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Abstract

The purpose of this study was to examine the effect of physical education supportive curricula and technological devices, heart rate monitor (HRM) and pedometer (PED), on physical activity. A single subject ABAB research design was used to examine amount and level of participation in physical activity among 106 suburban 4th and 5th graders during physical education class. A curriculum, which was pedagogically centered on the use of the technological devices, was also developed and studied. Six children from each group and the physical education teacher were interviewed. The results of a One Way ANCOVA, pointed towards group differences between supportive curricula and technology for HRMs, PEDs and increased physical activity.

Introduction

Physical education classes during school and physical activity after school are becoming significantly more important due to the rise in our youth's obesity rate. Increased time in physical education reduces the likelihood that young children will become obese (Cawley, Fritzvold, & Meyerhoefer, 2013). Obesity raises serious health concerns for children and adolescents in today's society. Recent data indicate that about 17 % (12.5 million) of children and adolescents aged 2-19 years are obese in the United States (CDC, 2011). Further, since 1980, obesity prevalence among children and adolescents has almost tripled (CDC, 2011).

Since physical education is a part of the total education of every child, schools have a responsibility to make an impact on children's physical activity and fitness levels (NASPE, 2013). Schools offer a unique environment to influence the area of fitness where they can develop health-related activities and assessment programs designed to promote proper activity and assess the physical wellbeing of children. Physical education and health education professionals are trained to teach children how to be physically active and eat properly. Furthermore, partnering with school districts should be a part of a public health approach to improving the health of overweight children (Carrel, Clark, Peterson, Nemeth, Sullivan & Allen, 2005). Physical educators have the opportunity to influence the activity patterns in children and adolescents through developmentally appropriate instructional programs administered during class (Buck, 2002).

Heart rate monitors (HRMs) and pedometers (PEDs) are frequently used by students in physical education classes (Ladda, Keating & Toscano, 2004; Duncan, Birch & Woodfield, 2012). These technologies provide augmented feedback and further instruct the students in

quantifying their exercise experience. Both instruments are appropriate to use with children, serve as self-monitoring tools and are useful in promoting physical activity (Duncan, Birch & Woodfield, 2012).

HRMs and PEDs features and tools bring a new awareness to individual physical activity measures and goals. They help represent the "new" physical education curriculum. Current research using PEDs and HRMs as a part of the new physical education present many implications for practice in the field of physical education. Using HRMs and PEDs individualizes instruction to meet students' needs because activities are focused on time spent in the target heart rate zone and how many steps they are accumulating during physical education class time. These technological devices could motivate students and build self-confidence, because they receive instant feedback about their level and amount of physical activity during physical education class. They raise the level of teacher and student accountability, provide a more objective means of assessing student performance and effort, motivate students to be physically active, and help students understand how physical, mental and emotional challenges affect their heart rate and number of steps (Tipton & Sander, 2004; Ignico & Corson, 2006; Strand & Mathesius, 1995).

A recent examination of the physical education pedagogical literature indicated a trend of emerging studies investigating the use of PEDs and HRMs in physical education classes (Le Masurier, 2004; Sequira, Rickenbach, Wietlisbach, Tullen, & Schutz, 1995). Previous research (Schofield, Mummery & Schofield, 2005; Grissom, Ward, Martin and Leenders, 2005; Duncan, Birch & Woodfield) also indicated that using PEDs and HRMs with children in physical

education classes increased the amount of physical activity. Previous research (Lubans, Morgan, Collins, Boreham, & Callister, 2009) also reveals using PEDs and HRMs together.

Previous research (Duncan, Birch & Woodfield, 2012; Oliver, Schofield & McEvoy, 2006; Ignico & Corson, 2006) also indicated that using integrated curriculum along with the devices can yield significant results. Duncan, Birch & Woodfield (2012) implemented a four week integrated curriculum with 59 children based on walking from one location to another. Body Mass Index were determined pre and post-intervention and steps/day were measured with pedometers throughout the research. The results indicated that steps/day were higher during and post the intervention.

Oliver, Schofield & McEvoy (2006) demonstrated how supportive curricula (SC) improved the effectiveness of technology. This research used PEDS as a motivational and educational tool for measuring accumulated physical activity. This study involved designing and implementing a four-week integrated elementary school curriculum unit, based around PED walking and quantified the physical activity levels in children. Results demonstrated an increase in physical activity, and the curriculum as an effective motivational tool for children.

Ignico & Corson (2006) demonstrated how teachers can motivate students to be physically active by providing concrete feedback and evidence of success in physical activity with HRMs. Participants were 175 fourth and fifth grade students. The treatment group received instruction at the beginning of the school year about using the HRMs and staying in the target heart rate zone. They also wore HRMs each day during class. The control group did not use HRMs for physical education class. The results indicated that the treatment group performed better on the mile-run performance.

Theoretical Framework

Deci and Ryan's self-determination theory, intrinsic motivation to be physically active stems from "our natural or intrinsic tendencies to behave in effective and healthy ways" (Deci & Ryan, 2011). HRMs and PEDS accompanied by supportive curricula can be used to promote intrinsic motivation by increasing awareness and comprehension of physical activity level and amount (Tipton & Sander, 2004; Ignico & Corson, 2006; Strand & Mathesius, 1995).

The range of research reviewed demonstrates the use and need for HRMs and PEDs in physical education settings. There are limited research studies to date, which monitor both students' physical activity and level within a physical education setting. Further, there are limited studies, which utilize supportive curriculum to accompany the implementation of HRMs and PEDs in physical education settings.

Purpose

This research project sought to fill a gap in the literature by creating supportive curricula for both HRMs and PEDs for physical educators to use in physical education settings. It also sought to determine whether using supportive curricula for HRMs and PEDs would increase both the level and amount of physical activity in fourth and fifth grade students.

Guiding Hypotheses

For this study, the researcher hypothesized that the supportive curriculum designed for HRMs and PEDs would increase both level and amount of physical activity in fourth and fifth grade students through intrinsic motivation. The combination of the immediate feedback of physical activity from the HRMs and PEDs with the supportive curricula provided by the

physical education teacher would promote intrinsic motivation to increase both level and amount of physical activity during physical education classes.

Method

Participants

A suburban upper elementary population, ranging in ages from nine to twelve (grades 4-5) constituted the participants for this study. The participants also participated in PE once a week for forty minutes. There were a total of 105 student participants in the research project; 93% of the total number of students and parents involved in the fourth and fifth grade classes agreed to participate in this project. Forty-seven of the participants were male and the remaining 58 were female. 1% of the participants were Black, 1% were Hispanic, 97% were White and 1% were Asian. These participants attended public school in the state of Rhode Island on the east coast of the United States. The researcher followed all proper channels with the Institutional Review Board (IRB) to gain approval to conduct research.

There were a total of six participant groups. The physical education teacher met with each group/class separately once a week. The three fourth grade groups participated in two PED SC groups (PED SC A and PED SC B) and one PED group. There were 14, 17 and 15 participants in each group respectively. The three fifth grade groups participated in the No HRM group, HRM SC group and HRM group. There were 18, 21 and 20 participants in each group respectively.

Materials

Polar HRMs (E200 non-downloadable and E600 downloadable series) were worn by the HRM SC group and the HRM group. Each group wore both models, but the downloadable

feature was not used in this study. All students indicated they had not previously worn heart rate monitors during physical education class. HRMs have been shown to be as accurate as an ECG (Engstrom, Ottosson, Wohlfart, Grundstrom & Wisen, 2012). Every student in all the groups wore a pedometer. The pedometers utilized were the Digi-walker Accusplit Eagle 170 model. The pedometer has been found to be 98% accurate (Accusplit, 2008) and a valid instrument for measuring physical activity (Tudor-Locke, Williams, Reis & Pluto, 2002).

Procedure

A single subject research design (ABAB) was used to examine the amount and level of participation in physical activity among 106 suburban 4th and 5th grade students during physical education class and whether the use of a technological device and/or teacher instruction contributed to increased participation in physical activity. The amount and level of physical activity is reported in steps/min and bpm respectively. While the research focus was the amount and level of activity in the gymnasium, the use of the technological devices, either a heart rate monitor (HRM) or a pedometer (PED), was studied. An interdisciplinary skill theme based supportive curriculum centered on the use of the technological devices was written specifically for this study. The supportive curriculum differed from standard practice by focusing on the successful implementation of heart rate monitors and pedometers and implications of level and amount of physical activity on the body in physical education classes. Daily vocabulary words, visual aids, specific detailed instruction and explanation linking physical activity, health and technology were utilized in the curriculum.

The physical education curriculum was dedicated to locomotor activities, space awareness, chasing, dodging, fleeing, and cooperative games, team building activities, throwing

and catching using equipment like balls, hoops and beanbags. This curriculum represented the diverse activities fourth and fifth graders normally participate in during physical education classes. The same curriculum was used for both HRM and both PED groups. Since an ABAB design was employed, the researcher alternated between locomotor and manipulative activities. This design ensured that the students received one day of locomotor activities and one day of manipulative activities throughout the entire length of the study.

A pilot study was conducted a semester prior to implementation. Fourth and fifth grade subjects from an urban school were asked to participate in the research project. Six pre-service physical education teachers were asked to teach in the study. The researcher held eight hours of teacher training for the pre-service teachers. The teacher training was split into two four hour training sessions. The sessions included: an overview of the research project, a review of how to use HRMs and PEDs, use of microphone and recorder, a review of all eight lessons, a review of all teacher scripts, questions were addressed and practiced teaching using scripts and reviewed data collection procedures. There were six participant groups: Group 1- HRM- instruction (HRM-I), Group 2-HRM (HRM), Group 3-HRM-control (HRM-Control), Group 4-PED-instruction (PED-I), Group 5-PED (PED), and Group 6-PED-Control (PED-Control). Major revisions were made to the design of the research project upon the completion of this pilot study, including finding one physical education teacher to teach all of the groups.

Six participant groups were employed for this research, three fourth grade PED groups and three fifth grade HRM groups. Cluster sampling was used to determine the participant groups. The HRM and PED groups wore HRMs and PEDs respectively, while participating in typical or “traditional” physical education class. The activities alternated between locomotor

activities, such as tag games, and manipulative activities such as striking, kicking and dribbling. The HRM supportive curricula (SC) and the PED SC groups wore the technological devices and (SC)/instruction with the devices representative of the "New" Physical Education (PE). There were three fifth grade classes available for the study at the elementary school. The researcher named each of the classes (groups) HRM, HRM SC and No HRM SC. Since there were also three fourth grade classes available for the study, the researcher chose to use one class for the PED group (traditional PE) and the other two classes for the PED SC groups (New PE). These two SC groups were named PED SC A and PED SC B. Since the HRMs were more difficult to use than PEDS, the researcher chose to designate the fifth grade classes for the HRM groups and the fourth grade classes for the PED groups.

The supportive curricula lessons included the same activities as the "traditional" PE classes, however these lessons offered rationale and background information on using the HRMs and PEDs. The students were taught how to read, interpret their step count and heart rate information from the devices and to set personal goals using the devices. The students were asked to frequently look at their step counts and heart rate information periodically throughout the lessons. The students in the HRM SC and PED SC groups also learned many new vocabulary words from the HRM and PED supportive curricula. Since the study employed the ABAB research design, the participants in the HRM SC, No HRM SC, PED SC A and PED SC B groups alternated between two weeks of baseline data (traditional PE) in which all of the groups received the same lessons and two weeks of treatment data (New PE); these groups received a total of four weeks of both traditional and New PE curricula. The HRM and PED groups (traditional PE) classes wore the devices and participated in their PE class without receiving this

supportive information from the teacher. The No HRM group wore a pedometer and received the same supportive curricula as the HRM SC group. This group served as the HRM control group because it would determine if the supportive curricula encouraged students to produce more physical activity or whether it was actually the HRM device. One experienced physical education teacher taught all of the groups to ensure credibility and reliability.

Steps/minute data were collected from the PED groups. Averages of steps/minute were calculated. Steps/minute and heart rate data were also collected from the HRM groups. Averages of steps/minute and heart rate in beats per minute (bpm) were calculated and a One Way Analysis of Covariance ANCOVA was conducted for both measurements.

In addition, six students were randomly selected from each group (thirty-six students total) to participate in an interview group. There were a total of three students for each group; two interview groups per participant group. They were interviewed at the completion of the research project. The researcher employed the use of an unstructured interview. An interview guide was used for each of the participant groups and included: What is this called? (pedometer or heart rate monitor was held up), Had you ever seen or used one before the teacher taught you about this device?, Why do you use this device during PE?, What did you learn from using the device?, What are some vocabulary words you remember?, Can you define the words?, What did you think of using it? and What was your favorite activity you did with the device?

Finally, the researcher also interviewed the PE teacher to gather additional qualitative data. This included: background data on her education, certifications, honors and awards, Please share your first impressions of this research., What did you think entering the project and before you started and after you began the lessons?, What are your thoughts on the curriculum piece of

the research?, What are some of the strengths of the curriculum and devices?, What were some weaknesses of the curriculum and using the devices? and What do you think the students thought about the curriculum and the devices? The data from the interviews was analyzed for emergent themes and categories of responses to supplement the quantitative data collected.

Results

The independent variables utilized for ANCOVA were steps/min and beats/min. The dependent variables were technology and SC. The covariate utilized for ANCOVA was baseline 1. The ANCOVA for steps/minute was significant for technology and SC, $F(1, 100) = 4.520$, $p < .036$, $F(1, 100)= 13.499$, $p<.000$ respectively. The ANCOVA for steps/minute was not significant for technology and SC combined $F(1, 100)= 3.188$, $p<.077$. The ANCOVA for beats/minute was significant for technology with SC, $F(1, 38) = 14.329$, $p < .001$. The ANCOVA for beats/minute was not significant for technology.

Tables one and two display the results of the descriptive statistics and Analysis of Covariance of steps/minute (Table 1) and beats/minute (Table 2) for baseline 1 and treatment 1 sessions including *n*, *M*, *SD*, SS, *df*, MS, *F* and *p* values.

Table 1: Descriptive Statistics and Analysis of Covariance for Steps/Minute

Source	n	M	SD	SS	*df*	MS	F	*p*
Technology	20	1005.30	191.916	379810.788	1	379810.788	4.520	.036
SC	49	1098.49	375.394	113494.69	1	1134394.69	13.499	.00
Technology with SC	21	1322.95	210.988	267932.365	1	267932.365	3.188	.077
Error					100			
Total					105			

- Technology includes the HRM group
- SC includes the No HRM, PED SC A and PED SC B groups
- Technology with SC includes the HRM SC groups

Table 2: Descriptive Statistics and Analysis of Covariance for Beats/min

Source	*n*	M	SD	SS	df	MS	F	*p*
Technology	20	131.1167	33.69332	1547.795	1	1547.795	1.906	.175
Technology with SC	21	164.6984	23.27467	11635.464	1	11635.464	14.329	.001
Error					38			
Total					41			

- Technology includes the HRM group
- Technology with SC includes HRM SC group

This indicated that the technology and SC separately were the most effective in promoting amount in steps/minute of physical activity among fourth and fifth graders. However, the technology and SC combined together were not as effective. Furthermore, the technology and SC combined were the most effective in promoting level in bpm of physical activity among fourth and fifth graders.

The results of the participant interviews revealed some interesting information regarding the effect of HRMs and PEDs on the level and amount of participation in physical education. When asked what they enjoyed about using the HRMs, student one responded, “Just seeing my heart rate because I never really thought of it before.” Student four added, “How fast your heart rate goes was very helpful” and “It is very hard to find your pulse with your fingers.” Student two responded, “It’s pretty cool to just see how hard you are breathing” and “I thought it was interesting to see a device that can actually show your heart rate, pretty interesting”. When asked if the HRMs helped them to participate in PE, student one responded, “No, could still participate in activities without it.” When asked if the students would like to wear the HRMs for every PE class, many of the students reported having issues with it working and taking a long time to put on the HRM. For example, student five responded, “It takes a lot of time to put on the equipment.” Student six added, “I had constant issues with it working”.

The students in the HRM SC group enjoyed wearing the HRMs, and, when asked why they enjoyed using the HRMs, student one responded, “To find out how hard we were working by looking at the heart rate.” Student two responded, “To find out how hard we were working by looking at the heart rate, learning something new.” Student five added, “It was something we had never done before.” Student six added that the “watch- how you could see heart rate, it showed

me if my heart rate was low then it showed me that I wasn't trying very heard." The students in the HRM SC group found the HRMs "Interesting, fun and educational. Could use it for different things to see your limit". The students in the HRM and HRM SC group learned eight and eleven vocabulary words respectively.

The students in the PED groups also enjoyed wearing the PEDs. The PED group knew that the PED measured steps. The students in the PED SC A and PED SC B group understood that the PEDs measured steps, distance in miles, calories and overall activity for the physical education class. The students in the PED SC A and PED SC B groups understood the correlation of acquiring more steps and increased physical activity. The children in the PED, PED SC A, and PED SC B groups learned six, thirteen and twelve vocabulary words respectively.

The results of the teacher interview provided data regarding the effect of HRMs on the level and amount of participation in physical education. According to the physical education teacher, "Some of the students were frustrated with the time spent attaching the HRMs and getting them working." When asked if she though the HRMs motivated the students to participate in PE, the teacher expressed a sincere interest in their value to a physical education program. Overall the physical education teacher felt that the benefits probably outweighed the negative issues with the students putting the HRMs on in a timely manner. The physical education teacher stated "the pedometers provided motivation for self-improvement in physical education class for each individual." Throughout the interview and implementation of the SC, the physical education teacher viewed the PEDs as a better motivation tool to use. Based on the teacher interview and information from the students in the PED group, it appears as though the HRMs and PEDs did affect the students' participation in physical education.

When asked if she thought the SC was effective, the physical education teacher responded, “Yes, the students saw a correlation of rest, active and moderate-intensity physical activity, and the effects on number of steps and heart rate.” She hypothesized the curricula would influence the students’ effort for activity level. The physical education teacher added that the curriculum “kept students focused” and “My students loved the challenge of the PEDs, HRMs and the intellectual challenge of the SC.

Discussion

This research project sought to fill a gap in the research literature by creating supportive curricula for both HRMs and PEDS for physical educators to use in physical education settings. It also sought to determine whether using supportive curricula for HRMs and PEDS would increase both the level and amount of physical activity in fourth and fifth grade students.

This study demonstrated that an effective physical education teacher who is knowledgeable about the content and pedagogy of physical education is able to achieve positive outcomes in terms of level of physical activity during their PE classes. As demonstrated with this research, HRMs and PEDS combined with supportive curricula increased level of physical activity in fourth and fifth grade students. Although amount of physical activity was not increased, the researcher surmised that the children focused on the SC and increasing the number of minutes spent in their target heart rate zone rather than amount of physical activity. The amount of physical activity was the focus of the PED SC and the No HRM SC. Those groups did increase their amount of physical activity. Ultimately, the physical education teacher combined with technology can increase students’ amount and level of physical activity.

Research with the self-determination theory (Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997) suggests that people who are motivated intrinsically are more likely to continue to participate in physical activity long term, experience higher levels of enjoyment and competence in movements. The current research study was designed to teach students about level and amount of physical activity in physical education class while providing them with immediate feedback from HRMs and PEDs. This combination may prove to increase intrinsic motivation thus leading towards an increased level and amount of physical activity in the groups that received technology and SC (HRM, HRM SC, No HRM, PED SC A and PED SC B groups).

This research indicated that the use of technological devices, supportive curricula and a combination of the two provided by a competent physical education teacher may result in increased amounts and levels of physical activity among fourth and fifth grade students. Ultimately, not only do physical educators need to use technology in physical education class, but they also need to provide meaningful lessons on how to interpret feedback provided from HRMs and PEDs.

Conclusions

In designing this study, the researcher has taken appropriate steps to reduce bias by suitable and adequate sampling, incentives to maximize response rate, as well as employing random selection (interviews) and a large sample size. Although these steps ensure validity of this study to a certain degree, a number of other factors could serve as threats. Due to the fact that this study took place in a small section of the Northeast United States, there were several geographical limitations. Working with a small and limited number of children in one part of the country might not adequately reflect the entire student population of fourth and fifth grade

students in PE class. In addition, those who declined to participate in the study may differ systematically from those who agree to participate in the study. There were 105 out of a possible 114 student participants. Nine students declined to participate.

In addition, all of the data collected were self-reported. The validity of this data could have been improved if collected by the researcher over a longer period of time. Instead of a ten-week study, data could be collected over a longer period of time, perhaps a twelve or fourteen week period, for a greater validity (Baumgartner, 2002). Further, the data collection was interrupted by several public school holidays, and this interruption in the school calendar may or may not have been factors. The PE teacher was absent from school for three days. This might have affected the data and subsequent results.

Furthermore, HRM printouts from downloadable HRMs were not used to aid in the supportive curricula for the HRM SC group as planned. Using the downloadable HRMs and printouts would have provided students continuous heart rate information throughout each physical education class. This would have given the students a deeper understanding of their heart rate throughout their physical activity participation. This was due to consecutive class periods and limited data collection time.

With respect to the interview process with the students and the physical education teacher, taking notes can provide an adequate record, but it can slow the interview down and be distracting to both interviewer and respondent (Baumgartner et al., 2002). This could foster an incomplete interview for an answer to a particular question. In addition, tape recording provides a complete account, but makes some respondents uncomfortable enough to inhibit their answers;

some individuals and parents refused to give permission to be tape recorded, and the transcription of the tapes was time-consuming (Baumgartner et al., 2002).

The study should be replicated to take into account the following implications for future research with HRMs and PEDS.

1. Use downloadable HRM printouts for further data collection and evidence of student level of participation in PE.
2. In addition to selecting highly proficient teachers as instructors, recruit and train teachers with varying degrees of experience and diversifying into middle and high schools.
3. The study can be replicated with a larger population.
4. The study can integrate a classroom component with interdisciplinary written lessons in Mathematics, Science, English, and Health to accompany the supportive curricula in PE.

HRMs and PEDS combined with supportive curriculum sustain the New PE philosophy and should be considered a critical tools and motivational devices to combat the lack of physical activity in children. This study found that technology, supportive curricula and a combination of the two increased steps/minute and beats/minute in both the HRM (steps/minute and average heart rate) and PED (steps/minute only) groups. Qualitative interview data from the students, indicated HRM and PED vocabulary words utilized in the research and activities proved to be valuable in the comprehension and application of supportive curricula. Ultimately, the HRMs and PEDs motivated students to be physically active during physical education. The supportive curricula aided the comprehension of students of how to use and interpret information from

HRMs and PEDs. It also guided the physical education teacher with “step by step” process of how to incorporate these devices into physical education classes successfully.

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