, and Mon-Williams (2010), conducted a study to determine the effect of exercise on cognition and attention in the classroom. Researchers used 6 schools in Aberdeen, Scotland where they investigated the effects of exercise in a primary classroom. The researchers compared results from two classrooms per school that were equivalent in size and ability. One class participated in exercises 30 minutes after lunch and the other class did not participate. Participants included 1,224 students throughout the Aberdeen school district. Researchers used an exercise program that was developed by the Curriculum Support team of Physical Education Health and Well Being in Aberdeen City Council. During this exercise period students completed
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aerobic and flexibility exercises in the classroom that lasted 10-15 minutes. Researchers then gave students cognition tests, in which responses were written down by participants and were taken at the end of the day. According to Hill et al. (2010), the tests that were administered to the participants could be defined as mental tracking tasks. These mental tracking tasks required the subject to track or follow two or more associated ideas at the same time. Participants alternatively were asked to divide or change the focus of their attention. Tests included: serial addition, size ordering, listening span, digit-span backwards, and digit-symbol encoding. The study lasted 2 weeks for each school, and participants completed tests at the end of the day for 5 days in a row. Researchers found that there was an improvement of test scores for participants who participated in exercises on all tests given.

Limitations of this Study

There were some factors that could have effected these results, such as the differences between populations throughout the schools, participant knowledge of testing materials, and the demand of curriculum before the tests that were given. Further research needs to be done to determine the effect of exercise on one sample group.

Discussion

Many of the studies cited in this literature review discussed the effects of 10-20 minutes of physical movement in children. The study done by Howie, Schatz, and Pate (2015), examined the effects of shorter periods of physical activity on children ages 9-12 years old. This study sought to see how physical activity effected academics as well as cognition in children ages 9-12. Howie et al. (2015), conducted a study in which
participants were in fourth and fifth grade general education classrooms and all participated in in each of the four conditions of the study. The study included 10 minutes of sedentary classroom activity, and either 5, 10, or 20 minutes of physical activity. This study used Brain BITES (Better Ideas Through Exercise) as an intervention in a general education classroom in South Carolina. Students participated in Brain BITES throughout the day at the same time each day to break up sedentary learning time. Subjects were encouraged to participate in physical activities through verbal cues and positive reinforcement. After they engaged in physical exercise they were administered an assessment in which they were tested on how many math facts they could solve in one minute. Findings of this study showed that after 10 minutes and 20 minutes of exercise participants scored significantly higher on the math timed test. Students did better on the math assessment after all 3 types of exercise than after sedentary time.

**Limitations of this Study**

Limitations of this study included higher level thinking skills that were not assessed. The study only measured rapid recall of facts and the memorization of these facts and not higher order thinking skills in math. This study also did not show a significance of shorter 5 minute breaks on mathematical assessments. In my study, I focused on how physical exercises in shorter increments effected higher order thinking math skills.

**Discussion**

According to studies aerobic fitness and physical activity are beneficial to cognitive and brain health during development. Chaddock-Heyman, Kienzler, King,
Pontifex, Raine, Hillman, and Kramer (2015), showed how the brain changed based on physical activities. The higher the level of physical activity children have, the better their cognitive control, memory, and academic achievement tend to be. Researchers sought to see how exercise and physical fitness effected the structure of the brain in preadolescent children, as well as the role they had on their performance in mathematical assessment. 48 children participated in this study, including 24 children with a higher degree of fitness and 24 children with a lower degree of fitness. Researchers measured their fitness levels by their oxygen intake while on a treadmill. They were then categorized into groups based on their oxygen intake. Finally, researchers took an MRI to measure participants’ cortical thickness. Researchers found that participants who were grouped as showing higher physical fitness levels had a thicker and more developed cortical portion of their brain. Researchers also measured participants’ academic achievements using a Wide Range Achievement Test. Results from the mathematic assessments showed that children with higher fitness levels performed better than children with lower fitness levels.

Limitations

Some of the weaknesses of this study were that it did not show the effects of a thicker cortical on academic testing. It also did not take into consideration background knowledge participants might have had on the mathematical concepts that were tested. The study that I did assessed a variety of mathematical concepts and compared the effects of physical activity had on those assessments.
Discussion

A study conducted by Kuo-Ming, Peng Ming, and Yi Ching (2014), concluded that physical fitness directly affected a students’ academic performance in a study completed in Taiwan. The study examined 1,339 fourth grade students in Taiwan and gave them a physical fitness test. The test included a measurement of participants’ body mass index, cardio-respiratory fitness, flexibility, strength, and endurance. The researchers of this study found that participants who were in the normal range from the physical fitness test had better academic grades. A survey was conducted to collect data on the participants’ academics. This survey excluded quizzes, general performance, and examinations. A mean was taken from the 1\textsuperscript{st} and 2\textsuperscript{nd} monthly examination and that data was then used to compare students.

Limitations of this Study

There were some factors that could have skewed the data from this study. Variables that might have affected data were the different instructors who taught the participants, as well as exclusions of quizzes, general performances, and examinations. This study did not take into account participants’ socioeconomic background. This study was reflective of Southern Taiwan and there could be cultural differences that effect data and the study could have turned out entirely differently if it were administered elsewhere.

Discussion

A study conducted in Massachusetts by Tremarche, Robinson, and Graham (2007), researchers sought to see the effects of physical education on state testing. This study included 311 fourth grade students from ages 9 to 11 years old, from 2 different
schools in Massachusetts in a two-month period. Each school had different set minutes for the physical education program. Participants were tested in math and ELA (English, Language, Arts). One school provided 28 hours of physical education each year, while the other school provided 56 hours. Schools varied in ethnicity, socio-economic background, and amounts of money that were allotted by the state per pupil. Both schools had similar physical education programs and students participated in similar extra-curricular activities. Participants of this study took the same state test, (the MCAS), and those scores were used in the researches study. Participants who had more physical education time had a higher mean score on the ELA MCAS test than those who had less physical education time. It showed that scores were significantly different. There was no significant difference for the mean between the two schools on the MCAS test. This study sought to determine if physical education classes had an effect on state testing scores. Researchers found that physical education could affect some areas of state standardized testing.

**Limitations of this Study**

There are some factors that could have affected the results of this study. One example of this would be that each school had different teachers, which could have affected test scores. Student learning styles and knowledge of testing material could have also affected the results. Further research needs to be done to see the effects of physical movement on student testing scores.
Discussion

In the study conducted by Sardinha, Marques, Martins, Palmeira, & Menderico (2014), researchers examined the effects of physical activities on academic performance and the participants’ knowledge of healthy life choices. This study consisted of 5th, 6th, and 7th grade students and was affiliated with a family intervention project in Portugal called Pediatric Obesity Prevention in the School Setting (PESSOA). The PESSOA was a school based program that measured social, physical, and personal factors in an environment that could influence the intensity or amount of physical activity of a participant. Schools were placed into one of three groups. The first group consisted of a control group in which participants were given general information about eating and health habits. The second group was an intervention group in which participants, in addition to the general counseling, received 90 minutes of weekly additional exercise. Finally, there was a second intervention group in which participates received general counseling, 90 minutes of weekly exercise, as well as health and weight exercise classes. The researcher compared academic grades at the end of the school year. Sardinha et al.’s (2014) found that participants who were more aerobically fit, and within a normal weight, performed better at school than those who were not aerobically fit and were overweight. This study’s results showed an increase in academic achievement in the schools that participated in the extra 90 minutes of weekly exercise.

Limitations of this Study

Many variables could have affected the results of this study. This study did not take the instructor or curriculum into consideration. Since not all participants were taught
by the same instructor or used the same curriculum, students could have done better on their grades due to the teacher or curriculum used. If replicated, this study could have different results based on where the study was administered. In addition, this study did not take into consideration cultural differences.

**Discussion**

Domazet, Tarp, Huang, Gejl, Andersen, Froberg, and Bugge (2016), completed a study that examined how physical activity and sports participation effected their performance on math assessment. The study examined 869 sixth and seventh graders. The participants were assessed with a modified Eriksen Flanker task while their levels of physical activity were monitored by accelerometers. Participants were asked to fill out questionnaires that recorded their history of participation in organized sports, unorganized sports, physical activities that were related to sports, and sedentary behaviors. Participants also filled out a questionnaire about how they commuted to school in the morning. Participants were then put into one of two groups, cyclists or non-cyclists. Results of this study showed a strong correlation between participants who were involved with organized sports and their performance on the mathematic assessments. The same held true for students who commuted to school via bicycles outperforming students who did not.

**Limitations of this Study**

Limitations were that the accelerometer did not measure physical activities such as cycling and swimming and inconsistent history of organized and unorganized sports.
Another limitation was that this study did not take into consideration the socioeconomic background of participants.

**Discussion**

In a study completed by Wittberg, Northrup, and Cottrell (2012), researchers examined how physical health affected academic achievement in Virginia. The American Journal of Public Health published this study. This study was done over a 2-year period during which investigators used a sample of 1,725 participants who were in either fifth or seventh grade (is it 5th or 7th or 5th through 7th) in West Virginia Public Schools. These participants took baseline fitness and academic assessments in fifth grade and were given a follow up assessment in seventh grade. According to Wittberg et al.’s (2012), students who stayed in a healthy fitness zone had significantly higher scores on the WETEST assessment than students who were in the needs improvement zone (NIZ). WETEST was the West Virginia State Standardized test used to measure student achievement in West Virginia. The data found during this study supported the theory that students who were in the normal health zone performed better on standardized tests.

**Limitations of this Study**

This study did not take into consideration students’ testing abilities or testing strategies that may have been taught to them over a 2-year period. The investigators also didn’t take attendance patterns, socio-economic status, self-confidence, or attitude into consideration when comparing data. This study could be used as a resource for my research on how brain break effects student academic testing scores.
Discussion

Brusseau and Hannon (2015), researched how physical exercise could be incorporated in schools while still considering the time constraints both teachers and students are under due to rigorous curriculum obligations. Physical activity breaks could include; stretching, jumping, walking, push-ups, sit-ups, and other exercises. The article written by Brusseau and Hannon (2015), examined physical activity plans that could be incorporated into classrooms. It discussed the importance of physical activities for young children and the positive effects it could have on student test scores. It also discussed the lack of physical activities in schools due to budget cuts, time restraints, and teacher resources. Brusseau and Hannon (2015), established procedures that schools could use to incorporate physical activities in the general education classroom. They maintained that strong support from administration and other staff would be very important to the program’s success in the school as a whole. Brusseau and Hannon (2015), put together a program that incorporated 60 minutes of physical activities that included staff involvement, physical activity during school, physical education, physical activity before and after school, and family and community engagement. They described each part of this plan and incorporated strategies for schools to incorporate each portion of it.

Limitations of this Study

The researchers did not discuss obstacles that schools could have while trying to implement these plans. For example, they did not discuss budget or time restraints, management of activities, or student participation. Should this plan be implemented in a
school, the school should also track progress to show effects of the CSPAP plan on student learning and development.

**Discussion**

Hruska & Clancy (2008), researched the positive advantages to incorporating movement into elementary and middle schools. They stated that physical movement helps to develop cognitive skills in young children. In their research, they also found that physical movement could be used as a motivational and coping skill. Another positive effect of using physical movement in the classroom that Hruska & Clancy (2008), found was to help teach kinesthetic learners. “A spatial or a kinesthetic learner, for example, benefits from the opportunity to "do the information" rather than only see or hear it” (Hruska & Clancy, 2008, p.13). Hruska & Clancy (2008), focused on the National Association Sport and Physical Education guidelines and researched ways that teachers could incorporate those standards into general education classrooms. Hruska & Clancy (2008) stated, “The integration of physical activity into other areas of curriculum is not new, but there has been renewed interest in the topic as evidenced by recent publications on the subject.” (p.15). Hruska & Clancy (2008), researched methods that would complete the National Association Sport and Physical Education standards and general classroom standards without wasting instructional time. For the study, *Brain Breaks: Will Physical Movement Effect Student Test Scores* the researcher believed that these movements would be used in addition to GoNoodle exercises to help incorporate physical exercise into the classroom.
Limitations of this Study

Hruska & Clancy (2008), did not integrate movements into curriculum that would work for all grade levels, nor did they take into consideration different state standards. The movement exercises they researched would have to be altered to work in different classrooms around the country.

Discussion

Finnan (2015), wrote an article that described the importance of incorporating physical activities in the elementary school setting. Finnan, (2015), discussed findings from a 4-year study which looked at the incorporation of yoga program in schools. The study tested the effect of yoga on students’ focus and perseverance in academic tasks. Finnan (2015), described an elementary school that had 400 participants who were in preschool through sixth grade. The first 2 years of the study was conducted in grades 2nd through 4th while the last 2 years were conducted in 3rd and 4th grade classrooms. Yoga was incorporated in classrooms where students participated in breathing, stretching, balance, and movement exercises. Results of this study showed that students showed more focus throughout the school day during instruction. Observations were recorded on student behavior and researchers found that students were more focused and involved in their lessons after a timed yoga break.

Limitations of this Study

Limitations of this study was that researcher did not test the effect of yoga on academics for students and that the study was done in one location. Another flaw in the study was the fact that results were based on subjective observations rather than data.
Brain Breaks: Will Added Physical Movement Breaks Affect Student Test Scores?

examined the effect or lack thereof of physical exercise on academic test scores. Some of the activities that will be used in this study will incorporate yoga activities.

Discussion

In the article written by Xu & Ke (2014), found the Microsoft Kinect provided teacher new ways to help students incorporate physical activity into the classroom. They argued that activities done in Microsoft Kinect had positive psychological advantages and enhances cognitive thinking. Xu & Ke (2014), discussed the need for more body sensory technologies to be researched. These researchers claimed that there was not much research on body sensory technologies and the effect on student academic achievement. However, Xu & Ke (2014) claimed there was a connection between physical movement and cognitive thinking abilities. They further examined how different gestures affected different cognitive skills.

Limitations of this Study

The researchers only looked at the Microsoft Kinect and looked at how it effected thinking, however, there was not much research to support these theories. In Brain Breaks: Will Added Physical Movement Breaks Effect Student Test Scores? technology program called GoNoodle was used as a tool to incorporate brain breaks.

Discussion

Brain Gym consists of exercises that calm or energize the brain. According to Nussbaum (2010): there were 26 activities that used movement that crossed the midline.
A study done by Nussbaum was implemented to evaluate the effectiveness of Dennison’s 26 Brain Gym movements on the academic performance of elementary school students as well as what effect it had on their behavior.

This study consisted of 364 second through sixth graders with Brain Gym being used as a response to intervention (RTI). During the study, a three-day rotation was used. During the rotation students completed different Brain Gym exercises. Data was collected from the general population as well as students who were considered at risk based on the state assessment. Researchers looked at the information from the reading and math portion of the assessment after students participated in the intervention over an eight-month period. After looking at the results, researchers found a positive correlation between students who participated in the study and their performance on the state mandated test.

Limitations of this Study

Unfortunately, the study did not take into consideration the changes that occurred in students during that time. Some extenuating circumstances that may have affected the results of the study could include students having gone through a change in their family or their interest level in school may have changed. The researcher also did not take into consideration the different teaching strategies that could have been used to prep students for the state assessment. As always, different instructors and their unique teaching styles could have affected the results.
Discussion

Researchers Watson, Kelso, and Ginger (2014), cautioned that it was essential to question whether or not these exercises had an effect on students’ academic performance. The study they implemented looked at the effects of Brain Gym on students with disabilities and how it affected their engagement at school as well as their academic performance. Their research consisted of three male students who were between the ages of seven and nine. Two of the participants were autistic while the final student was labeled as oppositional defiant disorder, ADHD, and auditory processing disorder. The study was done in an after-school program in which participants received academic instruction and vocational instruction. These students participated in a Brain Gym exercises before a lesson. Then the researchers used a 30 second measurement technique in which every 30 seconds the researchers observed if the participants were engaged in the academic lesson. The results of the study did not show a clear or significant difference in students’ engagement in the lesson when compared to the control group. The control group participated in an intervention that involved physical activity. Researchers also looked at the data from the baseline group who received time for unstructured fine motor activities for children with disabilities and compared it to the data of students who participated in Brain Gym exercises.

Limitations of this Study

Limitations of this study included that the control group had varying medical factors and that the ideal learning time period had already surpassed and testing was done during an after-school program. Finally, if this study were to be replicated with students
with different disabilities it could produce different results. Since students with disabilities are included in the general education classroom, they were included in this research. Due to this factor, the researcher believed it was important to research how physical movements affect students with disabilities academic performance.

**Discussion**

Taylor (2009), examined if Brain Gym increased academic achievement in math and reading/language arts. Participants for this study consisted of 60 fifth graders who were placed into one of three groups: an initial treatment group, a delayed treatment group, and a control group. Each group was made up of 20 fifth grade students. Participants in the initial treatment group participated in Brain Gym exercises in the morning while participants in the delayed treatment group participated in exercises in the afternoon. The control group did not participate in any exercises. The researchers hypothesized that students in the initial and delayed exercise groups would show higher math and reading/language arts scores than students who did not participate in any exercises. Their results did not show evidence that supported their hypothesis. The data they looked at was collected from students’ ThinkLink Global proficiency scores. Researchers concluded that Brain Gym exercises were ineffective in helping students perform better on academic tests.

**Limitations of this Study**

Some variables that could have affected this study were that Brain Gym was not done regularly enough throughout the day to be have a significant effect on students’ results. Studies in which participants would complete exercises more regularly could
have different results. The researchers also did not take into consideration that each group had a different instructor. This study could be used to support or refute the results of

*Brain Breaks: Will Added Physical Movement Breaks Effect Student Test Scores?*

**Discussion**

Stephenson (2009), looked at the Australian Internet for websites, articles, and studies that related to ‘Brain Gym’. The researcher found that of the 4,290 hits online the first 200 were advice for teachers and trainings that may be offered. Stephenson (2009), also found no evidence that supported the effectiveness of Brain Gym on student academic test scores. Most of the articles researcher found on the effectiveness of Brain Gym on achievement were endorsed or linked to the for-profit company.

**Limitations**

There were however some variables that Stephenson (2009), did not consider. Stephenson (2009), only looked on the Australian online websites and did not find other studies that might examine effects of Brain Gym in other locations.

**Discussion**

Reddy (2014), published a study in the Wall Street Journal that discussed the effect of exercise on students with ADHD. The study found that if students with ADHD were regularly provided with 30 minute periods of aerobic exercise before school they were able to pay more attention to instruction and were less moody. GoNoodle was an online program that teachers frequently used to incorporate physical activity into the
classroom throughout the school day. According to Reddy (2014), GoNoodle helped teachers use short bursts of activity of three to ten minutes to accumulate 30 minutes a day. Activities include jumping in place and doing squats. The program was developed by David Katz, co-founder of the Yale University Prevention Research Center, and is offered free to school districts through Dr. Katz’s nonprofit, the Turn the Tide Foundation. (p.3)

Limitations

Limitations of this study included the lack of student demographic information. The study did not discuss the unit of measure for students’ emotions or take into consideration different variables that could have affected participants’ moods; such as diet, family dynamics, and other factors.

Discussion

Shoval, Shulruf & Boaz (2011), conducted a study to measure the effect of exercise in the classroom on elementary grade students. Participants consisted of 158 students from second and third grade. Researchers analyzed and observed students’ learning and placed them into one of three behavioral groups. The three groups were ‘active’, ‘social’, and ‘passive’. Students were then given a pre and post tests on angles. The results of these tests indicate that students who are physically active while learning were more successful than students who were more socially active, even if at the beginning of the unit they did not perform well on the pretest.
**Limitations**

Student motivation, student prior knowledge of angles, and student interest would all be factors that could have influenced the results of the study. Shoval et al. (2011) did not take into consideration how these behavioral groups would perform when tested in different academic areas. It was a very specific study, which if replicated with a different subject or concept may have had different results. Also, the tool in which Shoval et al. (2011), categorized students was an observational tool and could have been skewed by the researchers’ bias.

The literature that was reviewed will be used to support or contradict findings in *Brain Breaks: Will Physical Movement Effect Student Test Scores?*
Chapter III Procedures

Description of the Research Design

This study sought to see if time spent on brain breaks was effective or if time could be used more productively as instructional time. This study sought to determine if there was a difference in academic testing results from having participated in brain breaks or not. This study presented different exercises that allowed students to move in an otherwise stagnant environment. The exercises were developmentally appropriate and allowed students to feel successful in the classroom.

This study utilized the experimental research method. This study was experimental because the researcher had two groups, an experimental and a control group. Experimental design “utilizes two groups, one that experiences the treatment while the other does not, so it controls for history and maturation bias.” (Tuckman and Harper, 2012, p.152). This study included students being divided into a control group and an experimental group. Students were divided equally between academic ability, demographics, age, and gender. The researcher alternated the experimental group and control group after each math unit. A subcategory of this design would be a quasi-experimental design. “Quasi-experimental designs are partly-but not fully-true experimental designs; they control some but not all sources of internal invalidity.” (Tuckman and Harper, 2012, p.158). “Quasi-experimental designs suit situations in which conditions complicate or prevent complete experimental control.” (Tuckman and Harper, 2012, p.158). This way all students in the researcher’s second grade class were able to actively participate in the researcher’s thesis project.
Data was collected and recorded from the formative and summative assessments and then compared between the control and experimental groups. Participants completed a total of 15 assessments in which the researcher collected and compare data. A variety of “brain breaks” were used in order to ensure student interest.

Brain breaks were chosen based on the GoNoodle program. This program was developed by Health Teacher Inc. They created a website that incorporates a variety of interactive brain breaks that were based on brain research. Exercises were chosen based on energizing and calming techniques depending on the time of day and previous classroom activities. Exercises were grade level specific and the researcher was able to choose age appropriate exercises by selecting 2nd grade on the GoNoodle choice menu. The website then chose age appropriate exercises that were developed, based on brain research from scientific journal articles, (Frontiers of Human Neuroscience and the Journal of Pediatrics). For example, calming brain breaks were used after lunch and recess to refocus students’ attention. Whereas, energizing brain breaks were used after extended periods of instruction or testing.

Data were collected from formative and summative assessments and compared between the experimental and control groups. Data included the percent of problems correct the students received on the given assessments. Formative assessments were given twice for each unit, once at the beginning of the unit and then half way through the unit. Summative assessments were given at the end of units based on the Common Core Curriculum.
Description of the Sample

Participants consisted of 22 students from the researcher’s second grade class at Alfred Elementary School in Otsego, Michigan. Participants ranged from 7-8 years of age. 91% of participants were Caucasian, 4% of participants were African American, and 4% of participants were Asian American. Participants were either male or female. Participants were from middle class families. Participants were divided into an experimental or control group. Math assessments that were previously completed helped the researcher divide students into groups. Participants were paired against students of similar mathematical abilities based on testing scores.
Description of the Instruments Used

The GoNoodle program consisted of interactive exercises on the GoNoodle website. The researcher determined which category of brain break that was used: calming or energizing. Students then had the opportunity to select an exercise from a given category. Exercises consisted of: *Exercises with Maximo*, which were yoga style exercises in which students practiced stretching, using different beginning yoga moves. Risks from this exercise included bumping into desks or another student. *Zumba Kids*, in which students followed along with a choreographed dance. Risk for this exercise included bumping into desks or another student. *Flow*, in which students practiced calming breathing exercises while standing and visualizing self-monitoring strategies. Risk for this exercise minimal and there were no foreseeable possible risks. *Run with Us*, in which students completed track and field events next to their desks. Risks for this exercise included bumping into desks or another student. And *GoNoodle Plus Freeze It*, in which students run in place and answer questions about health, ELA, and math. Risks from this exercise included bumping into desks or another student.
The researcher organized data from formative and summative assessments on a spreadsheet within the classroom teacher’s password protected desktop computer. Each student was given a number in place of his or her real name to protect each student’s privacy. The researcher used the following table to organize data:

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Experimental group student number</th>
<th>Percentage on assessment for experimental group</th>
<th>Control group student number</th>
<th>Percentage on assessment for experimental group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formative #1</td>
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<td>1b</td>
<td>2a</td>
<td>2b</td>
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<tr>
<td>Formative #2</td>
<td>1a</td>
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<td>2a</td>
<td>2b</td>
</tr>
<tr>
<td>Summative</td>
<td>1a</td>
<td>1b</td>
<td>2a</td>
<td>2b</td>
</tr>
</tbody>
</table>

The researcher used this table for the four math units that are covered from March to May. These units were: Geometric Shapes and Fractions, Using Strategies and Algorithms to Add and Subtract, Classifying and Reporting Data, and Addition and Subtraction within 1000. When grading each assessment, the researcher assigned one point per problem that was given. Percentages were then collected based on the number of problems participants got correct. Each assessment had a different number of possible points based on the assessment, these assessments are attached to the appendix.

Assessments were created by Otsego Public School 2nd teachers. Assessments are based off of the Common Core Curriculum that were adapted as Michigan’s state standards.
Explanations of the Specific Procedures Followed

Alfred Elementary School second grade students participated in GoNoodle Brain Break exercises immediately before formative and summative math assessments. The researcher recruited participants from her 2nd grade classroom at Alfred Elementary. There was no expressed permission of a school administrator in order to conduct this thesis project. The research project was explained to the parents of the students at parent teacher conferences on March 2 and 3, 2016. This gave an opportunity for attendees to ask questions and have further discussion regarding the project. Informed Consent was explained to the parents and the parents then had the opportunity to take the consent form home to review and send back. All parents of participants of study were in attendance of conferences. The researcher made it clear that the participation was optional and students would not be penalized for not participating or early withdraw.

This study took place at Alfred Elementary School, Otsego Michigan in the researcher’s second grade classroom. The study was conducted in the afternoon, approximately at 1:10 P.M. - 1:15 P.M. each weekday, (Monday through Friday). The researcher gave formative and summative assessments on Wednesdays or Thursdays. Variations may have occurred from changes in student schedules based on holiday parties, assemblies, snow days, or any other unexpected disruptions to the regular school day. Students who were part of the experimental group participated in “brain breaks” immediately before math formative and summative math assessments. The control group did not participate in “brain breaks” immediately before math formative and summative math assessments. Participants who were in the control group completed
a coloring page, read a book, or practiced writing while the experimental group completed the “brain break”. After the assessment, the two groups’ scores were compared. Students participated in activities for this study for 2 formative assessments per unit in addition to 2 summative assessments for the first unit, 1 summative assessment for the second unit, 1 summative assessment for the third unit, and 3 summative assessments for the fourth unit. This classroom’s second grade curriculum had 4 math units from March to May. These math units were based on Common Core Standards. The first unit that was used for this study was on geometric shapes and fractions. The Common Core Standards that were aligned with this unit were: 2.G.1: Recognize and draw shapes having specified attributes, such as a given number of angles or a given number of equal faces. Identify triangles, quadrilaterals, pentagons, hexagons, and cubes. 2.G.2: Partition a rectangle into rows and columns of same-size squares and count to find the total number of them. 2.G.3: Partition circles and rectangles into two, three, or four equal shares, describe the shares using the words halves, thirds, half of a third of, etc., and describe the whole as two halves, three thirds, four fourths. Recognize that equal shares of identical wholes need not have the same shape. The second unit that was used for this study was on using strategies and algorithms to add and subtract. The Common Core Standards that were aligned with this unit were: 2.NBT.5 Fluently add and subtract within 100 using strategies based on place value, properties of operations, and/or the relationship between addition and subtraction. 2.NBT.6 Add up to four two-digit numbers using strategies based on place value and properties of operations. 2.NBT.7 Add and subtract within 1000, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and
subtraction; relate the strategy to a written method. Understand that in adding or subtracting three-digit numbers, one adds or subtracts hundreds and hundreds, tens and tens, ones and ones; and sometimes it is necessary to compose or decompose tens or hundreds. 2.NBT.9 Explain why addition and subtraction strategies work, using place value and the properties of operations. The third unit that was used for this study was on classifying and reporting data. The Common Core Standards that were aligned with this unit were: 2. MD.9 Generate measurement data by measuring lengths of several objects to the nearest whole unit, or by making repeated measurements of the same object. Show the measurements by making a line plot, where the horizontal scale is marked off in the whole-number units. 2.MD.10 Draw a picture graph and a bar graph to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. The fourth unit that was used for this study was addition and subtraction within 1000. The Common Core Standards that were aligned with this unit were: 2.NBT.7 Add and subtract within 100, using concrete models, or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method. Understand that in adding or subtracting three-digit numbers, one adds or subtracts hundreds and hundreds, tens and tens, ones and ones, and sometimes it is necessary to compose or decompose tens or hundreds. Summative assessments are attached in the appendix.
Discussion of Internal Validity

According to Tuckman and Harper (2012), “Internal validity affects observers’ certainty that the research results can be accepted, based on the design of the study”, (p. 6). Based on the design of this study, one could argue that there may be a conflict of interest based on the fact that the researcher was also the students’ classroom teacher. Due to the teacher-student relationship, students may have tried to perceive which answer would be most appropriate to choose on the survey. With this in mind, however, it was noted on the researcher’s observation notes if the survey answer did not match what the researcher observed on the student’s writing piece. For example, if student A states that s/he “did not make changes to their writing”, but the researcher could clearly see visible marks of revision, it was noted as such.

The participation and/or findings of the study did not have any effect on how the classroom teacher graded each student and there was no coercing them to participate.

Discussion of External Validity

“A study has external validity if the results obtained would apply in the real world to other similar programs and approaches”, (Tuckman & Harper, 2012). This study could easily be repeated on a larger scale with more participants of differing backgrounds and populations. Due to the limited number of participants, however, the scope of the results was rather limited. Further, the uses of rubrics were not limited to writing alone. The method of using rubrics to assist learners could extend into all content areas and beyond.
Description of the Statistical Techniques and Methods of Analysis

The researcher analyzed the data by separate spreadsheets in Microsoft Excel. This allowed the researcher to create graphs and charts to display data, see trends, and determine results. The researcher then determined which two participants’ scores would be compared, based on participants’ math ability, age, gender, and socioeconomic background. Then the researcher assigned each participant a number and a letter that stayed consistent throughout the study. In order to track scores without showing the participants’ names, the researcher used numbers and letters to compare percentages collected from assessments. For example, participant 1A scores were compared to the participant who was assigned 1B. Participants’ number and letter stayed consistent throughout the study, however they switched between the experimental and control group. Participants were graded on each assessment based on the percent received correct out of the total number possible. Each question was weighted as a possible one point. The total number of points possible varied based on how many questions was on the assessment.
Chapter IV Results, Analysis of the Information, Data

This study sought to determine if there was a difference in academic testing results from having participated in brain breaks or not. In this study participants were divided into a control or experimental group. Groups were divided equally based on academic abilities, gender, age, and socioeconomic background. Participants in the experimental group participated in brain breaks before math assessments. Participants in the control group; read a book, drew a picture, or wrote during this time. Participants in both groups took the same math assessment. The researcher then compared data to see if brain breaks had an effect on academic testing. The researcher found that in some assessments, participants who partook in brain breaks outperformed their peers who did not participate in brain breaks, however in some instances participants who did not partake in brain breaks performed better than participants who did participate in brain breaks.
Tables for Formative and Summative Assessment

There were four charts that were used in the collection of data to determine if math test scores were effected by brain breaks. Each chart displayed a different unit of study, (geometry, double digit addition and subtraction, measurement, and triple digit addition and subtraction). The tables were organized by each unit of study, then, categorized into either formative or summative assessments. Participants who were categorized in the experimental group participated in brain breaks before assessment. Participants who did not participate in brain breaks were categorized under the control group. Data from the tables were gathered to see if there was an effect on testing scores based on brain breaks. Data was collected from both the experimental and control groups. The percentages for each participant were recorded based on the number and letter that was assigned to each participant. Participants did not switch numbers or letters throughout the study, however, they did switch between experimental and control groups. For example, participant 1A started in the experimental group in the first unit of study and then switched to the control group in the second area of study. If there was an AB marked in the table, then the participant was absent on the day in which the assessment was given, therefore their scores were not factored in.
First unit of study: Geometry
*AB- participants who were absent

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Based on the data gathered from the first unit of study, results showed that participants who completed ‘brain break’ had an average of 85.8% correct on formative assessment #1. Based on the data collected from the first unit of study, results showed that participants who participated in the control group for formative #1 had an average of 88.64%. For the first unit of study, formative assessment #2, participants who were in the experimental group scored an average of 96.36%, participants who were in the control group scored an average of 96.4%. Based on the table shown above, in the first area of study, summative #1, participants who were part of the experimental group scored an average of 96.72% and participants who were part of the control group scored an average of 95.72%. Based on the table shown above, in the first area of study summative #2, participants who were part of the experimental group scored an average of 95.09%, participants who were part of the control group scored an average of 92.45%.
Second Unit of Study: Double Digit addition/subtraction
*AB- participants who were absent

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Based on the data gathered from the third unit of study, results showed that participants who completed ‘brain break’ had an average of 78.45% correct on formative assessment #1. Based on the data collected from the third unit of study, results showed that participants who participated in the control group for formative #1 had an average of 63.9%. For the third unit of study, formative assessment #2, participants who were in the experimental group scored an average of 78.81%, participants who were in the control group scored an average of 69%. Based on the table shown above, in the third area of study, summative #1, participants who were part of the experimental group scored an average of 75.1% and participants who were part of the control group scored an average of 70.18%. Based on the table shown above, in the third area of study summative #2, participants who were part of the experimental group scored an average of 85.45%, participants who were part of the control group scored an average of 88.18%.

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Third Unit of Study: Measurement
*AB- participants who were absent
Fourth Unit of Study: Triple digit addition and subtraction  

*AB- participants who were absent

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Based on the data gathered from the fourth unit of study, results showed that participants who completed ‘brain break’ had an average of 74.4% correct on formative assessment #1. Based on the data collected from the fourth unit of study, results showed that participants who participated in the control group for formative #1 had an average of 64.45%. For the fourth unit of study, summative assessment #1, participants who were in the experimental group scored an average of 87.3%, participants who were in the control group scored an average of 89%. Based on the table shown above, in the first area of study, summative #2, participants who were part of the experimental group scored an average of 94% and participants who were part of the control group scored an average of 82.22%. Based on the table shown above, in the first area of study summative #3, participants who were part of the experimental group scored an average of 93%, participants who were part of the control group scored an average of 89.9%.
Interpretation of Results

The data for the first unit of study showed that in 2 of the 4 assessments, averages for participants who completed brain breaks before math assessments performed better than those who were in the control group and did not participate in brain breaks. In the second unit of study, data showed that in 2 of the 3 assessments, averages for participants who completed brain breaks before math assessments performed better than those who were in the control group. In the third unit of study, data showed that in 3 of the 4 assessments, averages for participants who completed brain breaks before math assessments performed higher than those who were in the control group. In the fourth unit of study, data showed that in 3 of the 4 assessments, averages for participants who completed brain breaks before math assessment were higher than those who were in the control group. Based on these results, the researcher can conclude that physical movement exercises had a positive effect on student mathematical testing scores. When comparing participants individually, the effects of brain breaks on math testing scores were inconclusive. Variables that could have affected these results could have been prior knowledge of subject area, teaching styles for the curriculum leading up to the assessments, interventions that were used during lessons, the participants’ understanding of unit of study, the participants’ engagement and focus throughout the unit, attendance and the assessment formats for this unit of study. Results of this study showed that there was a positive effect on math testing scores for second graders based on movement exercises. Based on the data that was collected from this study, results showed that participants who actively participated in brain breaks, performed better on math assessments. Averages showed that for 10 out of 15 assessments, participants who
participated in brain breaks out performed participants who did not participate in brain breaks.
Chapter V Discussion/Conclusion

Further discussion should be considered to see if outlier scores altered these results. There were also some inconsistencies in which future discussion would have to be held to determine the effectiveness of these findings for different populations. For example, there wasn’t a consistent pattern in the data that showed conclusive results when comparing students of equal academic ability. Inconclusive results could have been due to several variables, such as learning styles of participants, knowledge of different math units, development of each participant, participants’ engagement, attendance, interventions that were used to help participants learn units, level of rigor of assessments, and other unknown factors. Each assessment was on a different concept and no pattern could be found to determine if exercise was the only factor that led to a positive result. For example, for the first assessment 3 out of 4 assessments showed a positive correlation between exercise and testing scores. However, there could have been other factors, such as knowledge participants had on that unit of study, or the amount of sleep participants had the night before the assessment was given, or the amount of focus they had while taking that assessment. Future research needs to be done to determine the effect brain brakes has on math testing scores. Future research also needs to be done to see if these findings are consistent in different populations, or if findings are similar in smaller or larger group samples. Future research needs to be done to determine if these findings are consistent over longer periods of time.
References:


Appendices

Research Resources
The Right to Inform Consent

I, Katie Hughes, am conducting a research project: Will Physical Movement between Academic Learning Activities Effect Student Test Scores? in order to complete my Master’s program at Aquinas College. I will be facilitating a study in which I will explore whether there is an effect of physical exercise on student testing scores in math. I will be completing my thesis under the supervision of Dr. Winkle who is a professor of Education at Aquinas College.

The purpose of this study is to see how brain breaks will effect student math test results. It will compare data collected by me to see if physical movement or physical activities between academic learning activities affect students’ math test scores. This study seeks to see if time spent on brain breaks is effective or if that time could be used more productively as instructional time. This study seeks to determine if there is a difference in academic testing results from having participated in brain breaks or not. This study will present different exercises that will allow students to move in an otherwise stagnate environment. The exercises will be developmentally appropriate and will allow students to feel successful in the classroom. Brain break activities will include a variety of movement exercises from the GoNoodle program that was created by Health Teacher Inc. Brain break activities will be chosen from one of five exercises. These exercises are: Exercises with Maximo, which are yoga style exercises in which students practice stretching, using different beginning yoga moves. Risks from this exercise may include bumping into desks or another student. Zumba Kids, in which students follow along with a choreographed dance. Risk for this exercise may include bumping into desks or another student. Flow, in which students practice calming breathing exercises while standing and visualizing self-monitoring strategies. Risk for this exercise minimal and I do not foresee and possible risks. Run with Us, in which students complete track and field events next to their desks. Risks for this exercise may include bumping into desks or another student. And GoNoodle Plus Freeze It, in which students run in place and answer questions about health, ELA, and math. Risks from this exercise may include bumping into desks or another student. If participants do bump into a student desk or another student they are able to get ice from the front school office, depending on the severity. If need be participants can also opt out of doing the rest of the exercise and sit down if they bump into a student desk or another student.

This research will begin in March, 2016 and conclude the following May, 2016. Participants will consist of students from my 2015-2016 second grade class. This study involves students being divided into a control group and an experimental group. Students will be divided equally between academic ability, demographics, age,
and gender. I will alternate the experimental group and control group after each math unit, so all students will participate in brain break exercises. Students who are part of the experimental group will participate in “brain breaks” immediately before math formative and summative math assessments. The control group will not participate in “brain breaks” immediately before math formative and summative math assessments. Participants who are in the control group will complete a coloring page, read a book, or practice writing while the experimental group completes the “brain break”. After the assessment, the two group scores will be compared. Students will participate in activities for this study for 2 formative assessments per unit in addition to 1-3 summative assessments, depending on the math unit. This classroom’s second grade curriculum has 4 math units from March to May. Data will be collected and recorded from the formative and summative assessments and then compared between the control and experimental groups. Participants will complete a total of 15 assessments in which I will collect and compare data. The data that is collected from this study will be kept confidential. Student names will not be used in the publication of my research. Participants will be given a number and that number will be used to track data. Data will be stored on the teacher computer, which is password protected. I am the only one with access to the teacher computer. The door to the classroom will also be kept locked to ensure security. The school principal and custodian are the only other people to have keys to the classroom. Data will be destroyed at the end of the experiment in June, 2016. The data will be deleted from files on the teacher computer.

Brain breaks are already part of the school culture and administrators encourage teachers to use brain breaks throughout the school. Students who do not participate in my thesis study will still be expected to participate in brain breaks; however I will not collect data for analysis from nonparticipants. Participation for this study is voluntary and there is no penalty should participants not want to participate. Participants may discontinue this study at any time without penalty. Should you have any questions please feel free to email me at khughes@otsegops.org or Dr. Winkle at winkler@aquinas.edu. If participants would like to see the results of this study they should contact me at khughes@otsegops.org or Dr. Winkle.

If you read, understand, and are willing to allow your child to participate in my project, please sign your name and data below:

Participant (child's name)____________________________________

Parent/Guardian’s signature: _____________________________ Date: _______________
Assessments

First unit of study
Formative #1

Name: ________________

Challenge Page

<table>
<thead>
<tr>
<th></th>
<th>Sides</th>
<th>Corners</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Hexagon" /></td>
<td><img src="image2" alt="Arrow" /></td>
<td></td>
</tr>
<tr>
<td><img src="image3" alt="Pentagon" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image4" alt="Triangle" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image5" alt="Star" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image6" alt="Cross" /></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
First unit of study

Summative #1

Unit 3, Section 1 Assessment

Directions: For #1-6, write the name, number of sides, and number of angles for each of the shapes.

1. [Triangle]
   - Name of Shape:
   - Number of Sides:
   - Number of Angles:

2. [Rectangle]
   - Name of Shape:
   - Number of Sides:
   - Number of Angles:

3. [Square]
   - Name of Shape:
   - Number of Sides:
   - Number of Angles:

4. [Pentagon]
   - Name of Shape:
   - Number of Sides:
   - Number of Angles:

5. [Hexagon]
   - Name of Shape:
   - Number of Sides:
   - Number of Angles:

6. [Cube]
   - Name of Shape:
   - Number of Faces:
   - Number of Vertices:
7. Circle all of the quadrilaterals.

8. Explain how you know the shapes you circled are quadrilaterals.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
9. Draw a shape that has three sides and three angles.

10. Draw a shape that has six sides and six angles.

11. Draw a shape that has four sides and four angles.

12. Draw a different shape that has four sides and four angles.

13. Draw a shape that has five sides and five angles.

14. Draw an unusual shape with sides and angles.
15. Color a face.
   Draw and arrow to an edge.

    Draw and arrow to a side.
First unit of study

Formative #2

Partition Circles and Rectangles - Matching Worksheet

Match the pictures with their halves, thirds or fourths.

1.) [Diagram of a divided shape]  
   - a) Thirds

2.) [Diagram of a divided shape]  
   - b) 1/4

3.) [Diagram of a divided shape]  
   - c) Halves

4.) [Diagram of a divided shape]  
   - d) Fourths

5.) [Diagram of a divided shape]  
   - e) 2/3

First unit of study

Summative #2
Unit 3, Section 2 Assessment

Directions: Label the drawings below using the words halves, thirds, or fourths.

1. [Diagram of a square divided into four equal parts]

2. [Diagram of a hexagon divided into two equal parts]

3. [Diagram of a rectangle divided into three equal parts]

4. [Diagram of a rectangle divided into four equal parts]

5. [Diagram of a circle divided into two equal parts]

6. [Diagram of a triangle divided into three equal parts]

Name ____________________
THE EFFECTS OF BRAIN BREAKS ON TEST SCORES

7. Partition the rectangle into halves.
   Color one half red.
   Color one half blue.
   There are _____ halves in the whole.

8. Partition the rectangle into thirds.
   Color one third red.
   Color two thirds blue.
   There are _____ thirds in the whole.

9. Partition the rectangle into fourths.
   Color one fourth red.
   Color three fourths blue.
   There are _____ fourths in the whole.

10. Partition the circle into halves.
    Color one half red.
    Color one half blue.
    There are _____ halves in the whole.

11. Partition the circle into thirds.
    Color one third red.
    Color two thirds blue.
    There are _____ thirds in the whole.

12. Partition the circle into fourths.
    Color one fourth red.
    Color three fourths blue.
    There are _____ fourths in the whole.
13. Partition the rectangle into 2 rows and 4 columns.

How many squares are in the rectangle? _______

14. Partition the rectangle into 4 rows and 3 columns.

How many squares are in the rectangle? _______

15. Partition the rectangle into 3 rows and 3 columns.

How many squares are in the rectangle? _______
Second unit of study

Formative #1

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2-Digit Addition</strong></td>
<td></td>
</tr>
</tbody>
</table>

Rewrite each problem vertically and solve.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. $28 + 9 = $</td>
<td>b. $46 + 35 = $</td>
<td>c. $78 + 16 = $</td>
</tr>
</tbody>
</table>

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>d. $57 + 61 = $</td>
<td>e. $97 + 8 = $</td>
<td>f. $69 + 12 = $</td>
</tr>
</tbody>
</table>

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>g. $48 + 27 = $</td>
<td>h. $93 + 38 = $</td>
<td>i. $65 + 54 = $</td>
</tr>
</tbody>
</table>
Second unit of study

Formative #2

Monster Math
Two-Digit Subtraction

a.  
6 7
- 4 9

b.  
3 0
- 2 1

c.  
9 5
- 7 4

d.  
8 4
- 6 8

e.  
4 2
- 3 9

f.  
5 2
- 6

g.  
5 8
- 4 3

h.  
8 4
- 5 8

Subtraction: 2-digits w/ Borrowing
The Effects of Brain Breaks on Test Scores

Second unit of study

Summative

Unit 4, Section 1 Assessment

Name ____________________________

Addition and Subtraction Strategies
- Use a number line
- Partial Sums (expanded form)
- Place Value Addition
- Make a Model (base ten blocks)
- Draw a Picture
- Arrow Method
- Tape Diagram
- Standard Algorithm

1. Use a strategy to solve the following addition problems. Show your work!

a. $67 + 17 = $

b. $34 + 52 = $

2 pts. each
2. Use a strategy to solve the following subtraction problems. Show your work!

a. 83 - 41 =

b. 54 - 27 =
3. Use a strategy to solve the following problems. Show your work!

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>b.</td>
</tr>
<tr>
<td>57 + 72</td>
<td>63 + 28</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>d.</td>
</tr>
<tr>
<td>89 - 36</td>
<td>45 - 29</td>
</tr>
</tbody>
</table>
4. Use a strategy to solve the following word problems. Show your work!

a. Dana solved 54 problems during the math contest. Tracy solved 18 more problems than Dana. How many problems did Tracy solve?

Answer ........................................................................................................................................

b. Shane had 16 coins in his piggy bank. His dad gave him some more coins. Now Shane has 64 coins in his piggy bank. How many coins did Shane’s dad give him?

Answer ........................................................................................................................................
5. Lucy and Sara both used a different strategy to solve the same addition problem. One of them got the answer correct and one of them got the answer incorrect. Determine which girl got the answer correct and then explain what the other girl did wrong.

\[ 46 + 34 = \_
\]

<table>
<thead>
<tr>
<th>Lucy</th>
<th>Sara</th>
</tr>
</thead>
<tbody>
<tr>
<td>46</td>
<td>70</td>
</tr>
<tr>
<td>+</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td></td>
</tr>
<tr>
<td>=</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>70</td>
</tr>
</tbody>
</table>

Who got the answer correct? __________________________

Who got the answer incorrect? ________________________ Explain what she did wrong.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________
6. Fill in the missing addend. Explain how you determined what number to put in the blank.

\[ 15 + 39 = \underline{\quad} + 15 \]

2 pts.
Third unit of study

Formative #1

Name: __________________________

**Bar Graph of Coins**

Karla collects coins from Asian countries. The table below shows how many coins she has collected from four different countries. Use the information in the table to complete the graph.

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of Coins</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>13</td>
</tr>
<tr>
<td>Japan</td>
<td>15</td>
</tr>
<tr>
<td>Vietnam</td>
<td>4</td>
</tr>
<tr>
<td>India</td>
<td>10</td>
</tr>
</tbody>
</table>

**Karla's Asian Coin Collection**

Number of Coins

Countries
Third unit of study

Formative #2

Name: ________________________

Cookie Sales Pictograph

Four Girl Scouts sold cookies for one month. The list below shows how many boxes were sold by each Girl Scout.

Isabella - 40 boxes  
Emma - 15 boxes  
Sam - 35 boxes  
Grace - 50 boxes

Use the information from the list to complete the pictograph below and answer the questions.

<table>
<thead>
<tr>
<th>Name</th>
<th>Cookie Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isabella</td>
<td></td>
</tr>
<tr>
<td>Emma</td>
<td></td>
</tr>
<tr>
<td>Sam</td>
<td></td>
</tr>
<tr>
<td>Grace</td>
<td></td>
</tr>
</tbody>
</table>

KEY

Each = 5 boxes

1. How many boxes of cookies did the girls sell in all?
   1. __________

2. How many more boxes of cookies did Isabella sell than Emma?
   2. __________

3. Which two girls sold a total of 75 boxes of cookies?
   3. __________

4. Half of the cookies sold by Grace were Thin Mints. How many boxes of Thin Mints did Grace sell?
   4. __________
Third unit of study

Summative

**Unit 6 Assessment**

1. Measure the lines in inches. Plot the data on the line plot by placing an X for each measurement.

   a. 
   b. 
   c. 
   d. 
   e. 
   f. 
   g. 
   h. 
   i. 

   ![Line Plot]

   **A:** Most of the lines were how many inches long? ________ inches

   **B:** How many lines were 2 inches long? ________ lines

   **C:** How many more 2 inch lines are there than 5 inch lines? ________ more
2. The Second Graders were responsible for purchasing ice cream for an Open House event at school. They decided to collect data to determine which flavors to buy for the event. As a group, the students decided on the question, “What is your favorite flavor of ice cream?” and 4 likely responses, “chocolate”, “vanilla”, “strawberry”, and “cherry”. The data they collected is organized in the table below.

<table>
<thead>
<tr>
<th>Flavor of Ice Cream</th>
<th>Number of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chocolate (C)</td>
<td>12</td>
</tr>
<tr>
<td>Vanilla (V)</td>
<td>5</td>
</tr>
<tr>
<td>Strawberry (S)</td>
<td>6</td>
</tr>
<tr>
<td>Blue Moon (B)</td>
<td>9</td>
</tr>
</tbody>
</table>

Make a bar graph to represent the data from the table. Label the bottom and side of your graph.

Use the data from the bar graph to answer the following questions.

A. How many people picked chocolate, vanilla, and strawberry all together? _____ people

B. How many total people were asked about their favorite ice cream flavor? _____ people
3. At the Open House, the first 25 people chose the following flavors of ice cream.

<table>
<thead>
<tr>
<th>Flavor of Ice Cream</th>
<th>Number of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chocolate (C)</td>
<td>11</td>
</tr>
<tr>
<td>Vanilla (V)</td>
<td>5</td>
</tr>
<tr>
<td>Strawberry (S)</td>
<td>3</td>
</tr>
<tr>
<td>Blue Moon (B)</td>
<td>6</td>
</tr>
</tbody>
</table>

Use the ice cream data from the table to make a pictograph.

<table>
<thead>
<tr>
<th>Favorite Ice Cream Flavors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

😊 = 1 person

4. Use the pictograph you created to answer the questions below.

A: How many more people picked Chocolate than Blue Moon? _________ more

B: How many more people would need to choose strawberry to have the same amount of votes as chocolate? _________ more
Find the sums.

\begin{align*}
\text{a. } & 357 + 208 = 565 \\
\text{b. } & 299 + 234 = 533 \\
\text{c. } & 483 + 95 = 578 \\
\text{d. } & 250 + 590 = 840 \\
\text{e. } & 774 + 526 = 1300 \\
\text{f. } & 878 + 316 = 1194 \\
\text{g. } & 687 + 678 = 1365 \\
\text{h. } & 160 + 74 = 234 \\
\text{i. } & \$816 + \$905 = \$1721 \\
\text{j. } & \$999 + \$777 = \$1776
\end{align*}

1. Mr. Sanford bought a new grill and picnic table for his backyard. He spent $178 on the grill and $467 on the picnic table. How much did he spend in all? 

2. Mr. Sanford had a huge outdoor party. He grilled 145 hamburgers and 247 cheeseburgers for his guests. How many burgers did he grill in all?
Fourth unit of study

Summative #1

Unit 7, Section 1 Assessment

1. Use a strategy to solve the following problems. Show your work!

   a.  
   
   157  
   + 672  
   
   b.  
   
   363  
   + 428  
   
   c.  
   
   672  
   - 455  
   
   d.  
   
   827  
   - 136  

2. Use a strategy to solve the following addition problem. Show your work and explain what you did to get your answer.

a.  

\[
342 \\
+ 193
\]

Answer __________________

Explain what you did to get your answer:

_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

3. Billy solved the subtraction problem below. Look at his work and explain what he did to solve the problem.

b.  

\[
\begin{array}{c}
895 \\
- 247 \\
\hline
648
\end{array}
\]

Is his answer correct? __________

Explain what he did to solve the problem:

_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
Fourth unit of study

Formative #2

Name: ______________________

**Column Addition**

Find the sums.

<table>
<thead>
<tr>
<th></th>
<th>a. 54</th>
<th>b. 95</th>
<th>c. 99</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>48</td>
<td>60</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>+29</td>
<td>+57</td>
<td>+88</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>d. 91</th>
<th>e. 64</th>
<th>f. 79</th>
<th>g. 93</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>46</td>
<td>7</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>+67</td>
<td>+65</td>
<td>+78</td>
<td>+84</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>h. 70</th>
<th>l. 98</th>
<th>j. 59</th>
<th>k. 24</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>48</td>
<td>32</td>
<td>24</td>
</tr>
<tr>
<td>+22</td>
<td>+17</td>
<td>+85</td>
<td>+24</td>
</tr>
</tbody>
</table>

Cara played her violin of 3 different nights this week. She played for 24 minutes on Monday, 9 minutes on Tuesday, and 35 minutes on Thursday. How many minutes did she play in all? __________
Unit 7, Section 2 Assessment

1.  23
   46
   68
   + 37

2.  62
   25
   14
   + 59

3. The second graders in Otsego are collecting box tops. At the end of each week, they see how many total box tops their class has collected. At the end of the first week, this is how many box tops were collected by some of the students in two of the classrooms:

<table>
<thead>
<tr>
<th>Mrs. Jones' Class Box Tops</th>
<th>Mr. Pritchett's Class Box Tops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ronald</td>
<td>Brandon</td>
</tr>
<tr>
<td>39 box tops</td>
<td>22 box tops</td>
</tr>
<tr>
<td>Andy</td>
<td>Brian</td>
</tr>
<tr>
<td>40 box tops</td>
<td>18 box tops</td>
</tr>
<tr>
<td>Kristin</td>
<td>Danielle</td>
</tr>
<tr>
<td>61 box tops</td>
<td>88 box tops</td>
</tr>
<tr>
<td>Cathie</td>
<td>Lizzy</td>
</tr>
<tr>
<td>56 box tops</td>
<td>56 box tops</td>
</tr>
</tbody>
</table>

A: Find out how many box tops each class collected at the end of the first week. Show your work.

B: Explain how you found out.
Fourth unit of study

Summative #3

Unit 7, Section 3 Assessment

Look at the array. Write an addition equation.

1. ★★★★
   ★★★★  _____ + _____ = _____

2. ★★★★
   ★★★★  _____ + _____ + _____ + _____ = _____
   ★★★
   ★★★

3. ★★★★★
   _____ + _____ = _____

4. ★★★
   ★★★  _____ + _____ + _____ + _____ + _____ = _____
   ★★★
   ★★★

5. ★★★
   ★★★  _____ + _____ + _____ = _____
   ★★★
Look at the pictures in each set. Write the total number. Circle if the number is odd or even.

6. 

[Image of 6 apples] 

_______ odd even

7. 

[Image of 8 baskets] 

_______ odd even

8. 

[Image of 8 smiley faces] 

_______ odd even

Using your total for question 8, write an equation with equal addends to represent the amount:

_______ + _______ = _______