PEDAGOGY

Effects of a Physical Education Supportive Curriculum and Technological Devices on Physical Activity

Emily D. Clapham, Eileen C. Sullivan, Lori E. Ciccomascolo

Abstract

The purpose of this study was to examine the effects of a physical education supportive curriculum 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 fourth and fifth 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 indicated group differences between the supportive curriculum and technology for HRMs, PEDs, and increased physical activity.

Emily D. Clapham is assistant professor of kinesiology, Kinesiology Department, University of Rhode Island. Eileen C. Sullivan is assistant dean, Office of Partnerships and Placements, Feinstein School of Education and Human Development, Rhode Island College. Lori E. Ciccomascolo is interim dean, College of Human Science and Services, University of Rhode Island. Please send author correspondence to Emily D. Clapham, Kinesiology Department, University of Rhode Island, 25 Independence Way, Kingston, RI 02881. E-mail: eclapham@uri.edu

Physical education (PE) classes during school and physical activity after school are becoming significantly more important due to the rise in obesity in youth. Increased time in PE reduces the likelihood that young children will become obese (Cawley, Fritzvold, & Meyerhoefer, 2013). Obesity is a serious health concern for children and adolescents today. Recent data indicate that about 17 % (12.5 million) of children and adolescents aged 2 to 19 years are obese in the United States (Centers for Disease Control and Prevention [CDC], 2011). Furthermore, since 1980, the prevalence of obesity among children and adolescents has almost tripled (CDC, 2011).

Since PE is a part of the total education of every child, teachers have a responsibility to children in their level of physical activity and fitness (National Association for Sport and Physical Education, 2013). Schools are a unique environment to influence the area of fitness where teachers can develop health-related activities and assessment programs to promote proper activity and assess the physical well-being of children. PE 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 et al., 2005). Physical educators have the opportunity to influence children and adolescents in their activity patterns through developmentally appropriate instructional programs administered during class (Buck, 2002).

Students frequently use heart rate monitors (HRMs) and pedometers (PEDs) in PE classes (Duncan, Birch, & Woodfield, 2012; Ladda, Keating, Adams, & Toscano, 2004). Through these technologies, students receive augmented feedback and are able to quantify their exercise experience. Both instruments are appropriate to use with children, are self-monitoring tools, and are useful in promoting physical activity (Duncan et al., 2012).

By using HRMs and PEDs features and tools, students gain a new awareness of their physical activity measures and goals. These devices are part of the *new* PE curriculum. Researchers who have used PEDs and HRMs as a part of the new PE have presented many implications for practice in the field of PE. HRMs and PEDs are tools to individualize 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 PE class. By using these devices, students may feel motivated to be physically active

and have more self-confidence because they receive instant feedback about their level and amount of physical activity during PE class. Teachers and students are more accountable when using these devices. These devices are an objective means of assessing student performance and effort, and by using these devices, students learn how physical, mental, and emotional challenges affect their heart rate and number of steps (Ignico & Corson, 2006; Strand & Mathesius, 1995; Tipton & Sander, 2004).

A recent examination of the PE pedagogical literature indicated a trend of emerging studies with researchers investigating the use of PEDs and HRMs in PE classes (Le Masurier, 2004; Sequira, Rickenbach, Wietlisbach, Tullen, & Schutz, 1995). Researchers also indicated that using PEDs and HRMs with children in PE classes increased the amount of physical activity (Duncan et al., 2012; Grissom, Ward, Martin, & Leenders, 2005; Schofield, Mummery, & Schofield, 2005). Researchers also used PEDs and HRMs together (Lubans, Morgan, Collins, Boreham, & Callister, 2009).

Researchers also indicated that using integrated curriculum along with the devices may yield significant results (Duncan et al., 2012; Ignico & Corson, 2006; Oliver, Schofield, & McEvoy, 2006). Duncan et al. (2012) implemented a 4-week integrated curriculum with 59 children based on walking from one location to another. Body mass index was determined pre- and postintervention and steps per day were measured with pedometers throughout the research. The results indicated that steps per day were higher during the intervention and postintervention.

Oliver et al. (2006) demonstrated how a supportive curriculum (SC) improved the effectiveness of technology. They used PEDS as a motivational and educational tool for measuring accumulated physical activity. They designed and implemented a 4-week integrated elementary school curriculum unit, based around PED walking and quantified the physical activity levels in children. They found children's physical activity levels increased and the curriculum was an effective motivational tool for children.

Ignico and 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 students in 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 students in the

control group did not use HRMs for PE class. The results indicated that the students in the treatment group performed better on the mile run performance.

Theoretical Framework

Deci and Ryan's (2011) self-determination theory, intrinsic motivation to be physically active, stems from people's "natural or intrinsic tendencies to behave in effective and healthy ways" (para. 1). HRMs and PEDS combined with SC may be used to promote intrinsic motivation by increasing awareness and comprehension of physical activity level and amount (Ignico & Corson, 2006; Strand & Mathesius, 1995; Tipton & Sander, 2004).

The range of research reviewed indicates the use and need for HRMs and PEDs in PE settings. Few researchers to date have monitored students' physical activity and level within a PE setting. Furthermore, few researchers have used SC to accompany the implementation of HRMs and PEDs in PE settings.

Purpose

The purpose of this research project was to fill a gap in the literature by creating SC for HRMs and PEDs for physical educators to use in PE settings. The purpose was also to determine whether using SC for HRMs and PEDs would increase the level and amount of physical activity in fourth and fifth grade students.

Guiding Hypotheses

For this study, the researcher hypothesized that due to the SC designed for HRMs and PEDs, fourth and fifth grade students would feel intrinsically motivated to increase their level and amount of physical activity. Due to the immediate feedback of physical activity from the HRMs and PEDs combined with the SC provided by the PE teacher, the students would feel intrinsically motivated to increase level and amount of physical activity during PE classes.

Method

Participants

The participants for this study were a suburban upper elementary population, aged 9 to 12 (Grades 4 to 5). The participants also participated in PE once a week for 40 min. One hundred five student participated in the research project; 93% of the 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 58 were female. Of the participants, 1% 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 proper channels with the institutional review board (IRB) to gain approval to conduct research.

There were six participant groups. The PE teacher met with each group once a week. The students in 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 students in 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

The students in the the HRM SC group and the HRM group wore Polar HRMs (E200 nondownloadable and E600 downloadable series). Students in each group wore both models, but the downloadable feature was not used in this study. Students indicated they had not previously worn HRMs during PE class. HRMs have been shown to be as accurate as an electrocardiography (Engstrom, Ottosson, Wohlfart, Grundstrom, & Wisen, 2012). Every student in all groups wore a pedometer. The pedometers used were the Digi-Walker Accusplit Eagle 170 model. This 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 fourth and fifth grade students during PE 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 per min and beats per minute, respectively. Although the research focus was the amount and level of activity in the gymnasium, the use of the technological devices, a heart rate monitor (HRM) or a pedometer (PED), was studied. An SC with an interdisciplinary skill theme that was centered on the use of the technological devices was written specifically for this study. The SC was different from standard practice as it was focused on the successful implementation of HRMs and PEDs and

implications of level and amount of physical activity on the body in PE classes. Daily vocabulary words, visual aids, detailed instructions, and explanations linking physical activity, health, and technology were used in the curriculum.

The PE curriculum included locomotor activities; space awareness, chasing, dodging, fleeing, and cooperative games; team-building activities; and throwing and catching using equipment such as balls, hoops, and beanbags. This curriculum included the diverse activities fourth and fifth graders normally participate in during PE. The same curriculum was used for HRM and PED groups. Since an ABAB design was employed, the researcher alternated between locomotor and manipulative activities. This design ensured that the students received 1 day of locomotor activities and 1 day of manipulative activities throughout 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 PE teachers were asked to teach in the study. The researcher held 8 hr of teacher training for the pre-service teachers. The teacher training was split into two 4-hr sessions. The sessions included an overview of the research project, a review of how to use HRMs and PEDs, a review of how to use a microphone and recorder, a review of all eight lessons, a review of all teacher scripts, and a review of data collection procedures. In addition, the researcher addressed teachers' questions, and the teachers practiced using the scripts. The participant groups were Group 1: HRM-instruction (HRM-I); Group 2: HRM (HRM); Group 3: HRM-control (HRM-C); Group 4: PED-instruction (PED-I); Group 5: PED (PED); and Group 6: PED-control (PED-C). Major revisions were made to the design of the research project upon the completion of this pilot study, including finding one PE teacher to teach all of the groups.

The participant groups employed for this research were three fourth grade PED groups and three fifth grade HRM groups. Cluster sampling was used to determine the participant groups. The students in the HRM and PED groups wore HRMs and PEDs, respectively, while participating in typical—traditional—PE class. The activities alternated between locomotor activities such as tag games and manipulative activities such as striking, kicking, and dribbling. Students in the HRM and PED SC groups wore the devices and received SC/instruction. These groups represented the New PE. Three fifth grade classes were available for the study at the elementary

school. The researcher named the classes (groups) HRM, HRM SC, and No HRM SC. Since three fourth grade classes were also 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 SC groups were named PED SC A and PED SC B. Since the HRMs were more difficult to use than the PEDS, the researcher chose to designate the fifth grade classes for the HRM groups and the fourth grade classes for the PED groups.

The SC lessons included the same activities as the traditional PE classes; however, rationale and background information on using the HRMs and PEDs were offered in these lessons. The students were taught how to read and interpret their step count and heart rate information from the devices and to set personal goals using the devices. The students were asked to 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 new vocabulary words from the SC for HRMs and PEDs. Since the ABAB research design was employed in the study, the students in the HRM SC, No HRM SC, PED SC A, and PED SC B groups alternated between 2 weeks of baseline data (traditional PE) in which all of the groups received the same lessons and 2 weeks of treatment data (new PE); the students in these groups received 4 weeks of traditional and the new PE curriculum. The students in the HRM and PED groups (traditional PE) wore the devices and participated in their PE class without receiving this supportive information from the teacher. The students in the No HRM SC group wore a pedometer and received the same SC as students in the the HRM SC group. This group was the HRM control group because the information from this group was be used to determine whether the SC or the HRM device encouraged students to produce more physical activity. One experienced PE teacher taught all of the groups to ensure credibility and reliability.

Steps per minute data were collected from the students in the PED groups. Averages of steps per minute were calculated. Steps per minute and heart rate data were also collected from the students in the HRM groups. Averages of steps per minute and heart rate in beats per minute 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 (36 students total) to participate in an interview group. Three students were in each group, with two interview groups per participant group. They were interviewed at the completion of the research

project. The researcher used an unstructured interview. An interview guide was used for each of the participant groups and included the following questions: 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, including background data on her education, certifications, honors, and awards. The researcher also asked the following questions: 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 were analyzed for emergent themes and categories of responses to supplement the quantitative data collected.

Results

The independent variables used for ANCOVA were steps per min and beats per minute. The dependent variables were technology and SC. The covariate used for ANCOVA was Baseline 1. The ANCOVA for steps per 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 per minute was not significant for technology and SC combined, $F(1, 100) = 3.188$, $p < .077$. The ANCOVA for beats per minute was significant for technology with SC, $F(1, 38) = 14.329$, $p < .001$. The ANCOVA for beats per minute was not significant for technology.

Tables 1 and 2 show the results of the descriptive statistics and ANCOVA of steps per minute (Table 1) and beats per minute (Table 2) for Baseline 1 and Treatment 1 sessions including *n*, *M*, *SD*, *SS*, *df*, *MS*, *F*, and *p* values.

This indicated that the technology and SC separately had a significant effect on steps per minute of physical activity among fourth and fifth graders. However, the technology and SC combined were not as effective. Furthermore, the technology and SC combined

had a significant effect on beats per minute during physical activity among fourth and fifth graders.

Table 1
Descriptive Statistics and Analysis of Covariance for Steps per Minute

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

[a]Includes the HRM group.
[b]No HRM, PED SC A, and PED SC B groups.
[c]Includes the HRM SC groups.

Table 2
Descriptive Statistics and Analysis of Covariance for Beats per Minute

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

[a]Includes the HRM group.
[b]Includes the HRM SC groups.

The results of the participant interviews revealed interesting information regarding the effect of HRMs and PEDs on the level and amount of participation in PE. The students were asked what they enjoyed about using the HRMs. Student 1 responded, "Just seeing my heart rate because I never really thought of it before." Student 4 added, "How fast your heart rate goes was very helpful" and "It is very hard to find your pulse with your fingers." Student 2 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." They were also asked whether the HRMs had an effect on their participation in PE. Student 1 responded, "No, could still participate in activities without it." When asked whether they 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 5 responded, "It takes a lot of time to put on the equipment." Student 6 added, "I had constant issues with it working."

The students in the HRM SC group enjoyed wearing the HRMs, the researcher asked them why they enjoyed using the HRMs. Student 1 responded, "To find out how hard we were working by looking at the heart rate." Student 2 responded, "To find out how hard we were working by looking at the heart rate, learning something new." Student 5 added, "It was something we had never done before." Student 6 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 hard." 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 11 vocabulary words, respectively.

The students in the PED groups also enjoyed wearing the PEDs. They knew that the PED was used to measure 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 PE 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, 13, and 12 vocabulary words, respectively.

The researcher found data regarding the effect of HRMs on the level and amount of participation in PE from the teacher interview. According to the PE teacher, "Some of the students were frustrated with the time spent attaching the HRMs and getting them working." When asked whether she thought the students felt motivated to participate in PE by using the HRMs, the teacher expressed a sincere interest in their value to a PE program. Overall, the PE teacher felt that the benefits probably outweighed the negative issues with the students putting the HRMs on in a timely manner. The PE 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 PE teacher viewed the PEDs as a better tool to use to motivate the students. Based on the

teacher interview and information from the students in the PED group, the HRMs and PEDs had an effect on the students' participation in PE.

When asked whether she thought the SC was effective, the PE 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 curriculum would have an influence on the students' effort for activity level. The PE teacher added that the curriculum "kept students focused" and "[her] students loved the challenge of the PEDs, HRMs and the intellectual challenge of the SC."

Discussion

The purpose of this research project was to fill a gap in the research literature by creating SC for HRMs and PEDS for physical educators to use in PE settings. The purpose was also to determine whether using SC for HRMs and PEDS would increase the level and amount of physical activity in fourth and fifth grade students.

This study showed that an effective PE teacher who is knowledgeable about the content and pedagogy of PE is able to achieve positive outcomes in level of physical activity during their PE classes. As demonstrated with this research, HRMs and PEDS combined with SC had a positive effect on 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. The students in these groups increased their amount of physical activity. Ultimately, the PE teacher using SC combined with technology had a positive effect on students' amount and level of PA.

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

This research indicated that the use of technological devices, SC, and a combination of the two provided by a competent PE 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 PE class, but they also need to provide meaningful lessons on how to interpret feedback from HRMs and PEDs.

Conclusions

In designing this study, the researcher took appropriate steps to reduce bias by suitable and adequate sampling, incentives to maximize response rate, random selection (interviews), and a large sample size. Although validity of this study was ensured to a certain degree through these steps, several other factors could be threats. Because this study took place in a small section of the northeast United States, there were several geographical limitations. The limited number of children in one part of the country may not be an adequate reflection of the entire student population of fourth and fifth grade students in PE. In addition, those who declined to participate in the study may differ systematically from those who agreed to participate. One hundred five out of a possible 114 student participated. Nine students declined to participate.

In addition, the data collected were self-reported. The validity of this data could have been improved if the researcher collected them over a longer time. Instead of a 10-week study, data could have been collected over a longer time, perhaps for 12 or 14 weeks, for a greater validity (Baumgartner, Strong, & Hensely, 2002). Furthermore, the data collection was interrupted by several public school holidays, and this interruption in the school calendar may have been a factor. The PE teacher was absent from school for 3 days. This may have had an effect on the data and subsequent results.

Furthermore, HRM printouts from downloadable HRMs were not used to aid in the SC for the HRM SC group as planned. Using the downloadable HRMs and printouts would have provided students continuous heart rate information throughout each PE 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.

In regard to the interview process with the students and the PE teacher, note-taking is a good tool for an adequate record, but it is time consuming, making the interview slower, and may be distracting to the interviewer and respondent (Baumgartner et al., 2002).

This could have led to an incomplete answer to a particular question. In addition, tape recording could have led to a complete account, but some respondents were uncomfortable enough that their answers were inhibited; 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 with the following implications for future research with HRMs and PEDS:

1. Researchers should 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, researchers need to recruit and train teachers with varying degrees of experience, diversifying into middle and high schools.
3. Researchers may replicate the study with a larger population.
4. Researcher may integrate a classroom component with interdisciplinary written lessons in mathematics, science, English, and health to accompany the SC in PE.

HRMs and PEDS combined with SC are key to the new PE philosophy and should be considered critical tools and motivational devices to combat the lack of physical activity in children. In this study, the researcher found that technology, SC, and a combination of the two had a significant effect on steps per minute and beats per minute for students in the HRM (steps per minute and average heart rate) and PED (steps per minute only) groups. Qualitative interview data from the students indicated HRM and PED vocabulary words used in the research and activities were valuable in comprehending and applying an SC. Ultimately, by using the HRMs and PEDs, students felt motivated to be physically active during PE. Through the SC, students were able to comprehend how to use and interpret information from HRMs and PEDs. Also, the PE teacher used the SC as a step-by-step process of how to incorporate these devices into PE successfully.

References

Accusplit. (2014). AH120MAG. Retrieved on November 26, 2014, from http://www.accusplit.com/ProductDetail.aspx?ProductId=2705

Baumgartner, T., Strong, C., & Hensely, L. (2002). *Conducting and reading research in health and human performance*. Boston, MA: McGraw-Hill.

Buck, M. (2002). A*ssessing heart rate in physical education*. Oxen Hill, MD: American Association for Health, Physical Education, Recreation, and Dance Publications.

Carrel, A., Clark, R. R., Peterson, S. E., Nemeth, B. A., Sullivan, J., & Allen, D. B. (2005). Improvement of fitness, body composition, and insulin sensitivity in overweight children in a school-based exercise program. *Pediatric and Adolescent Medicine, 159*, 963–968.

Cawley, J., Fritzvold, D., & Meyerhoefer, C. (2013). The impact of physical education on obesity among elementary school children. *Journal of Health Economics, 32*(4), 743–755.

Centers for Disease Control and Prevention. (2011). Overweight and obesity. Retrieved June 16, 2011, from http://www.cdc.gov/obesity/childhood/data.html

Deci, E., & Ryan, R. (2011). An approach to human motivation and personality. Retrieved July 15, 2011, from http://www.psych.rochester.edu/SDT/

Duncan, M., Birch, S., & Woodfield, L. (2012). Efficacy of an integrated school curriculum pedometer intervention to enhance physical activity and to reduce weight status in children. *European Physical Education Review, 18*, 396–407.

Engstrom, E., Ottosson, E., Wohlfart, B., Grumstrom, N., & Wisen, A. (2012). Comparison of heart rate by Polar RS400 and ECG, validity and repeatability. *Advances in Physiotherapy, 14*, 115–122.

Grissom, T., Ward, P., Martin, B., & Leenders, N. (2005). Physical activity in physical education: Teacher or technology effects. *Family and Community Health, 28*, 125–129.

Ignico, A., & Corson, A. (2006). The effects of heart rate monitor training on children's mile run performance. *Journal of ICHPER-SD, 42*, 5–8.

Ladda, S., Keating, T., Adams, D., & Toscano, L. (2004). Including technology in instructional programs. *Journal of Physical Education, Recreation, and Dance, 75*, 54–56.

Le Masurier, G. (2004). Health related physical fitness and physical activity trends among American youth. *International Journal of Physical Education, 41*, 48–59.

Lubans, D. R., Morgan, P. J., Collins, C. E., Boreham, C., Callister, R. (2009). The relationship between heart rate intensity and pedometer step counts in adolescents. *Journal of Sports Sciences, 27*, 591–597.

National Association for Sport and Physical Education. (2013). Why children need physical education. Retrieved August 2, 2013, from http://www.aahperd.org/naspe/publications/teachingTools/whyPE.cfm

Oliver, M., Schofield, G., & McEvoy, E. (2006). An integrated curriculum approach to increasing habitual physical activity in children: A feasibility study. *Journal of School Health, 76*, 74–79.

Ryan, R., Frederick, C., Lepes, D., Rubio, N., & Sheldon, K. (1997). Intrinsic motivation and exercise adherence. *International Journal of Sport Psychology, 28*, 335–354.

Schofield, L., Mummery, W. K., & Schofield, G. (2005). Effects of a controlled pedometer-intervention trial for low-active adolescent girls. *Medicine and Science in Sports and Exercise, 37*, 1414–1420.

Sequira, M. M., Rickenbach, M., Wietlisbach, V., Tullen, B., & Schutz, Y. (1995). Physical activity assessment using a pedometer and its comparison with a questionnaire in a large population survey. *American Journal of Epidemiology, 142*, 989–999.

Strand, B., & Mathesius, P. (1995). Physical education with a heartbeat: Part II. *Journal of Physical Education, Recreation, and Dance, 66*(9), 64–69.

Tipton, J., & Sander, A. N. (2004). Heart rate monitors promote physical education for children. *Teaching Elementary Physical Education, 15*, 14–16.

Tudor-Locke, C., Williams, J. E., Reis, J. P., & Pluto, D. (2002). Utility of pedometers for assessing physical activity: Convergent validity. *Sports Medicine, 32*, 795–808.