

The Effect of Physical Movement Prior to Testing on Division Fact Score Performance

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Table of Contents

List of Tables	i
Abstract	ii
I. Introduction	1
Overview	1
Statement of Problem	2
Hypothesis	2
Operational Definitions	2
II. Review of the Literature	4
Movement Integration in the Classroom	4
Impact of Physical Education	5
Possible Movement Activities	10
Summary	10
III. Methods	11
Design	11
Participants	11
Instrument	12
Procedure	12
IV. Results	14
V. Discussion	15
Implications of Results	15

Theoretical Implications	15
Threats to Validity	16
Connections to Previous Studies/Existing Literature	17
Implication for Future Research	18
Conclusion	18

List of Tables

1. Table 1: Means, Standard Deviations, and t -statistic for Division Fact Fluency Scores under Physical Movement and Non-Physical Brain Break Conditions 16

Abstract

The purpose of this study was to investigate the effects that physical movement, prior to testing, had on student performance of division math facts. This study utilized a pre-experimental, one-group pretest/posttest design with a convenience sample of a group of fourth-grade students who served as their own controls. The study included 17 students, ten boys and seven girls, ranging from nine to ten years of age. Of those students, 14 were Caucasian, two were African American, and one was Asian. The null hypothesis was that among fourth-grade students who struggle with division fact fluency, there will be no significant difference in mean division fluency scores when students participate in five minutes of physical movement prior to testing as compared to when they participate in five minutes of a non-physical brain break prior to testing. The null hypothesis was rejected. This study includes practical and theoretical implications, and ideas for future research are discussed.

CHAPTER I

INTRODUCTION

Overview

With the recent implementation of the EnVision math program, this researcher has noticed many of her fourth-grade students do not have sufficient multiplication and division fact fluency to be successful with the new curriculum. No matter which mathematics program is implemented, students continuously come to fourth grade without the basic skills of fact fluency. In fourth grade, students are expected to learn major foundational skills such as long division and two-digit by two-digit multiplication, factors, multiples, and more. Math facts are the base of these foundational skills. Ideally, division math facts should be mastered in the third grade, yet year after year, students enter the fourth grade having not mastered these facts.

Schools continue to see an increased amount of pressure on school academic achievement (Waite-Stupiansky & Findlay, 2001). With this continuous increase in academic demands, educators need to reevaluate how to assist students in mastery of their facts so students can be successful. If something is not done now, students will be crushed under the weight of more complex mathematical problems. If students are able to have their facts memorized, they will be better able to concentrate on more complex mathematical strategies. This would allow for a deeper understanding and mastery of more concepts if students are not concerned with their facts.

Waite-Stupiansky and Findlay (2001) discuss the positive correlation between physical movement and the brain. They discuss the positive impact of physical movement and how the brain—where individuals' problem-solve, sequence, and plan—becomes engaged through

movement. Therefore, educators should consider how to incorporate movement into the daily classroom to increase academic scores.

Statement of the Problem

The purpose of this study was to determine whether fourth-grade students who struggle with division fluency would demonstrate better division fact fluency if they had physical movement prior to testing.

Hypothesis

The null hypothesis was that among fourth-grade students who struggle with division fact fluency, there will be no significant difference in mean division fluency scores when students participate in five minutes of physical movement prior to testing as compared to when they participate in five minutes of a non-physical brain break prior to testing.

Operational Definitions

Students who struggle with division fact fluency: Fourth-grade students in this researcher's co-taught mathematics class. These students do not demonstrate the division fact fluency expected of fourth graders based on their performance on fast fact sheets and standardized tests.

Division fluency scores: This score is the total number of division fast fact problems that were solved correctly over the course of four fast fact assessments under each condition. Students received credit for all items correct on each assessment, and they could receive credit for the same division fact if they answered the same division problem correctly on multiple assessments.

Fast-fact assessments: Each assessment consists of 100 division fact (one through ten) problems. Students are given five minutes to complete as many items as possible. The assessments are in a pencil and paper format.

Physical movement: Physical movement consists of movements that would raise a student's heart rate such as yoga movements, stretching, and light calisthenics. Some of the activities are presented through an online format, such as "Gonoodle.com," while others are teacher-led.

Non-physical brain break: Non-physical brain break consists of activities that do not raise the students' heart rate. Some activities include free drawing, writing, and briefly speaking with peers.

CHAPTER II

REVIEW OF THE LITERATURE

This literature review discusses the effects of physical movement prior to topic assessments on fourth grade student achievement. The first section of this literature review will discuss movement integration in the classroom. Section two will discuss the impact of physical activity on cognitive health, physical health, academics, and behavior. Section two will only focus on students at the elementary age. In the final section of the literature review, possible physical movement activities will be presented and discussed.

Movement Integration in the Classroom

Elementary school is an imperative building block to the future. Whether to increase academics for students or allow them to partake in more physical activity has been an ongoing debate. The following section will review the positive impact of movement integration in the classroom.

To discuss movement integration, we first need to define what it is. Lindt and Miller (2018) define movement integration is any type of physical activity that has been infused in a regular classroom time. This movement can consist of movement incorporated into a lesson or activity, short physical breaks, or physical movement during a transition period.

Schools continue to see an increased amount of pressure on school academic achievement (Waite-Stupiansky & Findlay, 2001). As such, as many educators feel the pressure to find time to teach all of the given requirements, one of the first subjects to be taken is recess. This may be doing more harm than good. According to Goldfield and Patterson (as cited in Savina, Garrity, Kenny, & Doerr, 2016) in order to meet standards and increase academic time,

schools are forfeiting physical education. According to Pate et al. (as cited in Savina et al., 2016) students across all academic levels are seeing an increase in sedentary activity with children spending about 43 minutes of every hour at school in a sedentary activity. Waite-Stupiansky and Findlay (2001) argue that recess is a necessary element to a child's day because it gives students the opportunity to have "unstructured and undirected" (p. 7) time. While this may seem like an educator's nightmare, it gives the students the ability to work on social interactions and other important components like problem solving. This, in turn, helps them to develop themselves and increase their personal self-esteem that may be brought back into the classroom.

According to the National Center for Chronic Disease Prevention and Health Promotion (CDC) in a recent 2014 survey, almost 80% of young children are not meeting the recommended 60-minute minimum of moderate to vigorous physical activity that is needed on a daily basis. This is also a higher percentage than the national average of about 70% of youth not meeting the recommended minimum.

During this literature review, there will not be a direct discussion about recess time; however, the time given prior to assessment testing exemplifies some of the same traits as recess does. Therefore, the benefits are similar, if not identical.

Impact of Physical Activity

Cognitive and Physical Health

The cognitive and physical growth at the adolescent age is critical. Being able to adequately nurture the cognitive and physical health at a young age is imperative. The use of physical activity in the classroom could help nurture the minds of young students. According to the U.S Department of Health and Human Services (2008), with just a single burst of exercise,

people may see a reduction in their anxiety and improvement in their sleep. With the pressure on student testing intensifying, the use of physical activity could assist in lowering student anxiety and improving test scores.

While some may argue that the physical health of youth does not affect academics, they may not have considered the damage poor physical health may cause. If a student is in poor health, it may become more difficult to focus and have energy to participate, and attendance may begin to suffer. A recent study was conducted to determine the correlation between physical fitness and students' assessment results.

Using students from grade levels fourth through sixth, Wang, Wang, and Huang (2012) conducted a study that gave students a questionnaire completed along with their parents in order to determine physical health. Then students were led through a series of health fitness assessments like sit and reach, push-ups, etc. The researchers then linked these health assessments with student academic testing scores to determine whether students' overall health has an effect on their academics. In their conclusion, Wang et al. found that there was a positive correlation between good health and academic scores.

Physical movement not only improves bodies but improves the mind. In a recent article determining the link between movement and learning, Waite-Stupiansky and Findlay (2001) discuss brain development and how physical movement impacts it. It has been shown that there is a link between movement and thinking. Waite-Stupiansky and Findlay discuss that the neurons in the section of the brain called the cerebellum connect to all the parts of the cortex and those neurons send signals to and from the cortex. Although the cerebellum only makes up for one-tenth of the brain itself, it contains more than 50% of the brain's neurons in this section alone. Waite-Stupiansky and Findlay also mention that when physical movement such as dancing,

stretching, or playing a game with a ball are involved, the part of the brain that makes up for where individuals problem-solve, sequence, and plan become engaged. Healy (as cited in Waite-Stupiansky & Findlay, 2001) discusses that after an animal study, physical movement contributes to a growth of brain cells. This demonstrates what a positive impact on humans that physical movement can be toward the brain and toward learning.

Students are asked to be sedentary for longer periods of time; this length of time without interruption with physical movement may hinder their learning. According to Ramstetter (as cited in Stapp & Karr, 2018), “a period of interruption followed by a period of concentrated instruction is necessary for optimal cognitive processing in children” (p. 12). It becomes increasingly apparent that the use of physical movement prior to testing may well result in cognitive and physical health benefit.

Academics and Behavior

High stakes testing has come to the forefront of academics at all educational levels. With the integration of physical movement prior to testing, students could see an increase in test scores as well as their behavior.

Foran, Mannion, and Rutherford (2017) focused on teachers’ perception of physical activity in the classroom. Foran et al. gave teachers who intentionally integrated physical movement prior to activities a survey to determine whether they believed movement enhanced the students’ academics and behavior. Teachers were used from Grades 1-6 and noted that there was a significant change in student behavior and academics. Teachers reported that students were better focused after a short burst of physical movement. They also noted that students’ academic test results improved after a time of physical movement. The mood of the entire room seemed to

change when physical movement was incorporated. Foran et al. state, “Several values related to their experience using physical activity; increased student focus, engagement, enjoyment, and changing the energy of the room” (p. 1).

Many classrooms integrate students with special needs. Physical movement can be even more positive for students with special needs like attention deficit hyperactivity disorder (ADHD). Mulrine, Prater, and Jenkins (2008) discuss the benefit of movement in the classroom specifically for students with ADHD. The authors discuss that students with ADHD are easily distracted, have a difficult time staying on task, and need redirection often. They continue to discuss how physical activity helps students with ADHD to stay more focused and need less redirection.

Donnelly and Lambourne (as cited in Brusseau & Hannon, 2015) discuss the impact of comprehensive school physical activity programming on children’s health and academics. They state that, “movement can increase students’ overall physical activity and improve time-on-task and attentiveness” (p. 2). Time on task and attentiveness are major components that educators are continuously trying to increase. Through the use of physical activity, educators are able to better achieve a more focused classroom and the possibility of improved academics.

Possible Movement Activities

With research showing the positive impact on students’ academics through the use of physical movement, it is imperative that educators are equipped with how to implement movement in the classroom. With bouts of movement up to ten minutes prior to assessments or even during transitions, academic scores, classroom behavior, and student well-being could be

improved. Although this literature review will give multiple suggestions for movement activities, educators will need to find what works for them and could modify the suggestions below.

There are multiple free sites for educators to use if they have internet access. One of the most popular sites is Gonoodle.com. This site entails a plethora of activities that are quick and easy to implement, making it so educators require no preparation. By using the site, Gonoodle claims to, “Boost productivity. Improve behavior. Build community” (Gonoodle, 2019). To capture the classroom’s attention more, students are navigated through choosing a classroom character. Students complete different activities of their choice, like yoga, karate, or racing. Students earn points for their character to grow and unlock other activities paralleling popular video games they may use at home.

Another “no-prep” option for educators is a site called, “Take 10.” This website includes breaks for ten minutes that include some type of educational aspect with movement. The site was developed by educator experts and health professionals. The site claims that, “gets kids moving without sacrificing time dedicated to academic learning” (Take10, 2019). Educators are able to purchase materials for the program specific to the grade of their choice. This program is not free like the prior site and costs about \$100.00. Many schools can use reimbursement for this purchase or make a purchase for school use.

For activities that do not need internet access, educators can create a jar of movement ideas. Ideas can be written on popsicles sticks and pulled prior to testing or when needed. Some examples that can be places in this jar for the classroom include:

- Stretching as a class
- Jumping jacks

- Running in place
- Passing a soft ball around to students in the room
- Completing squats, lunges, push-ups or sit-ups
- Simon says
- Star jumps
- Invisible jump rope

The activities suggested above may possibly be modified for each classroom setting to meet the needs of the students and the teacher.

Summary

The effect of physical movement prior to testing is a positive one. A look at cognitive and physical health has shown that the brain is activated more after a burst of physical activity. Also, physical movement can contribute to the improvement of mood due to the positive health benefits. Time on task and other behaviors will begin to improve when physical movement is integrated prior to academics. Many resources are given to educators to help incorporate small breaks of physical movement in the classroom to see these benefits. After a review of the literature and seeing how movement integration can impact students in the classroom, as well as the various options for educators, it is clear that movement in the classroom has a positive effect and should be incorporated.

CHAPTER III

METHODS

The purpose of this study was to determine whether fourth-grade students who struggle with division fluency would demonstrate better division fact fluency if they had physical movement prior to testing.

Design

This study employed pre-experimental, one-group pretest/posttest design with a convenience sample of a group of fourth-grade students who served as their own controls. The dependent variable was student scores on the paper and pencil division fact sheet. The independent variable was type of activity engaged in prior to fluency testing—physical movement or non-physical brain break.

Participants

The participants in the study were fourth-grade students attending a school in a middle-class suburban community in the mid-Atlantic region. They were a convenience sample from the researcher's below-grade level, co-taught math class, which consists of 17 students. The experimental group consisted of ten boys and seven girls. There were 14 Caucasian students, two African American students, and one Asian student. Ages ranged from nine to ten years old. There was one subject from the Classroom Support Program (CSP). This student recently was integrated into the general education population. There were four students out of 17 who receive special education services.

Instrument

The assessment given was a division fact sheet that was retrieved online from Math-Drills.com. This sheet consisted of 100 division facts 1-12, using the Obelus symbol. Students were given five minutes to complete the given assessment. The items were scored based on division facts; therefore, reliability or validity would not be an issue unless, the researcher made an error in grading. To ensure reliability and validity, the researcher checked all answers twice. Each answer given was worth one point, for a total of 100 possible points. A total of eight fact sheets were completed over the course of the study. All fact sheets were identical.

Procedure

Participants were students within the researcher's co-taught math class. Students within the class were identified as collectively demonstrating a weakness within the area of basic division math facts based off of performance throughout the year on various assessments.

Students were assessed on their basic division fact knowledge on Tuesdays and Thursdays throughout a four-week period. Each session alternated between using physical movement prior to testing or non-physical brain break activities. These five-minute movement activities consisted of online use of the program Gonoodle.com, teacher-led stretches, teacher-led exercise movements and listening to music while free dancing. The five-minute non-movement activities consisted of silently reading, speaking with peers while seated, coloring, or word searches.

This assessment used paper and pencil method for all testing. Students were timed using an online timer that was displayed on the board. Students were given a verbal reminder of the remaining time at two minutes left and then again at one-minute remaining.

The total number of points earned under each condition was added together, with the maximum number of points available under each condition being 400. The points earned under the physical movement condition were compared to the points earned through the non-physical brain break movement condition with a non-independent samples *t*-test.

CHAPTER IV

RESULTS

The purpose of this study was to determine whether fourth-grade students who struggle with division fluency would demonstrate better division fact fluency if they had physical movement prior to testing.

A non-independent sample *t*-test was conducted with the independent variable being the type of activity engaged in prior to fluency testing-physical movement or non-physical brain break and the dependent variable being student scores on the paper and pencil division fact sheet.

The mean division fluency score was significantly higher under the physical movement condition (Mean = 153.82, SD = 64.98) than under the non-physical brain break condition (Mean = 115.41, SD = 41.72) [$t(16) = 5.15, p < .001$]. Please see Table 1.

Table 1

Means, Standard Deviations, and t-statistic for Division Fact Fluency Scores under Physical Movement and Non-Physical Brain Break Conditions

Condition	Mean	SD	<i>t</i> -statistic
Physical Movement	153.82	64.98	5.15
Non-Physical Brain Break	115.41	41.72	

N = 17

* Significant at $p \leq .001$

Consequently, the null hypothesis that among fourth-grade students who struggle with division fact fluency, there would be no significant difference in mean division fluency scores when students participated in five minutes of physical movement prior to testing as compared to when they participated in five minutes of non-physical brain break prior to testing was rejected.

CHAPTER V

DISCUSSION

The purpose of this study was to determine whether fourth-grade students who struggle with division fluency would demonstrate better division fact fluency if they had physical movement prior to testing. The null hypothesis that among fourth-grade students who struggle with division fact fluency, there would be no significant difference in mean division fluency scores when students participated five minutes of physical movement prior to testing as compared to when they participated in five minutes of a non-physical brain break prior to testing was rejected. Students performed significantly better in the physical movement condition.

Implications of the Results

This study can be valuable from an educator's perspective because it indicates that teachers should provide movement opportunities within the classroom before assessments. Educators will also want to consider this method prior to state testing. Students verbally showed their enthusiasm during the exercise portion, with many asking to participate prior to other assignments. Because this is an easy and inexpensive intervention, other educators could quickly be able to adapt the activity to their own classroom without much prior set up. This study was based upon physical movement prior to assessments but could easily be used prior to other educational situations such as writing assignments or as a morning movement to get children focused for the day. As a result of this study, this researcher will continue to provide physical movement opportunities to her students.

Theoretical Implications

Findings support the theory that there is a link between movement and learning. Waite-Stupiansky and Findlay (2001) discuss the positive connection between movement and learning. They discuss that when movement such as dance is involved the part of the brain where individual's problem solve, sequence, and plan becomes engaged. The results of the current study support this idea: that it was not just a break in actual learning itself, but it was the physical movement in the break that made a difference in performance. In the current study, the researchers also observed students with more on-task behavior after physical movement which supports the findings of Waite-Stupiansky and Findlay.

Threats to Validity

The study contained several threats to internal and external validity. One of the biggest internal threats was that of the class size. With a sample size of only 17 students, the testing sample was very small. It is important to note that the statistical power was limited due to the sample size which could impact the validity of the results.

A threat to the internal validity was that the assessments were broken up quite a bit due to weather-related school closings. This did not allow for the assessment to be administered in a continuous manner as previously planned.

There was also a threat to internal validity with a student who had work refusal. This student physically and verbally refused all work during testing time. Due to the work refusal, the researcher had to remove student information from the data. This would be considered experimental mortality. It is possible that the intervention may have had a different impact on that student than it may have had on other students who remained in the study. Interruptions to the class from this student could have also impacted the work of other students.

A threat to external validity would be the limited diversity in math ability of the students. Students within the class were all performing below grade level or were had a diagnosed learning disability. The researcher did not have a group of on grade level students to include in the study. Consequently, it is not possible to generalize the results of this study to children of higher ability levels.

Connections to Previous Studies/Existing Literature

How to improve the academics of students has been an ongoing question in the world of educators. Educators are constantly competing with new technology and standards in the world of preparing students for the future and assuring they are prepared for society. Foran et al. (2017) focused on teachers' perception of physical activity in the classroom. While the study by Foran et al. was about the perception of the teacher, this still provides valuable information about how the classroom functions best. Teachers reported that students were better focused after a short burst of physical movement. They also noted that students' academic test results improved after a time of physical movement. The mood of the entire room seemed to change when physical movement was incorporated. Foran et al. state, "Several values related to their experience using physical activity; increased student focus, engagement, enjoyment, and changing the energy of the room" (p. 1). The findings of the current study were consistent with those of Foran et al. in yielding higher test results, and, through observations, the researcher noted there was an increase in student focus and a decrease in student disruption.

Donnelly and Lambourne (as cited in Brusseau & Hannon, 2015) discuss the impact of comprehensive school physical activity programming on children's health and academics. They state that, "movement can increase students' overall physical activity and improve time-on-task and attentiveness" (p. 2). Time on task and attentiveness are major components that educators are

continuously trying to increase. In the current study, the researcher's observations suggested that with the use of physical activity, students can increase their time-on-task and attentiveness. The researcher's observations showed more students who were focused on their work and not fidgeting in their seats.

Implications for Future Research

Educators will want to take their own class dynamic into consideration when implementing physical activity into their daily routine. There should be a continued emphasis on the importance of division fact fluency. There was a small sample group involved in the researcher's study over a short period of time. For future researchers, studies could benefit from an extended period and a larger and more diverse sample. This sample size could contain participants from different schools, grades, communities, and academic abilities.

It would also be beneficial to include other mathematic fact fluency to determine the effectiveness of physical activity. This could include the mathematically fact fluency of addition, subtraction, and multiplication, dependent on the grade level and focus. This research could also be expanded across another curriculum. For example, fluency in reading could be examined using the same methods.

Future research should examine the long-term effectiveness of physical movement prior to assessments. Hopefully the extended period of time would continue to support that movement can be positive prior to testing.

Conclusion

This study was an attempt to determine whether fourth-grade students who struggle with division fluency would demonstrate better division fact fluency if they had physical movement

prior to testing. Students who participated in physical movement performed at a higher level than students with non-physical brain breaks. This researcher also noticed an increase in student focus and time on-task when assessment followed physical activity. Practical implications of the study include providing online resources to guide children, offering teacher-led movement activities, or giving students free movement time. Hopefully future research can determine the most effective methods of using physical activity to improve academic performance.

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