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Math in Motion: Learning Math in a Physically Active Environment

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Abstract

Many studies have indicated that participating in regular exercise for the heart and lungs may be one of the most important factors for middle school students to achieve good grades in math and reading. The purpose of this study was to determine if exercise, specifically sprint routines, could improve math competency as well as students' confidence with solving word problems. In conducting this study, sprint exercises were used as a possible way for students to develop math fluency. The data collected suggests that incorporating physical activity with mathematic computational exercises can make modest gains to students' mathematical fluency.

Keywords: Physical Activity, Mathematical Competency, Sprints, Brain and Fitness, English Language Learner

Many studies have indicated that participating in regular exercise for the heart and lungs may be one of the most important factors for students to achieve good grades in math and reading. Aerobic exercise and resistance training have been found to improve the cognitive health of the brain (Ratey, 2008). According to Ratey (2008) exercise sparks new brain cell growth. He believes in order to have our brains work at peak performance our bodies have to work hard. Can this information help school age children improve their Math scores?

A good example of the power of exercise to boost brainpower was demonstrated in Ratey's (2008) groundbreaking book *Spark: The revolutionary new science of exercise and the brain.*

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Spark describes how a physical education class transformed students in the Naperville Central School district of Illinois. Students whodaily participated in a dynamic morning exercise program,while having access to exercise time throughout the school, day showed dramatic increases in their Math, Reading and Science scores as a result. Brain cells are similar to muscle cells. There is growth with use and atrophy with disuse.

Your Brain on Exercise

Exercise encourages your brain to work at optimum capacity by causing nerve cells to multiply andto strengthen neural interconnections. Animal tests have illustrated that during exercise, nerve cells release proteins known as neurotropic factors. One in particular, called brain-derived neurotrophic factor (BDNF), triggers other chemicals to promote neural health that directly benefits brain functions, including learning (Ratey, 2008). Gervaso (2014) states that exercise has such a positive effect on the nervous system. When an individual exercises they can think more clearly, perform better, and improve one's morale.Stimulating your nervous system will help an individual to function at a higher level. A study conducted by an education student at Manhattan College set out to prove that exercise, specifically sprint workouts, could improve math competency as well as students' confidence. Motivating middle school students in mathematics is a challenge for many teachers today. Adolescence marks the beginning of a downward trend in motivation and achievement in academics (Ryan 2001). According to the New York City Department of Education, 75.5% of seventh grade English Language Learners (Ells) scored a level 1, the lowest performance, on the 2013 New York State Math Test. Only 8.6% of these students scored a level 3 or higher on the same math exam that year. Students' achievements in math and confidence in doing math can be greatly affected by their attitudes. This summer research study was initiated to help middle school students in New York City increase their Math scores.

Research Study

The purpose of this study was to determine if exercise, specifically sprint routines, could improve math competency as well as students' confidence with solving word problems. The study took place in an urban middle school in New York City.

Participants

Participants in the study included seven English language learners, five males and two females, who were in danger of failing mathematics. Students were in grades six or seven. The school selected these seven students to receive tutoring because they scored a Level 1, the lowest level of performance on the New York State mathematics test in the previous year. The seven students had repeated at least one grade level and previously attended summer school. The students were not receiving any additional support services at the school.

Procedures

The researcher tutored the students in small group two or three times a week for forty minutes each day over an eight-week period. Students worked in groups of two or three and were pulled from non-core subjects or activities, such as physical education and part of their lunch period, for tutoring. At least once each week during the tutoring session, students began with the sprint routine.

Instrument

Sprints are exercises used to strengthen mathematical computations while helping students gain confidence in their math abilities (Ramos, 2011). The instrument used for this study was the math sprint worksheet that was part of a nine step routine. The worksheet consisted of 44 computation problems for Part A and 44 similar computation problems for part B.

Sprint Routine Procedure

Participants began tutoring sessions completing a sprint worksheet once a week. Students had 60 seconds to complete Part A.The researcher assumed the role of an athletic coach in this routine. With each Sprint routine, the researcher would tell the students they had 60 seconds to complete as many of the exercises as they could. She told them they were not expected to complete all the exercises just as many as they could. She placed the exercise face down in front of them and told them to wait for the signal to begin. She used her cell phone as a timer and signaled the students with “On your mark, get set, go.” At the end of the 60 seconds, she signaled the students to stop by saying “Pencils down”.

If students completed all 44 problems before the minute, they stood at their place. The researcher then corrected the first part of the sprint worksheet with the class by reading the correct answers at a quick pace. Students were directed to shout "yes" and punch out after each response they answered correctly, circle incorrect answers, and then write the number they answered correctly at the top of their worksheet. The researcher asked students to raise their hands if they had one or more correct, two or more correct, three or more correct etc. until no one raised their hand any more. Within these small groups, the student who had the most correct was acknowledged. The researcher then gave students the opportunity to complete the remaining problems. Before moving to part two of the Sprint, the researcher involved students in some form of calisthenics such as jumping jacks, stretching exercises, or jogging in place. While students physically exercised they also participated in mental math exercises such as counting by multiples of fours, counting backwards from 50 by fives, skip counting from one inch to the smallest part of an inch. These combination physical and mental math exercises lasted for about one minute. Students returned to their seats and prepared to take the second part of the Sprint. Students had 60 seconds to complete this Sprint as well. The researcher corrected this part with the students following the same routine as in Part A and had them mark the number of correct answers at the top of their worksheet. Students also wrote how many more they had correct in the second part from the first part. The researcher asked the students to raise their hands if they improved by one or more, two or more, three or more etc. until no hands were raised. Math achievement was based on how many more questions each student answered correctly on the second part. The student who had the greatest improvement from Part A to Part B was acknowledged.

Data Collection Procedures

Data was collected over the eight weeks of tutoring to determine if students' Sprint scores increased. The researcher collected the data from each student's two-part worksheet. Students were assessed on how many more problems were answered correctly on the second part of the Sprint when compared to the first part.

Over the eight weeks of tutoring, students completed a total of seven Sprint routines. Sprints were used only when all students were present in the small groups. Because of the high rates of absenteeism, the Sprint routine could only be completed about once a week over the eight weeks.

Data

In the first round of Sprints, students' scores ranged from 9 to 33 out of a possible score of 44 in Part A. After the physical and mental calisthenics, students' scores on Part B ranged from 22 to 43. Students noted an immediate improvement that provided a positive response from students. Students were more receptive to the Sprint exercise after they noted this improvement. Sprints 2-7 revealed very similar results with increased or maintained math scores for every student between Part A and Part B. The results are found in Table 1.

Table 1: Student Raw Scores from Sprints

	Sprint 1		Sprint 2		Sprint 3		Sprint 4		Sprint 5		Sprint 6		Sprint 7	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Dominique	9	26	29	36	4	12	11	17	22	29	-	-	30	38
Patrick	33	36	18	25	40	41	17	39	22	31	-	-	-	-
Jessica	27	31	31	34	-	-	17	18	22	32	-	-	38	41
Randy	27	43	23	26	27	30	13	15	-	-	-	-	38	38
Robert	23	27	19	20	-	-	-	-	12	17	23	26	33	38
Jefferson	10	22	18	18	-	-	6	13	7	9	22	26	29	37
Leo	23	24	23	27	-	-	22	26	15	21	-	-	36	40

Note. Highest possible score: 44. Students completed seven Sprint exercises with two Sprints of

For the final Sprint (Sprint 7) the researcher repeated the first Sprint exercise the students had taken during the first week of the tutoring session. The researcher wanted to compare students' scores from the first week to the final week of tutoring. The results are presented in Table 2. Six of the seven students were present to complete the final routine of the Sprint.

Data Analysis

In reviewing scores for each sprint, the data reveals that students improved or remained constant between Parts A and B in each exercise. While in some instances there was great improvement between Part A and Part B such as Patrick in Sprint 4 with an increase of 22 correct answers, Dominique and Randy in Sprint 1 with an increase of 17 and 16 points respectively, the median score improvement was 5.5 points. In two instances, Jefferson in Sprint 2 and Randy in Sprint 7, the scores between Part A and Part B remained unchanged.

Table 2: Student Growth in Eight Weeks

	Sprint 1		Sprint 7	
	A	B	A	B
Dominique	9	26	30	38
Patrick	33	36	-	-
Jessica	27	31	38	41
Randy	27	43	38	38
Robert	23	27	33	38
Jefferson	10	22	29	37
Leo	23	24	36	40

Note. Highest possible score: 44. Sprint 1 and 7 were the same sprint exercises distribute

In comparing scores from Part A in Sprint 1 with scores from Part B in Sprint 7 the range of improvement was from 11 to 29 points. The median score improvement was 18.8 points with improvement shown for six of the seven students who were present for the final Sprint exercise.

Discussion of the Findings

The purpose of this study was to determine if physical exercise and mental math exercise through Sprints could improve math competency skills for seven middle school students. The data was gathered over an eight-week period in tutoring sessions with two or three students in each session. Students completed Part A of a Sprint in 60 seconds, engaged in calisthenics and mental math exercises for another 60 seconds, and then had another 60 seconds to complete Part B of the Sprint. The data shows improvement in student performance of the math problems between Parts A and B. The data also shows improvement in student math performance over the eight weeks of tutoring. These students were not receiving any additional support services other than their regular classroom instruction.

Research today on brain, mind, and body reveal significant links between movement and learning. Brain compatible learning suggests incorporating math, movement, and physical education (Reilly, Buskist, and Gross, 2012). This research with students' participation in the math sprints showed some improvement in math scores from the first week of tutoring to the final week.

Students' participation in the math sprints had no statistical significant effects on their math achievement; however students did progress in their fluency to solve problems accurately. These findings support previous studies that have found physical activity increased task performance (Correa-Burrows, Burrows, Orellana, & Ivanovic, 2014; Ratey, 2008).

Five of the seven students passed their grade requirements in mathematics for the year. Two students would attend summer school and at the time of this report the researcher had not received the final results for passing for the two students attending summer school.

Students' willingness to attempt the Sprints also increased from the first week to the last. In the beginning the researcher had to coax the students to come to the tutoring sessions and then to work during the session. Students who were taken from the physical education class for tutoring protested the most. Randy commented: "It is the only class I'm good at and my team needs me." Students also complained that the Sprints were too hard although the selected worksheets were from a fourth grade level, at least two levels below where the students should be performing. As students noted their own improvement with the Sprints, they showed signs of confidence by challenging each other and commenting, "I'm going to be better today than you." In the last few weeks of the tutoring, students asked if they could do the Sprints.

Conclusions and Recommendations

Exercise encourages the brain to work at a more optimum capacity. In conducting this study, the researcher assumed the Sprint exercise was a possible way for students to develop math fluency. The data suggests that incorporating physical activity with mathematic computational exercises can make at least modest gains to students' mathematical fluency.The data reveals positive growth for each of the seven students in the study.

The limitations of this study that prevent generalization to a larger population include the small sample size. Seven middle school students who were also English language learners were the participants in this study, and therefore the results cannot be generalized to other populations.

In this study, the researcher used the math "sprints," for which validity and reliability were established based on the Sprint routine produced by the Ramos Group (Ramos, 2011) or the Davidson Group (Davidson, 2012). The researcher could not control this study for variables such as absenteeism, when students received tutoring and the impact of missing classes such as physical education or part of their lunch period, or students' previous mathematical fluency. The researcher did not have prior information to determine the actual mathematical performance level of the students, other than knowing they had performed at the lowest level of the State test the previous year. The researcher selected Sprints from a fourth grade level when she noted students were not able to successfully answer more than seven fifth grade math problems the first time she tried the Sprint.

Recommendations

Based on the findings in this study it is recommended that:

1) The Sprint routine is more frequently implemented in middle school math classes for greater impact.
2) The study is replicated with a larger group of middle school students and preferably with classes of students rather than just small groups.
3) Various forms of calisthenics are used as an independent variable to determine if certain physical movements have greater impact on math learning.
4) Research on Sprint routines are expanded.

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