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FITNESS

Becoming One in the Fitness Segment: Physical Education and Mathematics

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Abstract

A considerable amount of evidence supports the value of teaching physical education (PE) and the Common Core in unison. This study investigated mathematics concepts taught during fitness segments in elementary PE. Specifically, we studied student perceptions about linking PE activities and mathematics. We wanted to determine if math concepts could be added to the fitness portion of elementary PE classes without a reduction in the amount of physical activity performed, and if student absorption of mathematics knowledge increased by combining the two fields. Fifty-five upper elementary-age students (8–12 years old) of various ethnic backgrounds from one school in Arizona participated. They wore pedometers and also completed mathematics worksheets preintervention and postintervention. Results showed that 54 of 55 students had extremely positive perceptions, indicating their enjoyment of mathematics as a part of the fitness activity. The students completed the math problems during the fitness segment, with a significant increase in mathematics knowledge. We did not find significant differences between step counts in the regular fitness and mathematics fitness segments. The students enjoyed the mental challenge of mathematics content while being physically active in the fitness segment of the class.

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A growing body of evidence suggests that partnering with teachers from other subject areas can improve learning across content areas. Cross-content linking can help build partnerships with classroom teachers who are concerned about high-stakes testing (Wright, 2009), and it may also lead to the development of allies who support and move forward the physical activity agenda. When physical education (PE) and mathematics are combined, students are receiving content in a new and captivating way and are experiencing increased cognitive function post–physical activity (Scrabis-Fletcher, 2016). This study shows that with more mathematics planned into the PE classroom, students can learn PE and math concepts, which could lead to a lifetime of health and mathematics.

Mathematics and Physical Education

With proper planning, mathematics can be effectively added to PE to benefit mathematics knowledge (Usnick, Johnson, & White, 2003). In the Usnick et al. (2003) study, third to fifth grade students (for example) were engaged in geo-dancing to help them develop an understanding of spatial concepts, symmetry, and sequencing. Students who struggled with spatial concepts and sequencing in math did exceptionally well in a physical activity environment that embedded mathematics. Students also reported positive attitudes about this combined exercise, calling it "physical math."

Reed et al. (2010) used the opposite integration, implementing physical activity into a core curricula (i.e., Language Arts, Math, and Social Studies) for 30 min/day, 3 days/week. The experimental group averaged roughly 1,200 pedometer steps each integration day, which meets the recommended 1200–2000 steps in a 30-min PE class (Pangrazi, 2007). This group also achieved significantly higher test scores on the Social Studies state-mandated academic achievement test. Additionally, the experimental group received higher scores on achievement tests in the areas of mathematics, science, and language arts.

Several studies have explored cross-disciplinary relationships among content areas (e.g., DeFrancesco & Casa, 2013; Peters, Geiger, Goos, & Dole, 2012; Phillips & Marttinen, 2013; Wade, 2016). For example, Hatch and Smith (2013) studied a PE activity in mathematics and physics classrooms. The study theme was projectile motion, and students were given different roles. One student threw the object, and then group members later studied the video of the object being

thrown. The study results showed the cross-disciplinary approach led to significantly increased student learning related to projectile motion and math concepts and to increased physical activity participation. Peters et al. (2012) incorporated mathematics concepts into PE, and although the students learned a lot about conversions, math (rather than physical activity) consumed most of the lesson time.

Multiactivity Conceptual Framework

The conceptual framework guiding this study is the multiactivity PE curricular model, in this case, the Dynamic Physical Education curricular model (Pangrazi, 2007). In this model, the lesson has four parts (introductory activity, fitness, lesson, and game). This model provides teachers an opportunity to seamlessly implement the math content activities during the fitness portion of the lesson through the model of Knowledge-in-Action (KIA; Hodges, 2015). The KIA format includes using station activities for physical activities that require students to talk about concepts (e.g., take your heart rate). In this study, PE teachers used the KIA format to incorporate mathematics concepts into the fitness segment.

This study aimed to investigate mathematics concepts taught during fitness segments in elementary PE. First, we investigated student perceptions about the link of PE and mathematics. Second, we sought to determine if mathematics concepts could be added to the fitness segments of PE classes without a reduction in the amount of physical activity performed. Finally, we were interested if mathematics knowledge increased (assessed by worksheets) over the 4-week intervention project.

Method

Participants

Students. Participants were from one school consisting of two third grade and two fourth grade classes. Human subjects approval was obtained from the university and school district, with parents providing consent and students providing assent. Four class groups with a total of 55 students, 25 boys and 30 girls, from a public charter school consisting of 487 students participated. Six participants were removed from the study (five due to absences and one due to behavioral issues). Table 1 shows students' ethnic backgrounds and the schools' free and reduced lunch data.

Table 1
Elementary (K–5) Students' Descriptive Statistics

Gender						Free/
				African	Asian	reduced
Male	Female	Caucasian	Hispanic	American	American	lunch
%	%	%	%	%	%	%
51	49	59.6	19.9	9.7	2.9	34.6

Teachers. Teachers from two third grade and two fourth grade classes participated. All four teachers were female and varied in their teaching experiences. A seasoned third grade teacher had been teaching for 15 years, and the other third grade teacher had just begun her second year. Both of the fourth grade teachers had been teaching for 5 years. Although both students and teachers were participants in this study, the students were the target of observation in the research. The four teachers identified as Caucasian ethnic backgrounds.

Procedures

For the first week of the study, the students used pedometers to record their steps from the typical fitness segment only. For the second week of the study, the students participated in mathematics fitness using KIA-style (Hodges, 2015) lessons and wore pedometers recording steps for the fitness segment of the lesson only. At the end of the 2-week implementation, participants took a posttest for the Common Core math concepts. They were also given a postsurvey that assessed their perceptions of the mathematics activities implemented in the fitness segment of their PE classes. Further, a subsample of students participated in short postintervention interviews (in groups of four), and teachers were interviewed in their teaching groups. For the first week, the students completed Regular Jackpot Fitness and took the pretest and presurvey; for the second week, the students completed Math Jackpot Fitness and took the posttest and postsurvey, which we used to determine the differences.

Teachers gave ample instruction during class time prior to this intervention. The third grade students were using the curriculum Engage New York, and the fourth grade students were using both the Engage New York and Singapore Math (Math and Focus) curriculum. The KIA mathematics lessons were station activities that

addressed math concepts, and the lessons involved physical activity done with a partner. They focused on knowledge of healthy behavior (e.g., the difference between moderate and vigorous physical activity and the effects each one has on the heart, and identifying activities that correctly relate to the fitness component) without sacrificing physical activity time within PE classes (Hodges, 2015).

The math fitness intervention combined physical activity and math concepts throughout the duration of fitness. The fitness intervention that we used for the study was the Jackpot Fitness activity in which students work in pairs to complete various exercises. In this activity, different "jackpots" (boxes) are filled with different fitness tasks. One jackpot was filled with a variety of strength exercises (push-ups, sit-ups, squats), the second jackpot contained flexibility exercises (hip bend, quadriceps stretch, straddle stretch), and the third jackpot held cardiorespiratory exercises (carioca, jump rope, jog). These three jackpots thus offered different fitness components that increase health benefits. For regular Jackpot Fitness, the card gave the amount of repetitions the students were to perform (e.g., "Perform 15 jumping jacks"). For Math Jackpot Fitness, each card still had the name of the exercise for the student to perform, but instead included a math problem to find the amount of repetitions (e.g., "Perform 5 × 3 jumping jacks"). Table 2 gives a detailed description on the typical fitness and mathematic fitness activities.

Instruments

Perception surveys. We used a survey to gain a better understanding of the students' perceptions about PE. We used the Subramaniam and Silverman (2000) student attitude toward physical education instrument. Students were given a presurvey before they completed fitness with mathematics; students also completed a postsurvey after they completed mathematics fitness. We used these to track any potential differences. The survey included 12 items. With every statement, the survey gave an example to improve student understanding. The survey items were given on a Likert scale of 1 = *strongly disagree*, 2 = *disagree*, 3 = *uncertain*, 4 = *agree,* and 5 = *strongly agree*. Depending on the question, a 1 and a 5 could both be scored as positive or negative. For example, Question 2 states, "I feel the fitness I learn in my physical education class is useless to

Table 2
Description of the Activities in the Fitness Segments of Physical Education Lessons

Activity	Description
Jackpot Fitness	Students are placed into partners. Three "jackpots" (boxes) are filled with fitness activities. One jackpot is filled with a variety of strength exercises (push-ups, sit-ups, squats), the second jackpot is filled with flexibility exercises (hip bend, quadriceps stretch, straddle stretch), and the third jackpot contains cardiorespiratory exercises (carioca, jump rope, jog). The students begin at one of the jackpots of choice and randomly pick out an activity to perform. Partners take turns selecting a card from one of the three boxes. The students must rotate to a different box each time. The students might repeat an activity, but they cannot consecutively perform an activity, therefore selecting a different card with this in mind is acceptable.
Mathematics Jackpot Fitness	Students are placed into partners. Three "jackpots" (boxes) are filled with fitness activities. One jackpot is filled with a variety of strength exercises (push-ups, sit-ups, squats), the second jackpot is filled with flexibility exercises (hip bend, quadriceps stretch, straddle stretch), and the third jackpot contains cardiorespiratory exercises (carioca, jump rope, jog). Each card has a math problem for the students to quickly solve so that they know how many of each activity to perform, for example, "Perform 8 × 2 jumping jacks." The goal of this fitness is to complete as much exercise as possible while practicing math they are currently working on in the classroom. The students begin at one of the jackpots of choice and randomly pick out an activity to perform. Partners take turns selecting a card from one of the three boxes. The students must rotate to a different box each time. The students might repeat an activity, but they cannot consecutively perform an activity, therefore selecting a different card with this in mind is acceptable.

Note. Modified from *Dynamic Physical Education for Elementary School Children* (p. 161), by R. Pangrazi, 2007, San Francisco, CA: Pearson Benjamin Cummings.

me"; a 5 would be a negative response, and a 1 would be the most positive response. Multiple examples were given and questions from the students were answered during survey administration so that we could check for their understanding.

Common Core mathematics assessment. The pre–post mathematics assessment measured the difference in scores after students practiced math concepts during fitness. Students were given a mathematics assessment; the instrument included 32 items. The classroom teachers told the physical educator what their students were currently being assessed on in math class: addition (e.g., 12 + 18), subtraction (e.g., 19 − 9), division (e.g., 6/3, 4/1), multiplication (e.g., 3×5, 5×1), decimals (e.g., 3.0×10), and skip counting (e.g., 3, 6, 9, ___, 15).

Interviews. We used the interviews to assess the students' overall experience engaging in an interdisciplinary approach of combining mathematics with PE. After the mathematics fitness intervention, one group of four students in each class were interviewed. Both genders were involved in each interview group and were chosen upon asking for volunteers. We chose the number of four students so that we would have a sample from each class while still gaining a variety of responses from all of the selected interviewees. Group interviews were audio recorded and transcribed verbatim. Students were asked questions that compared regular PE class to PE with mathematics. The following questions are a sample of what was asked during the students' interviews: (a) Do you think it's important that you learn about different subjects in physical education? Why? (b) Which do you prefer: regular physical education or physical education with math? Why? Once the participant completed their response, the question was open to any other comments by the participants. Field notes from observations of the students' participation during the fitness segments with and without mathematics activities were also recorded (e.g., how engaged the students were).

We also interviewed the teachers. We interviewed two groups of two teachers about the KIA fitness segments with mathematics concepts and they were asked 10 questions. For example, (a) Do you think mathematics in physical education would be a good idea? Why or why not? (b) What were your students' thoughts of the integration of math into physical education?

Pedometers. Pedometers were crucial in this study, determining whether physical activity remained constant across conditions. Pedometers recorded students' step counts, which we used to determine physical activity patterns during the fitness segments of the lessons. Students were familiar with wearing a pedometer from their regular PE program. They put on and wore the pedometers for the typical fitness segment and then again for KIA mathematics fitness segment and recorded step counts at the end of each fitness segment. Students wore the pedometers for the same amount of time; the same songs were used, which ensured accurate step count data.

Data Analysis

Descriptive statistics were calculated for all variables and by gender (Tables 3 and 4). We analyzed interview data using constant comparison to identify common themes across participants and to compare teachers' and students' perceptions. To explore potential group differences between regular fitness and mathematics fitness for perceptions, steps taken, and mathematics scores, we conducted *t* tests.

Table 3
Descriptive Statistics for the Fitness Mathematics Program

Assessment	*M* (*SD*)	Range
Preperceptions of Math and Physical Education Combined	40.29 (4.00)	31–56
Postperceptions of Math and Physical Education Combined	40.59 (3.08)	33–46
Premathematics Test Score	24.05 (4.90)	9–31
Postmathematics Test Score	25.94 (3.65)	15–31
Step Counts During Fitness Segments		
Regular Fitness	614.51 (286.09)	17–1519
Mathematics Fitness	650.70 (198.08)	310–1176

Table 4
Gender Descriptive Statistics

Gender	Descriptive statistics	Survey		Test		Steps	
		Pre	Post	Pre	Post	Regular	Math
Female	*M*	41.10	41.36	22.80	25.20	571.53	642.77
	SD	2.91	2.67	5.30	3.80	275.47	210.66
	Range	11	10	8–30	15–30	17.0–1156.0	310.0–1176.0
Male	*M*	39.29	39.62	25.70	26.90	668.25	660.63
	SD	4.92	3.34	3.90	3.30	295.83	185.13
	Range	25	13	16–31	15–31	239.0–1519.0	459.0–1078.0

Results

Student Perceptions

Survey. The descriptive results of the surveys pre and post were positive (Table 3). Before the implementation process, fifty-four out of 55 students felt positively about the idea of incorporating mathematics into the fitness portion of PE; after the implementation, all students felt positively about incorporating mathematics into PE. The *t* test for student perceptions showed no significant differences over time, $t(53) = -.60$, $p = .55$; however, there was a slight gender difference, $t(52) = 2.13$, $p = .03$, with girls reporting higher perceptions of math fitness than boys did.

Interview. Some common themes resulted from the interview data. First, students almost unanimously supported including KIA mathematics concepts in the fitness portion of the lesson and believed they were learning more. For example, one fourth grade girl said, "I actually really liked it because it gives us a little more practice out of our regular class." Similarly, a fourth grade boy said, "It's helping us with, like, people that aren't getting, they're having troubles in class, they're learning more out of class too." The third and fourth grade teachers also felt optimistic about the continuing of mathematics into PE.

The second theme was that students enjoyed the challenge of KIA mathematics fitness. Students reported that they liked the fitness portion of the lesson anyway (with music) and that their perceptions were even more positive with mathematics fitness. A third grade boy mentioned, "Sometimes we won't really know the equations and I just really want to learn more." This was also the sentiment from a third grade girl:

> I think that it is a good thing to have that in PE, because it's more challenging and fun and the more challenging it is, the more fun it is and because it's fun when you teach us different things, because then when we're older and we move onto a different grade, we will know more.

When asked about advice they would give to the researchers of this study, both teachers responded with, "Stick to it. Sometimes you are going to feel overwhelmed, but as you get better at it, the kids are going to get better at it." One teacher mentioned, "They absolutely loved the pedometers, they were so excited about the counting and who went the furthest; they were all over that and they did know . . . that was math."

The common theme from all of the third and fourth grade teachers was to keep physical activity as the primary objective but to continue the implementation of other subject areas. One teacher stated, "Make sure that you don't take away anything you're doing now, because I think for you, all you can do is add. I think the kids love it, we love it. Whenever we're out there, we're watching you, it's awesome." Field notes supported teacher and student perceptions, such as "The students seem really engaged. They seem to work better with their partners because they need to rely more on each other for not just the exercise, but the math knowledge"; "The students look like they are really enjoying the challenge and they begin the exercise quickly after the problem is solved"; and "Students run up and feel comfortable asking questions regarding the math problems."

Physical Activity

Table 3 shows descriptive statistics for fitness and mathematics fitness segment groups for steps taken. The *t* test for differences in steps taken as measured with pedometers showed no significant

differences between groups, $t(53) = 1.08$, $p = .29$, which was the desired outcome.

Mathematics Knowledge

The *t* test for differences in mathematics knowledge showed significant differences between conditions, $t(53) = -4.20$, $p < .01$. This result revealed improvement in student learning outcomes based on the KIA mathematics fitness segments.

Discussion

The Becoming One study was different than the Reed et al. (2010)study because we incorporated mathematics into PE rather than physical activity into mathematics; however, the results of interdisciplinary/cross-curricular teaching was significantly positive in both studies. There is something special about how PE and the Common Core, more specifically, mathematics, work together. Although the two sound like they could be on opposite sides of the learning spectrum, both can become one, to increase students' academic achievement. The students had positive experiences with the integration lessons because the learning was meaningful to them. Some students during the Becoming One interviews went on to explain that they learned the mathematics better when moving.

Hatch and Smith (2013) reported student enjoyment during transition away from the traditional classroom environment (p. 49). The researchers described that something abstract was made real to the students so that they could better understand concepts. One student wrote, "I actually understand a little more physics through this project" (Hatch & Smith, 2013, p. 49).

Peters et al. (2012) also incorporated math; the difference was that math consumed more of the lesson time in the Peters et al. study and physical activity consumed more of the lesson time in the Becoming One study. The students from the Peters et al. study learned a lot about math conversions in one lesson; teaching all of the conversions information in one lesson while keeping physical activity as the first priority would be difficult. However, modifications in the length of the conversions unit and/or modifications to the amount of mathematics content taught could allow for more physical activity time. Furthermore, we agree with Peters et al. (2012) that "there is great potential to address other strands of mathematics within all

learning areas," especially in PE (Peters et al., 2012, p. 27). Both studies were successful in improving mathematics knowledge; however, this study kept physical activity as the main priority in the fitness segment of a four-part PE lesson.

Implications for Practice

KIA fitness with mathematics fitness done during the fitness portion of a PE lesson was successful with the population of third and fourth grade students. However, it will be important for researchers to study KIA activities and mathematics with different samples of students, across grade levels and across contexts. Further studies of mathematics implementation into PE will continue to benefit the literature base and field.

One important lesson learned was for the PE teacher to talk to the classroom teachers and see what the students are learning during the time of the implementation; this will ensure usefulness in other subject areas (without taking away from physical activity concepts). Students could have had a negative experience if the PE teacher had not communicated with the classroom teacher before implementation or a partnership. Making sure that as a teacher, you are available at all times is also key, because the students had questions. When the problem was explained, the students seemed more open to the mathematics implementation because they knew the teacher was there to help. One limitation of the study was the lack of a comparison group (since students also had mathematics in the classroom). However, students and teachers reported improved knowledge outcomes from the KIA mathematics fitness lessons, which supported the credibility and trustworthiness of the findings. Two fourth grade teachers shared the usefulness of having the mathematics assessment data, noting that it is important that students "show growth in their learning" and "that they've learned the expectation that [the teacher] would have" as the objective.

The pedometers encouraged the students to be active during the mathematics fitness, because not only were they trying to solve a mathematics equation, but they also wanted a high number reading. Using pedometers during the mathematics fitness was essential for keeping the students active, because they were being held accountable at all times during the KIA fitness portion of the lesson. Another

aid in physical activity was the music played; the music was upbeat, which appeared to create positive feelings toward PE under both conditions. Last, the fitness activity card would normally give a number for the amount of repetitions for students to perform an exercise, but modifying the numbers to equations was an enjoyable task.

Conclusions

Overall, the KIA fitness mathematics model was more positive than expected; the students responded positively through surveys and interviews, had significant improvements in mathematics knowledge scores, and maintained similar step counts during the fitness lesson segments. Although every class and school environment is different, mathematics fitness may be worth trying because of the benefits that could occur for student learning in PE and mathematics. With the use of pedometers and assessments, teachers can formulate the outcomes of lessons in terms of physical activity and mathematics knowledge.

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