

**FITNESS****Does HOPSports Promote  
Youth Physical Activity  
in Physical Education Classes?**

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**Abstract**

*This study investigated how a technological intervention, HOPSports (HOPS), impacted youth physical activity (PA) in a physical education (PE) class. Research indicates rising levels of youth television watching and video game use, physical inactivity, and related overweight. One approach to increase youth PA is to use technology-based environments, a preferred setting among youth. The purpose of this research was to objectively compare the PA levels of youth engaged in HOPS-based PE classes with those engaged in traditional teacher-led classes. Activity outcomes were measured using Actigraph accelerometers. Youth (n = 387) in Grades 4 to 8 participated in a longitudinal intervention study. Youth were significantly more active, on average, when using HOPS. Findings suggest HOPS may be most effective by promoting diverse, dynamic program options that PE teachers may not otherwise select. With the possibility of increasing PE class sizes due to shrinking budgets, using HOPS may be one viable strategy to increase PA and combat rising youth obesity levels.*

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Diverse technologies are increasingly available, and this has prompted significant societal shifts in the United States (Nelson, Gordon-Larsen, Song, & Popkin, 2006). Included in these societal shifts are the increased use of information and technology, most notably television, digital games, and computers (Kautiainen, Koivusilta, Lintonen, Virtanen, & Rimpela, 2005). This technology has become more readily available as the price of personal computers has dropped considerably and availability to the Internet has increased. Consequently, computer access is now available to 80% of American households (Nielson Company, 2010). By increasing children's sedentary behaviors, these technological advances have changed the ways in which children interact with their environment and have become a factor in the prevalence of childhood obesity.

Innovative technologies provide children with an abundance of entertainment options involving indoor, sedentary activities (Yancey et al., 2009). Roberts, Foehr, and Rideout (2005) reported that half of U.S. children have a television on in their household most of the time. Furthermore, two thirds of children aged 8 to 18 have a television in their bedroom. Weekly screen time for children is as high as 55 hr per week, and the average home has a television on for 8 hr per day (Lanningham-Foster et al., 2006). An examination of time spent playing video games revealed that the average child aged 8 to 10 spends approximately 65 min per day playing video games, whereas youth aged 10 to 14 spend 52 min per day and 15- to 18-year-olds spend 33 min per day playing video games (Baranowski, Buday, Thompson, & Baranowski, 2008). Watching television and playing video or computer games are primarily low-energy activities and have been consistently associated with low levels of physical activity (PA; Kautiainen et al., 2005; Lanningham-Foster et al., 2006).

Children's increased use of technology has been linked to reduced leisure-time PA since these sedentary activities compete for the same time resources as other more active pursuits (Kautiainen et al., 2005). One study which examined longitudinal and secular trends in PA found that technologic advances have negatively impacted leisure-time PA (Nelson, Neumark-Stzainer, Hannan, Sirard, & Story, 2006). The authors noted that although the amount of time a child spends watching television may remain unchanged, total sedentary time may increase via other sedentary media-driven activities, such as computer or video games (Nelson, Neumark-Stzainer, et al., 2006). Another contributing factor is that energy

intake may increase in conjunction with television viewing, as this type of sedentary behavior is frequently associated with unhealthy dietary patterns (Dunton, Schneider, & Cooper, 2007).

Ultimately, children today are less engaged with the world outside their home and are less physically active (Burdette & Whitaker, 2005a, 2005b; Ehrlich & Kennedy, 2005). Unfortunately, physical inactivity is a primary pathway to obesity and disease (Goran, Reynolds, & Lindquist, 1999), and this trend in rising inactivity rates has been found to coexist with increasing levels of obesity. The prevalence of obesity in the United States among children aged 6 to 11 has increased from 4% in the 1960s to 18% between 2003 and 2006 (Ogden, Carroll, & Flegal, 2008; Ogden, Carroll, Flegal, & Johnson, 2002).

In an attempt to reverse sedentary behavior, some researchers have developed interventions aimed at reducing the amount of time children spend using screen-based media during leisure time. Because children spend an average of 4 hr a day watching television and playing video games, it is logical to assert that reducing the amount of time spent in these activities may reveal an avenue for increasing leisure-time PA (Epstein, Myers, Raynor, & Saelens, 1998; Robinson, 1999). However, many of these attempts have been relatively ineffective. Based on increasing participation rates in screen-based activities, youth appear to value screen-based activities during leisure time. Consequently, interventions that attempt to have youth substitute their screen-based time with a less valued activity have often been unsuccessful (Lanningham-Foster et al., 2006). Similarly, efforts to specifically increase PA by specifically reducing electronic gaming have been relatively unsuccessful (Maddison et al., 2007; Straker & Abbott, 2007).

## **Review of Literature**

An alternate approach for reversing sedentary behavior is the use of activity-promoting video and computer games (Lanningham-Foster et al., 2006). As such, researchers have begun to investigate the relationship of children's technology use and PA achievement. The majority of research linking youth and technology thus far has focused on nonprogrammatic interventions (i.e., individual level interventions rather than programmatic interventions that might be appropriate to offer to groups, such as offering a karate class) to reduce youth's screen-based media time (Boone, Gordon-Larsen, Adair, & Popkin, 2007; Faith et al., 2001; Harrison, Burns,

McGuinness, Heslin, & Murphy, 2006; Jason & Brackshaw, 1999; Marshall, Gorely, & Biddle, 2006; Mota, Gomes, Almeida, Ribeiro, & Santos, 2007). Research that focused on games designed for active input (e.g., dancing games, virtual body controllers) found that game play was positively associated with PA (Olds, Ridley, & Dollman, 2006; Ridley, Hill, & Olds, 2003; Ridley & Olds, 2001).

The extensive amount of time that youth spend playing video games suggests that this medium already reaches a great number of diverse youth (Baranowski et al., 2008; Warburton et al., 2007). As a result, video games may be able to attract and retain the attention of children and adolescents and therefore become an effective component for behavior change (Baranowski et al., 2008). Additionally, active video games may provide a more popular option for lifetime PA than traditional exercise and sports (Trout & Christie, 2007). Warburton et al. (2007) found that the use of interactive video games was effective in promoting exercise adherence among college-aged males. The mass appeal of video games among young children, youth, and young adults may allow this form of intervention to become a useful tool to promote PA (Warburton et al., 2007). Given that previous research suggested the use of technology by an individual may positively influence PA, the current study examined the use of technology to facilitate PA in a group setting.

This study was not the first to examine the efficacy of a technology intervention in youth group settings (Hayes & Silberman, 2007; Sayre, 2007; Trout & Christie, 2007). Previous studies focused on the potential contributions of video gaming for youth, but they failed to quantify PA outcomes. Although Trout and Christie (2007) did not quantify PA research, they suggested that an advantage to using technology mediums in youth group settings is exposure. For example, if youth develop a preference for aerobic video games played in a youth group setting, such as a physical education (PE) class or after-school program, they may be more likely to carry these preferences home to their own video game systems (Sayre, 2007).

Hayes and Silberman (2007) also refrained from documenting PA outcomes, but they suggested numerous benefits for implementing interactive video games into a PE setting. According to Hayes and Silberman, benefits include opportunities to acquire the language of sports and other physical activities, to practice in a psychologically and physically safe environment, and to participate under differentiated instruction types and with enhanced motivation. These

games also provide many opportunities for learning, as many games offer tutorials and instruction on how to play the game, customizable game play parameters, various levels of difficulty, and tools for feedback and analysis of game play (Hayes & Silberman, 2007). Another benefit to this interactive system is that it does not produce the level of competition that occurs during typical youth games. Therefore, youth can focus their energy on self-improvement rather than on letting their team down (Trout & Christie, 2007). However, studies have not assessed how the interactive games perform against a real session of the same game in their ability to promote PA among participating youth (Sayre, 2007). The current study addressed this gap in the literature by using objective, quantifiable measures to compare PA outcomes (moderate and vigorous PA) achieved during PE sessions with and without a technology intervention. For the current study, one PE technology, HOPSports (HOPS), was investigated.

### **Theoretical Perspective**

The current study relies on the assumptions of social cognitive theory (Bandura, 2001; Glanz, Rimer, & Lewis, 2002). Social cognitive theory seeks to explain the adoption of behavior with the interplay of three variables—the environment, the individual, and the individual’s behavior—each of which constantly influences the other. According to social cognitive theory, personal factors and environmental factors influence behavioral outcomes and demonstrate a reciprocal relationship with one another. To this end, technology (HOPS) is introduced in this study to alter the children’s activity environment. We expected that this change in the external physical environment, that is, the introduction of HOPS, would promote a positive change in youth PA behavior patterns. Similarly, social cognitive theory indicates that changes to the environment (the addition of HOPS) may impact participants differently based on intervening personal factors. With this in mind, the current research investigated the relationship of personal factors (children’s gender, grade in school, race/ethnicity, and body mass index) on PA behavior outcomes (levels of moderate and vigorous PA).

### **Research Questions**

This study investigated the efficacy of one classroom technology, HOPS, for increasing PA in one structured activity setting, a PE class. Researchers asked the following questions:

1. Were youth more or less physically active when PE sessions used HOPS than when the PE sessions did not use HOPS?
2. Which youth (i.e., gender, race/ethnicity, grade level, and body mass index) were most likely to achieve significant positive improvements in their PA levels by using HOPS during PE?

## **Methodology**

### **Intervention**

The HOPS technology system was adopted for the current study. According to its website ([www.hopsports.com](http://www.hopsports.com)), “HOPSports is a multi-media, technology driven, standards-compliant physical education system.” The system consists of a media cart and computer system preloaded with 250+ lessons taught by athletes and performers that are projected onto a large screen. The lessons provide sport-specific training and are intended to engage youth in a variety of cardiovascular and strength training programs. At the time this article was written, the cost of a basic HOPS system was \$19,900. A basic system comes with 10 mats. Supplemental equipment included with the basic system consists of color- and shape-coded exercise mats, large exercise balls, and exercise sticks. Extra mats cost \$100 each, and “sandbells” are each an additional \$10.

To perform HOPS, each student is at a station within a gymnasium or classroom (see Figure 1). The teacher selects a particular sports module, such as baseball, yoga, or hip-hop dance. Then, students follow on-screen cues and proceed through sport-specific or fitness instructions (see Figure 2).

### **Study Design**

A longitudinal pre-experimental single group design using crossover treatments was adopted for the study (Babbie, 2010). The 387 children enrolled in the study logged 3,096 PE sessions (an average of eight per child). Each enrolled participant engaged in PE classes as often as possible during the study timeframe with the treatment (HOPS) and in control PE classes (without HOPS). As such, sometimes the students had the HOPS intervention (1,617 sessions, 52.2%) and sometimes they had a traditional PE course (1,479 sessions, 47.8%). Students did not have PE classes at times, for example, due to general assemblies or testing. The treatment

orders were varied randomly to prevent order bias in the study. In each school, PE classes typically occurred two times per week, with the exception being when school holidays or other school programs, such as general assemblies or testing, affected the schedule. Students participated in the study for 4 months. The intervention was used during 52.2% of the sessions, although HOPS and non-HOPS periods were alternated randomly by classroom teachers.



**Figure 1.** Components of the HOPSports system set up in a school gymnasium.



**Figure 2.** Students following on-screen cues from the HOPSports system.

## Setting and Population

The intervention was tested in PE classes in North Carolina elementary and middle schools. The study population comprised students enrolled in the approximately 30 schools who were engaged in a statewide trial of the HOPS system in their PE classes. This population was selected by a third-party organization who sought to distribute HOPS to geographically and culturally diverse areas of North Carolina. This third-party organization (i.e., not HOPS) paid researchers to complete an independent and objective study of PA outcomes associated with HOPS. Participating schools received a HOPS system in exchange for their willingness to participate in the study. The sample of three schools selected for this additional study of the PA outcomes associated with HOPS was a purposive sample. We selected these schools as the sample for this study from the population of 30 schools in the larger study based on the following criteria: (1) low income (greater than 50% of students were eligible for free or reduced-price lunch) and racial/ethnic diversity of the student body (minority students comprised more than one third of the student body), (2) proximity to researchers of this study in an effort to minimize transportation costs associated with data collection, and (3) willingness to comply with study protocol. Children who returned assent and consent forms were eligible to participate in the study. For their participation, each child received a T-shirt and goody bag with a pedometer, ball, Frisbee, and whistle. The first three schools selected for participation consented to participate in this research. Each school had only one PE teacher. One of the teachers, a male in his mid-20s, had less than 3 years of teaching experience, and the two females were in their 30s and 40s and had approximately 10 and 20 years of teaching experience. Because the students' activity levels were being compared within groups (i.e., schools), the effect of the teacher on their activity levels was thought to be minimal. In consideration of social cognitive theory, however, the teachers need to be considered an active agent in student learning and a part of the learning environment. From this lens, we expected the teachers' attitude toward HOPS and non-HOPS sessions to have bearing on the students' receptivity to the two formats. All three teachers expressed excitement about the use of HOPS in their classes. Each teacher received a half-day training session from the HOPS company to familiarize them with HOPS. The lead researcher provided an additional 2-hr training to explain study procedures.

## Sample

At each school, all students in Grades 4 to 8 were invited to participate in the study. Grades 4 to 8 were selected because the most precipitous decline in PA is observed among youth from fourth grade forward (Bradley, McMurray, Harrell, & Deng, 2000). A total of 387 out of 418 possible youth in these grades agreed to participate and returned both parent consent and child assent forms.

## Measures

The presence or absence of the technology intervention was the primary independent variable. Teachers kept daily class lesson logs documenting which activities occurred during each class. To allow teachers to maintain control over their course content and learning objectives, we did not tell teachers which activities to offer, but we did tell them to offer as much as possible the same type of activity both with and without HOPS to students. During the HOPS sessions, the teachers were responsible for turning on the HOPS system, getting the children into place with their equipment, supervising the activities, and providing instructional feedback when necessary. Participation using HOPS sometimes preceded and sometimes followed participation in the traditional activity (i.e., the similar sport or fitness activity without HOPS technology).

Personal factors including gender, grade, race/ethnicity, and body mass index (BMI) were also tested as factors that might influence the efficacy of the intervention. Although we sought schools with diverse population incomes, the schools would not allow us to collect data on the household income level of participants because of interests in maintaining sensitivity toward their population base. PE teachers took height and weight measurements prior to the start of the study. We then converted these raw measures to a gender and age-specific percentile BMI score. Using values provided by the Centers for Disease Control and Prevention, we classified children as underweight, healthy weight, overweight, or obese. The schools provided the remaining demographic data.

Minutes of moderate and vigorous physical activity (MVPA) were used as dependent variables. PA was assessed with accelerometers (Actigraph model GT1M, Pensacola, FL) using 30-s epoch recording intervals. Actigraph accelerometers have been identified as the gold standard for objective PA monitoring and have been found reliable in able-bodied populations, school aged through adult. Extensive

reliability and validity data have been presented elsewhere (de Vries, Bakker, Hopman-Rock, Hirasings, & van Mechelen, 2006) and demonstrate that the Actigraph has been validated in children to estimate PA. Following guidelines established by the Actigraph company and to minimize needs for personnel, we downloaded accelerometer data at the end of each data collection week using the Actisoft Lifestyle Monitoring System Version 3.3.0. Data were cleaned into individual class sessions and scored, and interpreted raw Actigraph counts were transformed to activity intensity using an adaptation of Freedson's equation (i.e., Trost's 30-s epoch cut-points) where  $METs = 2.757 + (.0015 * \text{counts/min} - 1) - (0.08957 * \text{age}) - (0.000038 * \text{counts/min} - 1 * \text{age})$  (McMurray, Ring, et al., 2004). Because the classes were different lengths, only the middle 25 min of activity during each class were used for analysis (Glanz et al., 2002; Puyau, Adolph, Vohra, & Butte, 2002).

## **Analysis**

First, study participants were described using frequency statistics. Second, a summary of the activity sessions and PA intensities associated with these sessions was presented. Third, a repeated measure analysis of variance with covariates (RMANOVA) was undertaken to compare minutes of MVPA achieved by participants with and without HOPS. Differences between factors (i.e., boys vs. girls) and within factors (i.e., subjects' PA with HOPS vs. subjects' PA without HOPS) were presented for the entire sample and in subgroups according to demographic variable of interest (i.e., gender, grade level, race/ethnicity, BMI). The other demographic variables were entered as covariates for between-factor tests because they have been found previously to moderate PA behavior (Berkey, Rocke, Field, et al., 2010; Sallis, Prochaska, & Taylor, 2000). Last, PA data were investigated according to activity type. A multivariate analysis of variance (MANOVA) was employed to compare the efficacy of different activities (sport, dance, fitness, and game activities) with and without HOPS according to gender, grade, race/ethnicity, and BMI.

## **Results**

A total of 3,096 activity sessions were accrued by the 387 children who participated in the study. These activity sessions were recorded across a period of 5 school weeks. Any one child completed from five to 11 sessions. On average, each child engaged

in eight sessions. Approximately half of these sessions employed HOPS (52.2%) and half did not use HOPS (47.8%).

### **Characteristics of the Sample**

The demographic variables analyzed in the study included gender, grade level, race/ethnicity, and BMI (see Table 1). The sample ( $n = 387$ ) had 179 males (46.3%) and 208 females (53.7%). Youth in the study ranged from fourth to eighth grade with 9.6%, 9.8%, 34.9%, 24.0%, and 21.4% of the youth in each grade, respectively. The majority of the youth were Caucasian (63.0%), but other groups were represented as well, with 13.4% who were African American, 14.7% who were Hispanic/Latino, 2.8% who were multiracial, and 5.9% who were in another category, marked for this study as *Other*.

### **Comparing Activity Intensity With and Without Intervention**

As shown in Table 1, RMANOVA findings indicated that, on average, youth spent a greater proportion of time in MVPA when HOPS was used than during sessions without the technology ( $F = 24.56, p < .01$ ). During non-HOPS sessions, youth, on average, participated in 9.5 min of MVPA, whereas youth participated in an average of 14 min 45 s of MVPA in sessions using HOPS. This indicates an increase of greater than 5 min.

Additional comparisons were made according to the type of activity. The PE teachers documented in logs activities in which the schools participated. Teachers were provided a recording log to describe their class lesson plans each day. The recording log instructed the teachers to enter the name and a short description of the activity at the end of each workday. Whenever possible, teachers submitted full lesson plans for each research session. Based on the activity descriptions, the researchers classified each day's activity into one of four researcher-determined categories: sports activities, dance activities, fitness activities, and games (see Table 2). Sports activities that teachers reported during the 5-week study included volleyball, indoor floor hockey, badminton, basketball, golf, and soccer. Dance activities that teachers reported included HOPS hip-hop dance, HOPS break dancing, and non-HOPS Dance Dance Revolution. Fitness activities included cardio kickboxing, aerobic kickboxing, group aerobics, yoga, and ladder circuits. Games included capture the flag, steal the sticks, tag, and red rover.

**Table 1**  
*Minutes of Moderate and Vigorous Physical Activity Achieved With HOPSports Compared to Sessions Without HOPSports*

Participant classifications	RMANOVA Between-Factors Test Statistic <sup>a</sup>	RMANOVA Within-Factors Test Statistic	Minutes of Moderate and Vigorous PA		
			HOPS Sessions ( <i>n</i> = 1,617, 52.2%)	Non-HOPS Sessions ( <i>n</i> = 1,479, 47.8%)	Δ
<b>All participants</b> ( <i>n</i> = 387)		24.56**	14.75	9.50	5.25
<b>Gender</b>	NS				
Male ( <i>n</i> = 179)		4.51*	14.25	9.50	4.75
Female ( <i>n</i> = 208)		6.23*	15.25	9.75	5.50
<b>Grade level</b>	19.22*				
4th ( <i>n</i> = 37)		NS	16.25	14.25	2.00
5th ( <i>n</i> = 38)		NS	18.00	13.75	4.25
6th ( <i>n</i> = 135)		15.22**	14.75	10.0	4.75
7th ( <i>n</i> = 93)		11.30*	13.50	8.0	5.50
8th ( <i>n</i> = 83)		13.87*	13.50	7.75	5.75
<b>Race/Ethnicity</b>	NS				
African American ( <i>n</i> = 52)		NS	14.25	9.25	5.00
Hispanic (non-white) ( <i>n</i> = 57)		4.62*	15.25	9.75	5.50
Caucasian ( <i>n</i> = 244)		18.76**	14.75	9.50	5.25
Multirace/ethnicity ( <i>n</i> = 11)		NS	13.00	8.75	4.25
Other ( <i>n</i> = 23)		NS	15.50	10.25	5.25
<b>Body Mass Index</b>	NS				
Healthy weight ( <i>n</i> = 212)		22.15**	15.75	11.00	4.75
Overweight ( <i>n</i> = 112)		16.49*	14.25	9.25	5.00
Obese ( <i>n</i> = 82)		16.66*	12.75	7.75	5.00

Note. PA = physical activity. NS = Not significant.

<sup>a</sup>RMANOVA testing between factors specified the other factors (i.e., gender, grade level, race/ethnicity, body mass index) were entered as covariates.

\**p* < .05. \*\**p* < .01.

**Table 2**  
*Activities Conducted During Study Fitness Sessions and Related Physical Activity Intensities*

Type of Module	% of observations	Physical Activity Intensity							
		Sedentary 0–1 METS		Light 1–3 METS		Moderate 3.01–6 METS		Vigorous > 6 METS	
		%	min	%	min	%	min	%	min
<b>All HOPSports Modules</b>									
( <i>n</i> = 1,617 observations)	48	23	5.8	18	4.5	48	12.0	11	2.8
Sports activities	46	28	7.0	32	8.0	36	9.0	4	1.0
Dance activities	32	30	7.5	27	6.8	45	11.25	5	1.3
Fitness activities	15	15	3.8	10	2.5	55	13.8	16	4.0
Games	7	47	11.75	5	1.25	48	12.0	15	3.75
<b>All Non-HOPS Modules</b>									
( <i>n</i> = 1,479 observations)	52	36	9.0	26	6.5	24	6.0	4	1.0
Sports activities	46	30	7.5	30	7.5	36	9.0	4	1.0
Dance activities	21	22	1.1	29	7.3	55	13.8	9	2.3
Fitness activities	29	49	12.3	31	7.8	20	5.0	4	1.0
Games	19	46	11.5	21	5.3	17	4.3	2	0.5

*Note.* METS = Metabolic equivalent of tasks.

In both HOPS and non-HOPS sessions, youth in the study participated in sports activities the most (46% of both HOPS and non-HOPS sessions) and games the least (7% of the HOPS sessions and 19% of the non-HOPS sessions). When participating in HOPS sessions, youth spent most of their time in moderate PA regardless of activity category. In non-HOPS sessions, however, youth participating in fitness activities or games spent a larger percentage of their time in light activity. Non-HOPS sessions related to sports and dance activities still resulted in youth spending most of their time in moderate activity. Given that the Centers for Disease Control and Prevention (2013) recommends youth spend at least 60 min each day in MVPA, it is important to consider the percentage of time youth spend in either moderate or vigorous PA. During sports-related sessions, youth spent 40% of their time in MVPA, whether or not they used HOPS. Chi-square tests of significance revealed significant differences in the proportion of class periods spent in MVPA for HOPS and non-HOPS dance, fitness, and game sessions. When participating in dance-related sessions, youth were less active when using HOPS, recording 50% of their time in MVPA when using HOPS compared to 64% of their time in MVPA when they were not using HOPS ( $\chi^2 = 12.31, p < .03$ ). During fitness-related and game-related sessions, participants spent more time in MVPA using HOPS. For fitness-related sessions, the amount of time spent in MVPA was 71% when using HOPS compared to just 24% when not using HOPS ( $\chi^2 = 21.17, p < .01$ ). During game-related sessions, the amount of time spent in MVPA was 63% when using HOPS and only 19% when not using HOPS ( $\chi^2 = 17.62, p < .01$ ).

Next, an examination of between-factor and within-factor effects in the RMANOVA indicated activity outcomes associated with subgroups of the student sample. PA data were also investigated according to activity type. The researchers investigated the role of each demographic factor (gender, grade, race/ethnicity, and BMI) independently and when allowed to interact with the presentation mode (presence or absence of HOPS).

**Gender.** When using HOPS, both male and female students logged significant increases in MVPA levels. On average, boys gained 4 min 45 s of MVPA using HOPS and girls gained approximately 5.5 min of MVPA using HOPS. These higher increases by girls resulted in statistically similar levels of MVPA when activity levels during HOPS were compared by gender.

MANOVA results related to gender indicated that girls and boys had statistically similar minutes of MVPA in games and fitness activities. Girls engaged in significantly more MVPA during dance sessions than boys ( $F = 9.45, p < .04$ ). Conversely, boys engaged in significantly more MVPA than girls during sports activities ( $F = 5.46, p < .05$ ). However, we observed no significant differences in gender x presentation mode (HOPS vs. non-HOPS) interaction tests for any activity type. In other words, all four types of HOPS sessions resulted in similar PA outcomes for boys and girls.

**Grade.** Results also indicated significant increases in MVPA for youth in all grades when HOPS was adopted. However, youth in Grades 7 and 8 had statistically greater MVPA increases than youth in lower grades ( $F = 19.22, p < .05$ ). Fourth graders engaged in MVPA during 65% of HOPS sessions (16 min 15 s) compared to 57% (14 min 15 s) of non-HOPS sessions. Fifth graders increased MVPA by 4 min 15 s, and sixth, seventh, and eighth graders increased time in MVPA by 4.75 min or more. Despite reduced gains in MVPA, children in lower grades were significantly more active than those in older grades during HOPS sessions.

Examination of grade and presentation mode together revealed significant differences in students' responses to activity type by grade ( $F = 14.56, p < .01$ ) and by grade x presentation mode ( $F = 21.19, p < .01$ ). Analysis of the Bonferroni post hoc results indicated that fourth and fifth grade participants were significantly more active in games and fitness activities than children in all other grades. In addition, children in eighth grade were significantly less active than children in younger grades in dance activities. When activity type and presentation mode were investigated together, sixth, seventh, and eighth grade participants were significantly less active than fourth and fifth graders in sports and dance that used HOPS. Fourth graders were significantly more active than all older students during HOPS dance sessions.

**Race/ethnicity.** No significant differences were found in the effects of HOPS on students based on their race/ethnicity. However, when HOPS was compared to non-HOPS sessions for students of particular race/ethnicities, significant improvements in minutes of MVPA were observed among some races/ethnicities. Hispanic students gained an average of 5.5 min of MVPA using HOPS, and Caucasian students gained 5.25 min using HOPS. No statistically significant differences were found in minutes of MVPA by activity type according to race/ethnicity. Also, no significant differences

were found for activity type x mode of presentation according to race/ethnicity.

**Body mass index.** Results indicated no differential effect of HOPS according to students' BMI. Thus, BMI categories experienced statistically similar MVPA increases regardless of whether HOPS was used. However, activity intensities during HOPS significantly improved for children with healthy weight and for children who were overweight or obese (4.75 to 5.0 min). When activity types were investigated, no statistically significant differences were observed in minutes of MVPA by activity type according to race/ethnicity. Also, no significant differences were found for activity type by mode of presentation according to race/ethnicity.

## Discussion

Overall, youth in this study were observed to be significantly more physically active during the intervention in which HOPS was used as the primary means to provide PE instruction. Statistical analyses of MVPA from all sessions combined indicated youth were significantly more active, on average, when using HOPS than when not. When HOPS was used to facilitate the PE session, youth received an average of 21.5% more MVPA per session. Three possible explanations for this difference come to mind.

First, the incorporation of technology may peak students' interest levels as technology-rich environments have often been found to be preferable among today's youth. Because this may peak students' interest, class interruptions can be minimized. Without HOPS, observed behavioral problems, even minor ones, require the instructor to stop teaching to address the behaviors. We recommend an extended longitudinal study to assess whether gains observed from the technology intervention can be sustained across a full semester or academic year.

Second, the use of HOPS provides an environment in which students engage in an activity while the instructor circulates throughout the room. Although well-developed lesson plans can also be used to provide a positive environment, HOPS allows for a screen-based character to model the activities and provide verbal and visual performance cues to keep the classroom focused on the lessons so the instructor can monitor behavior, address behavior problems, and provide one-on-one instruction.

Third, HOPS offers many lessons that may be novel or unique to a PE class. Although each PE teacher has his or her own strengths,

few teachers are likely to be comfortable teaching the range of lessons offered by the technology—lessons ranging from break dancing, to hip-hop, to yoga. Therefore, it is possible that the lessons that HOPS provides may extend the range of what is taught in class and by extension extend opportunities for PA.

Fourth, social cognitive theory tells us that children learn not only from direct instruction and performance, but also from their vicarious experiences, peer interaction, and of course, teachers. Social cognitive learning theory is based on learning as a social event that occurs under several circumstances and results in a variety of outcomes. Successful teachers use this interaction of social elements to ensure that quality learning occurs. The three school sites adopted for this study expressed interest and time commitment to the integration of HOPS into their classroom. This enthusiasm and buy-in may have been observed and modeled by students, which could indirectly lead to enhanced PA outcomes when using HOPS compared to non-HOPS lessons.

To determine the impact on subpopulations, each demographic variable was considered independently and remaining demographics were held constant. Youth with healthy body weights and in lower grades were found to be more active with HOPS than overweight, obese, or older youth. Most notable, however, is that the difference in MVPA between individuals with healthy weights and those who were overweight or obese was smaller with HOPS than without it. When overweight and obese youth used HOPS, their MVPA increased from 31% to 51%. Overall, findings demonstrate that HOPS increased activity levels of youth with all BMIs, but did not reduce the gap between the most active children with healthy weights and the less active overweight or obese children.

Although boys and girls had similar activity levels while using HOPS, girls had significantly greater increases than boys. Typically, research indicates boys are more physically active than girls at these ages (Whyte & Hart, 2003); however, this was not the case when HOPS was used with our sample. Results suggest HOPS may be a mechanism to bridge the MVPA gender gap often found when youth reach adolescence. Although activity levels varied by gender, youth of different races/ethnicities had similar activity levels when using HOPS and saw similar MVPA gains using HOPS.

Although students of different genders, races, and BMI were found to receive similar increases when the intervention was applied, older students in this study in seventh and eighth grades were found

to be significantly more physically active due to the application of the HOPS intervention than those in lower grades. That said, children in lower grades remained more active irrespective of HOPS status. Although youth in lower grades were more active with or without HOPS, using HOPS resulted in smaller differences among lower grade levels. This may be a result of older students having had more experience with technology, particularly activity-based or game-related technology. In addition, this could result from the increased coordination older students have that is required for many dance and martial arts activities. A full explanation is outside the scope of this study. Regardless, the finding that older youth receive greater gains in PA using HOPS is particularly important given the substantial volume of research documenting declines in youth PA as age advances (Goran, Gower, Nagy, & Johnson, 1998; Goran & Trueth, 2001; Guthold, Cowan, Autenrieth, Kann, & Riley, 2010).

With school budgets decreasing in many communities, PE programs are often among those asked to do more with less. One way to accommodate this request is to increase class sizes (National Association for Sport and Physical Education, 2006). Larger class sizes make it more difficult for one instructor to maintain the attention of an entire class while also being able to provide cues to individual students that might help improve performance. For example, a teacher might work with a student to place the foot opposite their throwing hand in a lead position when throwing or to place their right hand on top of their left hand on a bat when batting right handed. All the instructors in this study noted that because onscreen characters “led” participants in skills during HOPS sessions, they were free to monitor the room and work individually with students who needed assistance. Although certified PE teachers can be expected to demonstrate an activity and provide verbal cues to all students while walking the room to monitor and address behaviors, most teachers find it difficult to simultaneously cue an entire class and provide instructional feedback to individual students, monitor behavior, and address behavioral problems when necessary.

On the other hand, when schools are asked to do more with less, the purchase of a relatively expensive technology system may be difficult. Another limitation is that the HOPS system is similar to operating a computer and a screen projector and therefore may not appeal to PE teachers who are less technologically savvy. Because the purpose of this paper was limited to a comparison of one classroom technology to the absence of that technology, additional systems and

strategies to increase children's PA should be investigated in future research. Popular press articles note the expansion of Dance Dance Revolution, Wii Fit game consoles, heart rate monitoring, and other gaming systems into schools and PE classrooms. Depending on the number of units purchased, these strategies are likely to be a considerably less expensive alternative to HOPS and objective research of these systems is warranted. Furthermore, researchers have begun to investigate the efficacy of cost-free interventions for increasing PA among children. For example, Bassett, West, and Shores (2011) observed a significant increase in moderate PA among elementary school children with the inclusion of music with approximately 130 to 140 beats per minute during PE classes. In a different approach, Perry et al. (1987) relied on peer counseling and training to increase healthy behaviors among adolescents. These fee-free approaches are another mechanism to increase PA in PE and recreation settings.

### **Limitations**

We acknowledge that our findings are limited given (1) the flexibility the instructor had in choosing the activities in which their classes participated; (2) the relatively limited number of sessions during which data were collected; (3) the lack of information collected that could identify what influence the teacher had on the planning, implementation, and quality of the non-HOPS sessions; and (4) the lack of longitudinal data to indicate how quickly students' interests in this technology might fade. Ideally, we would have liked to have matched the activity sessions exactly, but the PE instructors were interested in matching the sessions to students' interests and existing lesson plans when possible. Although results suggest that both the technology intervention and demographics are relevant to PA achievement in this study, which components can be held responsible remains unknown. When HOPS sessions consisting of only traditional sports or only dance were compared to similar non-HOPS sessions, no differences were found. These findings suggest HOPS may be most effective in its ability to offer diverse, dynamic program options that PE teachers, depending on their experience with fitness and dance, may not otherwise select.

Future research should consider implementing a means-end analysis, which allows specific program components (i.e., behavior modeling, opportunities for self-efficacy, social reinforcements) to explain observed intervention outcomes. Without a clear

understanding of which components facilitate PA, we must stop short of attributing all observed success to the technology intervention alone. As with any study, additional research is needed to more accurately assess the value of HOPS in a comprehensive youth fitness program.

### **Significance**

In conclusion, HOPS appears to be effective at promoting MVPA among youth in PE classes. Depending on the ability of the equipment to maintain the long-term interest of students, the positive impact of this intervention is considerable when adoption across a school year is considered. However, results do not provide overwhelming evidence that this intervention exceeds the performance of non-HOPS sessions in all situations. Instead, findings appear to suggest the key to higher MVPA levels lies in the activity choices PE teachers make. The most significant value of this technology, therefore, may be its provision of activity lessons that are relatively easy to facilitate, some of which, such as hip-hop dance, instructors may not feel comfortable teaching or modeling. The value of HOPS might therefore be more dependent on the teacher's experience with a variety of activities, as well as his or her ability to plan engaging, physically active lessons, than on the technology itself. In addition, technology-based lessons may benefit from continuous video modeling, upbeat music, and verbal cues, although video modeling without feedback has not been found to effectively improve gross motor skills (Hosford & Johnson, 1983; SooHoo, Takemoto, & McCullagh, 2004). A significant advantage of HOPS may be its ability to engage large groups of youth while the leader moves throughout the room providing individual feedback on participant form.

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