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Graduate Studies

# USING POLAR GOFIT TECHNOLOGY TO INCREASE CHILDREN'S MODERATE TO VIGOROUS PHYSICAL ACTIVITY TIME IN PHYSICAL EDUCATION

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USING POLAR GOFIT TECHNOLOGY TO INCREASE CHILDREN'S MODERATE TO VIGOROUS PHYSICAL ACTIVITY TIME IN PHYSICAL EDUCATION

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ABSTRACT

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Today's children are lacking physical activity (PA). The majority of students do not achieve adequate amounts of PA daily and weekly. Physical education is a major source of PA for many children, therefore teachers have to do their best to help their students achieve as much time in moderate to vigorous physical activity (MVPA) as possible. Technology has become a major part of the world and it is suggested that teachers can use it to help students achieve higher amounts of MVPA in class. However, it is unclear how exactly these technologies influence and encourage students' activity. The purpose of this study was to determine how technology implementation can best help students achieve more MVPA time. Thirty-three children from a school in the mid-west volunteered to be a part of this study. Students wore accelerometers and heart rate monitors in class for 9 basketball lessons. Various conditions were implemented to see how the students reacted to the different technology pieces. It was found that students achieved significantly more MVPA time when they had feedback from the heart rate monitors than when they had not feedback about their performance. Students also achieved significantly higher MVPA when the feedback gave them a goal for the class, however the MVPA time achieved with the goal was not significantly different from having only the feedback without goal. The results showed that students are able to achieve significantly higher amounts of MVPA when they are receiving feedback from technology than when they are only wearing the devices.

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# INTRODUCTION

The Center for Disease Control and Prevention (CDC; 2015) has set forth recommendations for children ages 6 to 17 years old to suggest these children accumulate at least 60 minutes of physical activity (PA) each day, and most of this PA that children receive in a day should be moderate to vigorous physical activity (MVPA). However, studies show that children in the United States are falling short on reaching these recommendations (Biddle, Gorely & Stensel, 2004; Trudeau & Shephard, 2005). For instance, Avery and Brandt (2010) showed that elementary aged students achieved, on average, 19 minutes of MVPA per day through their pedometer-based study. A longitudinal study using accelerometers revealed that the number of children who achieved the daily recommendations for PA declined over time as the children aged from 9-15 years old (Nader, Bradley, Houts, McRitchie, & O'Brien, 2008).

School based PA strategies may be essential as it is the major or sole source of MVPA time for many children (Centeio, et al., 2014; Erwin et al., 2014; Gordon-Larsen, McMurray & Poplin, 2000). Also supporting this notion, a longitudinal study (Tudor-Locke, Ainsworth, Adair, Du & Poplin, 2003) revealed that only 8% of students (6-18 years old) participated in MVPA outside of school and the majority of MVPA was achieved in school. Gordon-Larsen, McMurray, and Poplin (2000) found that PE was the only source of PA for some adolescents (ages 11-21) based on student recall of activities. It was also found that 30% of study participants (16 years old) achieved all of their PA in PE (Westerstahl, Barnekow-Berqkvist, & Jansson; 2005). However, still many students are not achieving adequate amounts of MVPA in PE. Avery and Brandt (2010) found that students were achieving about only 10 minutes of MVPA in PE. Innovative instructional strategies, such as instructional and curricular models, may be necessary to effectively promote students' MVPA in PE classes.

Many researchers have made efforts to increase PA levels in PE using curricular and instructional models, but there were mixed results. Luepker et al. (1996) and McKenzie et al. (1996) showed significant increases in PA using the Coordinated Approach to Child Health PE (CATCH-PE) model. Third grade students' activity levels rose 39% in the intervention schools and 23% in the control schools. However, Donnelly et al. (1996) did not see a major increase in overall PA in their study using CATCH-PE with children in grades 3 through 5. Sallis et al. (1997), McKenzie et al. (1997) and Verstraete et al. (2007) used Sports, Play and Active Recreation for Kids (SPARK) as an instructional model promoting PA and found that the students (ages 9-10 years old) in a SPARK classroom spent up to twice the time in MVPA as those who were in a traditional PE setting, showing SPARK to be very effective at increasing PA in students. Ideas such as Move it Groove it (MIGI) (van Beurden et al., 2003) and Trial of Activity for Adolescent Girls (TAAG) (Webber et al., 2008) were instructional methods that also helped to increase MVPA in PE but not to the same success as SPARK. Due to its positive results in students' PA promotion, the SPARK program was identified and honored by the Centers for Disease Control and Prevention (CDC) and Department of Education as a national model for programs designed to increase PA and combat childhood obesity (Avery and Brandt, 2010). Though instructional and curricular changes can be effective, the research findings have been inconsistent. Other strategies such as technology could help improve the MVPA time students achieve in PE even more when paired with these instructional and curricular models.

Use of PA monitoring devices has been recommended to increase students' MVPA time in PE because it has been seen to positively influence student's motivation and participation. Mears (2010) reviewed the different technologies that are popular in PE such as pedometers, accelerometers and heart rate monitors, and highlighted their positive contributions to PE. For instance, these technologies provide feedback to the students that can be useful to both the student and teacher such as step counts, PA intensity and current heart rates. The President's Council on Physical Fitness and Sport (2002) reported that tangible cues from technology devices improve student's PA participation as motivating reminders. Partridge, King, and Bian (2011) found heart rate monitors to be motivating to students when their grade was dependent on achieving certain levels of heart rates as measured in beats per minute (bpm). According to Nichols, Davis, McCord, Schmidt and Slezak (2009), heart rate monitors help assess whether students have exercised in the appropriate heart rate zones and offer objective measures to increase student motivation and participation. However, it is not clear if simply wearing the device motivates students or if the data feedback is the motivating factor.

The Polar GoFit Program (Polar Electro, Lake Success, NY) has become popular with physical educators as it allows students to view their current heart rate throughout class and track their progress toward a goal time in the target heart rate zone. While many physical educators use the Polar GoFit program, to our knowledge, there is no research evidence showing that students seeing the progress toward the goal time in a target heart rate zone will motivate them to achieve more time in MVPA. Therefore, the purpose of this study is to investigate the effect of wearing a heart rate sensor on MVPA time in elementary aged students. Four specific research questions were investigated for this purpose: (a) the effect of the Polar GoFit program with the heart rate sensor on MVPA time, (b) the effect of the heart rate sensor with the Polar GoFit program set to a target heart rate zone on MVPA time, (c) if effects vary by grade and, (d) if effects vary by gender.

*Assumptions:*

1. Students would be working to their best ability in every class.
2. The H-7 heart rate sensors and GT3X+ accelerometers are reliable and valid to accurately measure heart rates and physical activity of children.
3. The teacher accurately followed all the lesson plans.
4. The basketball unit used is assumed to be well representative of other PE units and the activity transferable to other invasion games.

*Delimitations:*

1. Samples in $3^{rd}$ – $6^{th}$ grades selected from one private elementary school in Midwest
2. One basketball unit due to time of year and facilities available
3. Lessons taught by one teacher

*Limitations:*

1. The scheduling of PE class times
2. Class time is limited to 30 minutes allowed for each PE class
3. Demographics of the chosen population

*Operational definitions:*

1. Heart rate (HR): the number of BPM the heart is beating at, as measured by the Polar H7 monitor
2. Moderate to Vigorous Physical Activity (MVPA): the level of activity desired from children for at least 60 minutes per day; measured here with the ActiGraph GT3X+
3. Time in MVPA: the amount of time students spent in MVPA during the class period as measured with the ActiGraph GT3X+

# METHODS

## Participants

Thirty-three children were conveniently recruited from a private elementary school in Midwest. These 33 students accounted for 54.1% of the students invited to participate for the study. Of the participants 18 were female (54.5%) and 45.5% were male (15 students). Overall the participating students were said to be in very good (55%) to excellent (40%) health as reported by their parents and participated in 4-5 hours (33%) and more than 6 hours (45%) of physical activity weekly outside of school. Grade by grade demographics can be found on Table 1. There is only one class per grade level and therefore all students in grades 3 through 6 were invited to participate in this study. Only 3rd through 6th grade students were invited because lower grade students may not appropriately understand the concept of heart rates intensities when displayed for them on the screen. Third grade students had PE twice per week and 4th grade students had PE 3 times per week. The 5th and 6th grade schedule varied weekly; a small group of students participated three times per week while the rest of the students participate 1 or 2 days per week depending on the band schedule. Fifth and 6th grade students were in PE together; either all of 5th or all of 6th grade were in the gym along with a couple students from the other grade that do not partake in band.

Table 1. Student Demographics by Grade

| Grade | Total* | Males* | Females* | Health | PA |
| --- | --- | --- | --- | --- | --- |
| 3rd | 12 | 5 | 7 | VG – E | 4-5 |
| 4th | 7 | 3 | 4 | VG – E | 4-5 |
| 5th | 6 | 3 | 3 | VG – E | 2-3 |
| 6th | 8 | 4 | 4 | VG – E | 6+ |

*Note. *=Number of students, VG-E=very good to excellent, PA=physical activity hours weekly outside of school*

Twelve participants (36%) had at least one missing value in their MVPA data (9 days total for each participant) due to absences. According to a recommendation of Fielding, Fayers and Ramsay (2009), Little's test was conducted to diagnose the missing data pattern, and it was found that the data were missing completely at random (MCAR; $\chi^2(69) = 69.254$, $p$=.469). Group mean substitution was used to replace daily missing percentage of time in MVPA. This study was reviewed and approved by the university Institutional Review Board for protection of human subjects. Prior to data collection, the participants and their parents/guardians provided written informed assent and consent after being informed of the protocol of the study. In addition, permission was obtained from the school principal.

**Instruments**

The Polar H7 heart rate sensor (Polar Electro, Lake Success, NY) with a chest strap was used to track student heart rates throughout the lessons. These allowed the researcher to track participants' heart rates as well as acted as the motivating tool as students partook in the study. Cheatham, Kolber, and Ernst (2015) used the Polar H7 belts with blue tooth in their study and found it to be a reliable measurement of HR in adults. There is no research that validated the Polar H7 in children but, a similar heart rate sensor, the Polar S810 has been validated with an electrocardiogram to accurately measure HR for children (Gamelin et al., 2008). The Polar GoFit software (Polar Electro, Lake Success, NY) was used to track and display students' heart rates on the screen throughout the lesson. The heart rate sensors transmitted the students' heart rates to a software program on a tablet. The information was then projected onto a screen so students recei the instant feedback throughout the lesson.

In addition, Actigraph GT3X+ accelerometers (Actigraph, Pensacola, FL) were used to objectively track the time in MVPA during class time. Using piezoelectric crystals, accelerometers record the frequency and magnitude of the body's acceleration during movement. As acceleration occurs, the acceleration signal from the accelerometer is digitized and generates an "activity count". The activity counts are then summed over a predetermined time interval or epoch (e.g., 1 second, 15 seconds, or 30 seconds). The ActiGraph GT3X+ accelerometers have been widely used for assessing PA and many studies have shown the GTX3+ is a valid and reliable tool to assess MVPA in children (Robusto & Trost, 2012). When parents/guardians were asked to provide written consent, a one-page questionnaire was included to gather demographic information including height and weight to properly set up the H7 and GT3X+ devices and to accurately estimate time in MVPA during data analysis.

## Procedures

SPARK curriculum was taught by a certified PE teacher for 30 minutes each class, so that all participants were under the same lesson content and the same teacher. A basketball unit, including suggested lesson plans from the SPARK curriculum was be used throughout the study for each grade level to keep a uniform environment in all classes. Each lesson proceeded with an instant activity warm up followed by the main activity time. SPARK was chosen as it is a research based curricular model that has become widely used and respected especially for young children in PE. Several studies show that SPARK significantly increases MVPA time for children and adolescents (Locke & Lambdin, 2003; Sallis et al., 1997).

Prior to each class, the H7 and GT3X+ devices were programed and initialized to randomly assign devices to each participant to avoid potential systematic errors in the devices. Based on the random assignment, an H7 and a GT3X+ were distributed to each participant at the beginning of class and was returned at the end of each class.

Upon completion of all informed consent/assent forms, data was collected in nine PE lessons per grade. Two trial lessons habituated the participants to the proceedings of the class structure. During these two trial sessions, the teacher briefly provided an orientation about the instruments in this study. What the study was looking for was not divulged and students were asked to follow their regular participation routine in PE to minimize reactivity that could jeopardize the study results. During these lessons the teacher explained the devices and how they work, what MVPA is, how the GoFit technology would display the time in MVPA, as well as how the lessons would be structured. Participants had opportunities to wear the H7 sensor and GT3X+ accelerometer and to ask questions prior to data collection. SPARK lessons were also introduced to help students can get accustomed to the lesson features such as instant activity and skill models.

Students' MVPA time was consecutively observed for 9 days. For the first 3 days, students wore the H-7 sensor with GT3X+ to see student activity time while wearing a heart rate monitor without having any visual feedback. Students' heart rates were automatically saved to the Polar GoFit program on an iPad for later analysis. Students wore the devices during the next 3 lessons, but their heart rates were projected on a screen using Polar GoFit, allowing students to see their current heart rate while they participated in class activities. This allowed researchers to see the effect of the Polar GoFit program and its visual feedback on students' MVPA time. During the last three lessons, the Polar GoFit was set to a goal in the "Performance" zone that is 70% to 100% of maximum heart rate. While they wore the two devices Polar GoFit was projected on a screen to see the effect of the Polar GoFit program along with a specific goal on students' MVPA levels. As students proceeded through the lessons, this goal encouraged students to stay in the MVPA zone and let students check if they were in the target zone. The display on the screen had a square for each student that it showed their accumulated time in the target zone and changed color based on their current heart rate to show what zone they were in. A green check appeared if they were in the proper zone and a red arrow would appear if they were to low indicating they should work harder. Also, a badge would appear on the bottom of their square for every 10 minutes they achieved in the zone. This badging system gave students something to aim for and the time ticked by in their square. These three classes were set to a goal time of 10 minutes because after students arrived, got their devices on and the class began the lessons typically ran for 20-24 minutes.

## Analysis

Considering children's sporadic PA patterns, a 15-second epoch length (i.e., sampling interval) was used when downloading PA data from the accelerometers. Due to the different lesson lengths, percentage of time spent in MVPA was estimated using cut points of Freedson (2005). After missing data replacement, the average percentage of time spent in MVPA from three lesson segments of each condition (heart rate sensors only, heart rate sensors with visual feedback on Polar GoFit and heart rate sensors with visual feedback on Polar GoFit setting a target heart rate zone) was calculated for the data analyses.  Throughout the data collection period, the researcher visually inspected data for anomalies and possible issues. A repeated measures ANOVA was used to examine the effects of the heart rate sensors with the Polar GoFit program with and without setting a target heart rate zone on percentages of time spent in MVPA. Separate two-factor mixed ANOVAs were used to examine if the effects on percentages of time spent in MVPA vary by grade and gender. All necessary assumptions for the ANOVAs were checked before conducing the analyses. Alpha level was set at .05 for all analyses.

## RESULTS

Average percentages of time spent in MVPA were 34.99% in condition 1 where students only wore heart rate sensors, 46.76% in condition 2 where students wore heart rate sensors with visual feedback on a screen through Polar GoFit and 44.50% in condition 3 where students wore heart rate sensors with visual feedback on a screen through Polar GoFit setting a target heart rate zone. Descriptive statistics and correlations are presented in Table 2.

Table 2. Descriptive Statistics and Correlations for Conditions 1, 2, & 3.

| Conditions | M | SD | Skewness | Kurtosis | Condition 1 | Condition 2 |
|---|---|---|---|---|---|---|
| 1 | 34.99 | 8.34 | .32 | 1.99 | | |
| 2 | 46.76 | 10.24 | -.09 | 2.25 | .56** | |
| 3 | 44.50 | 10.57 | .46 | 2.52 | .37* | .59** |

*Note.*p<.05; ** p<.001*

A one-way ANOVA showed that there is a significant difference in the percentage of time spent in MVPA between wearing heart rate sensors alone and wearing the sensors with the Polar GoFit program, Wilk's Lambda = .352, F (2, 31) = 28.60, $p < .001$. Tukey's post-hoc test was used to examine pair-wise differences in three conditions and revealed that there was a significant difference between conditions 1 and 2, as well as between conditions 1 and 3. However, no significant difference was found between conditions 2 and 3. These findings indicate that wearing heart rate sensors is effective to increase students' MVPA levels when their real-time heart rates are displayed on a screen, but displaying accumulated time toward a goal is not effective to further increase students' MVPA levels.

Two separate two-factor mixed ANOVAs were conducted to examine if the effects of wearing heart rate sensors with the Polar GoFit program on the percentage of time spent in MPVA are dependent upon gender and grade of students where the condition (i.e., time) was a within factor, and gender and grade were a between factor separately. It was shown that students' MVPA time was significantly different by conditions, Wilk's Lambda = .335, F (2, 30) = 29.82, $p < .001$ and gender, F (1, 31) = 31.30, $p < .001$. However, there was no significant condition×gender interaction effect. Figure 1 shows the change seen by genders over the 3 conditions. Though the boys have significantly higher scores the pattern in the changes are not significantly different.

In the second mixed ANOVA analysis, there was a significant effect of condition on MVPA, Wilk's Lambda = .274, F (2, 28) = 37.06, $p < .001$, whereas there was no significant main effect of grade on MPVA. Condition×grade interaction effect was significant, Wilk's Lambda = .629, F (6, 56) = 2.43, $p < .05$. Figure 2 presents the data collected over the 3 conditions represented by each grade level.

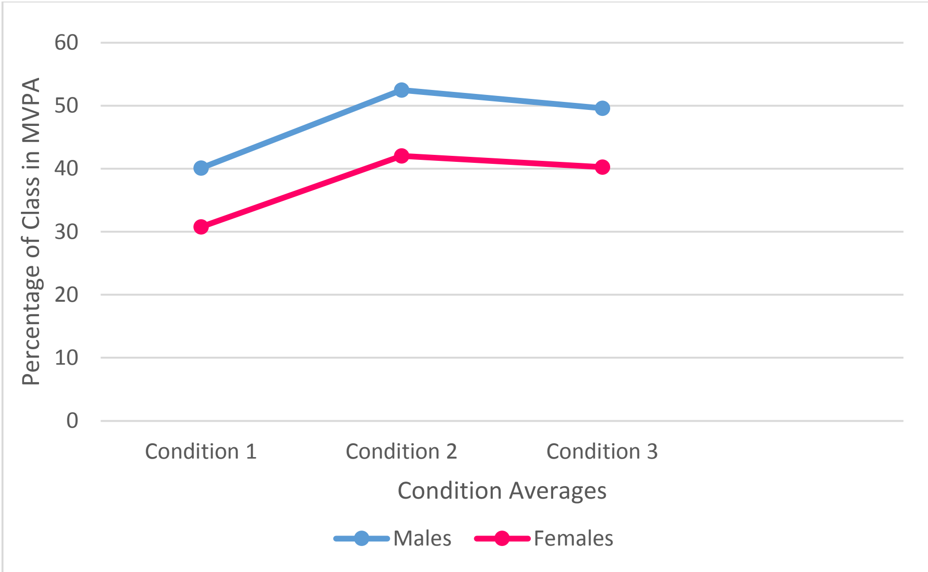


Figure 1. Conditional changes by gender

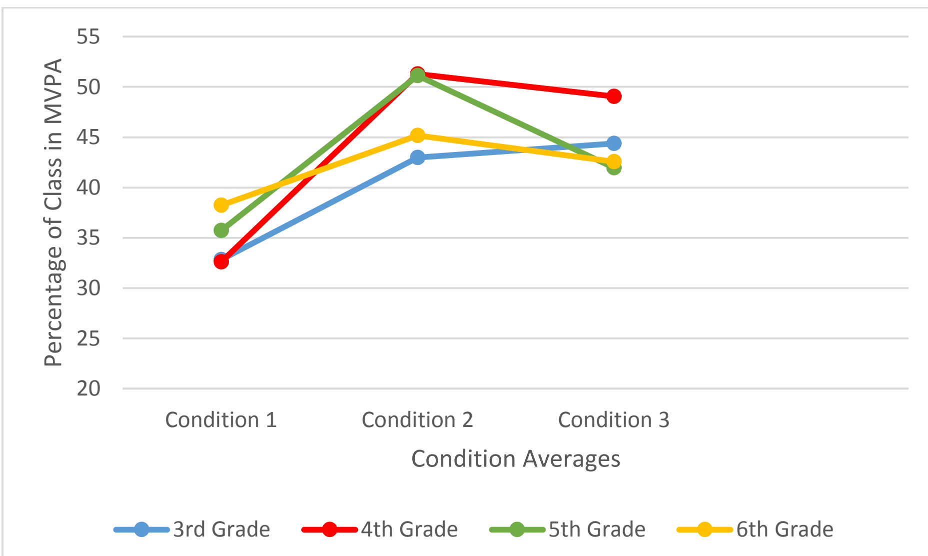


Figure 2. Conditional changes by grade

# DISCUSSION

The purpose of this study was to examine how a Polar heart rate sensor with and without the Polar GoFit real-time heart rate tracking program would affect students' time spent in MVPA. Three conditions were designed to examine the effect of this technology on MVPA time: (a) using the heart rate sensors only, (b) using the heart rate sensors with real-time feedback displayed on a screen where students were able to see their current heart rates and (c) using the heart rate sensors with the real-time display and a goal to achieve. This study also investigated how different grade levels and genders influenced students' MPVA time in different conditions.

The results indicated that students achieved significantly more time in MVPA when they had a visual feedback from the Polar GoFit program (condition 2) compared to only wearing a heart rate sensor (condition 1). Previous studies showed that activity monitors, such as heart rate sensors/monitors provide students with a tangible cue to motivate and remind them to participate in physical activity (Nichols, Davis, McCord, Schmidt & Slezak, 2009; President's Council on Physical Fitness and Sport, 2002), this study found children also became more physically active when immediate visual feedback is given with the wearable device. Although there are numerous activity monitors that provide real-time activity data through their own display window (e.g., clip-on pedometers, wrist-band accelerometers, sport-watch heart rate monitors), using a heart rate sensor with a display program is unique particularly in physical education settings because a teacher can control and adjust frequency and duration of providing the visual feedback. The activity trackers with internal display function often distract students because the devices frequently make students check their activity data during instruction and activity time in physical education lessons. Thus, it is recommended for physical educators to use a wearable activity monitor with a separate feedback program to promote MVPA, and help students stay on-task in physical education classes. When students could see their activity levels their activity increased. This finding reflects Hollander's (2012) findings, that activity trackers made people aware of their activity and thus increased motivation. The students were self-motivated to perform better as they watched their heart rate fluctuate throughout the class. This self-improvement and self-desired achievement students showed reflects what Partridge, King, and Bian (2011) who found that students were more motivated when their grade was not depended on the outcome of their activity levels but were intrinsically motivated.

It was expected that students would have more MVPA time when a goal was set (condition 3) than with other two conditions. Hollander (2012) found that awareness from technology stimulated people's desire to reach an end goal, but surprisingly students didn't achieve more MVPA time with a goal than when just provided visual feedback without a goal. Students were encouraged to achieve 50% of class time in MVPA and a badge was given on the display for those who achieved the goal. A potential reason for this finding would be the class environment. Due to short class periods, lack of passing time and lateness of class start, classes averaged a time just over 20 minutes from start to end. Thus, the goal for the class was set to 10 minutes to be as close to this 50% mark as possible; MVPA goals are only able to be set a goal time in 10 minute intervals. Most students (72.73%) were able to achieve at least 10 minutes for every class with the goal set. But, even with the goal achievement students did not average as much time in MVPA over the last 3 classes, as they did in the 3 classes with their heart rate shown. Another reason might be that the novelty of the technology could have simply worn off. The goal was set for classes seven, eight and nine. Students had been using the heart rate monitors for 6 classes before the goal was set, and perhaps they were simply not as excited about wearing the devices. In addition, students may have stopped working as hard once they met the 10 minute goal. Students were encouraged to accumulate as many minutes as possible in the goal range, but perhaps after achieving the goal they might feel satisfied and not desire to achieve more time as Hollander (2012) found.

The study also examined how gender and grade levels reacted differently to the technology conditions. There was not a significant difference in how genders reacted to the different conditions. The lack of difference between genders could be due to lack of gender differentiation at this age. Children at this age often have not entered their years of puberty and thus the lack of differentiation may allude to the similarities in activity. There was a significant difference found between grade levels activity levels. This can be attributed to the time spent in the data collection phase. The varied time to completion could have helped certain grades to be more or less motivated.

## Suggestions for Future Research

To the authors' knowledge, this study was the first study to compare objectively measured physical activity levels on three conditions with the different technologies abovementioned. Using an accelerometer to objectively measure MVPA, controlling lesson content (i.e., basketball) and teacher factors (i.e., the same teacher) that might confound study findings were strength of this study. At the same time, there were some limitations of this study that future researchers may consider for their research design.

First, class schedules were different by grade level. Third graders took 5 weeks to get through 9 lessons, 4th grade finished in 4 weeks, 5th grade took 7 weeks and 6th grade spent 5 weeks on the 9 lessons. With inconsistent time in the basketball unit due to the unpredictability of the schedule at the school, students might have different responses from boredom and lack of enthusiasm. A more consistent and equal class schedules may produce different results.

Second, class time was a major limitation. Researchers thought that a 20 minute goal in a class that would run just over 20 minutes was too lofty of a goal and could potentially discourage students. However, in a class that is 30 or 35 minutes in true length 20 minutes, though more that 50% of class, may be very realistic and achievable. Researchers discussed the potential for more MVPA time in condition 3 had there been the option of setting the goal to 15 minutes. With the Polar GoFit system goal time are set in 10 minute increments and a badge is awarded for every 10 minutes in goal time. Had the increments been 5 minutes each, there would be more opportunity for badge rewards and more options for those teachers who have shorter class times. Longer class times may allow for different results with a goal that is both challenging and realistic to motivate students.

Finally, there was a demographic limitation because this study was done in one small private school in the Midwest. Other demographic areas may again produce different responses from students. Students from different backgrounds, economic status, and location (rural, suburban, large cities) may have different levels of motivation.

Considering all limitations abovementioned, future researchers should seek to gain a better understanding of technology influences in different ages. Students in high school and middle school may show different responses to the conditions. Also, gaining a better understanding of goal setting with students can be beneficial as well; a more challenging goal can help to comprehend if they are motivated with the goal at this age. Related to the goal stage of research, it would valuable to look into how long the students stay motivated with the devices. Researchers designed this study for 9 days, and after 6 classes, 3 without feedback and 3 days of feedback their activity levels dropped off. It is unclear if this is from boredom or a goal that was not challenging enough.

Getting a base line measure for students' MVPA without the heart rate monitor would be beneficial to future research as well. This would help to see if wearing the device alone made any difference in their activity from their usual practices or if without feedback the devices have no influence. There are several ideas that can expand on this research to better understand the influence technology has on students MVPA time in PE.

# CONCLUSION

Many children do not reach current physical activity goals (60 minutes every day), and PE alone is not adequate for achieving these goals. However, PE is considered to be critical because almost all children go to school and spend a large amount of time at school. Technology can be a major play when it comes to easily increasing student time in MVPA during PE. In this study we found that students achieved significantly their amounts of MVPA when they had technology providing them feedback. Students were self-motivated to be more active when they were able to see their activity levels throughout the lesson. Whether they had a goal set or simply were viewing their current heart rates students were significantly more active with feedback. Physical education is a major source of PA for many students so it is important to help them achieve as much MVPA time as possible when in class.

Therefore, teachers have to be active users of technology and use it to help improve their students' experience. Incorporating technology that provides students with feedback about their current activity levels, such as heart rate monitors, can help to increase student time in MVPA without the teacher having to make major adjustments to their curriculum. Students are able to keep track of their activity levels for themselves, which increases the students' internal motivation and in turn increases their overall PA. This self-motivation will help children build better physical activity habits that lead to a healthier life.

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# APPENDIX A

# INSTITUTIONAL REVIEW BOARD APPROVAL LETTER

UNIVERSITY of WISCONSIN
LA CROSSE

To: Brandi Pettit

From: Bart Van Voorhis, Coordinator
Institutional Review Board (IRB) for the
Protection of Human Subjects
bvanvoorhis@uwlax.edu
5-6892

Date: November 24, 2015

Re: **RESEARCH PROTOCOL SUBMITTED TO IRB**

The IRB Committee has reviewed your proposed research project: ***"Using the Polar GoFit Technology to Increase Student Time in MVPA during Physical Education Class"***

Because your research protocol will place human subjects at minimal risk, it **has been approved under the expedited review category in accordance with 45CFR46, 46.110(a)(b).**

Since you are not seeking federal funding for this research, the review process is complete and you may proceed with your project. Remember to provide participants a copy of the consent form and to keep a copy for your records. Consent documentation and IRB records should be retained for at least 3 years after completion of the project.

Please note that this approval is for a one year period only, from the date of this letter. **If the project continues for more than 12 months, an IRB renewal must be requested using Attachment C on the IRB website. Please submit Attachment C one month prior to the date on this letter. Continued data collection beyond this date will place your project in non-compliance. The IRB is required to report instances of noncompliance to the Federal Office of Human Research Protections.**

Good luck with your project!

Bart A. Van Voorhis

cc: IRB File
Jooyeon Jin, Faculty Advisor

# APPENDIX B

# STUDENT ASSENT AND PARENTAL CONSENT FORMS

**Informed Assent**

Project Title: USING POLAR GOFIT TECHNOLOGY TO INCREASE CHILDREN'S MVPA TIME IN PHYSICAL EDUCATION

Principal Investigator: Brandi Pettit

Student Advisor and Emergency Contact: Jooyeon Jin, Ph.D

We are asking you whether you want to be in a research study. Research is a way to test new ideas and learn new things. You do not have to be in the study if you do not want to. You can say Yes or No. Even if you say yes now, you can change your mind later.

Ask questions if there is something that you do not understand. After all of your questions have been answered, you can decide if you want to be in this study or not.

This study is about your physical activity. We are looking at how much physical activity time you are able to achieve in PE while wearing heart rate monitors and accelerometers.

If you take part in this study, we will ask you to wear a belt that has a small box on it (activity monitor) and a chest strap with a box on it (heart rate monitor) while in PE classes. These devices will tell us how much activity time you achieved in class and how high your heart rate rose.

If you don't want to wear the belt or chest strap you can stop anytime. We won't be mad if you decide not to continue participating.

We will write a report when the study is over, but we will not use your name in the report.

If you want to be in this study, sign your name on the line below.

Participant's Name (printed): ______________________________________________

_____________________________________ _________________________

(Signature of Participant) (Date)

_____________________________________ _________________________

(Signature of Person Obtaining Assent) (Date)

**Informed Consent Form for Parents/Guardians**

**Project Title:** USING POLAR GOFIT TECHNOLOGY TO INCREASE CHILDREN'S MVPA TIME IN PHYSICAL EDUCATION
**Principal Investigator:** Brandi Pettit
**Student Advisor and Emergency Contact:** Jooyeon Jin Ph. D.

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**1. WHAT IS THE PURPOSE OF THIS FORM?**
This form contains information that will help you decide whether to be in this study or not. Please read the form carefully and ask the researcher questions about anything that is not clear.

**2. WHY IS THIS STUDY BEING DONE?**
This study is being done to examine the effects of technology on student physical activity time in the physical education setting.

**3. WHY IS YOUR CHILD BEING ASKED TO BE PART OF THIS STUDY?**
Your child is being asked to participate because he/she is in 3rd-6th grade at Crucifixion Elementary school.

**4. HOW MANY CHILDREN ARE PARTICIPATING IN THE STUDY AND HOW LONG WIL LIT LAST?**
The study will involve students in 3rd-6th grade at Crucifixion school. We hope to have at least 30-40 students participate. The study will last about 2 months and consist of 8 lessons in their P.E. curriculum, each lasting about 30 minutes. The classes will happen as part of the scheduled curriculum in the school day.

**5. WHAT HAPPENS IF I AGREE TO LET ME CHILD PARTICIPATE?**
If you agree to take part in the study your child's activity levels will be monitored in 8 lessons with the Polar H7 heart rate monitor as well as the ActiGraph GT3X+ accelerometer. 10 lessons are part of the study, 2 to habituate the students to the classroom procedures of the lessons, 2 in which students wear only the GT3X+, 2 in which they will wear a Polar H7 heart rate monitor without any visual feedback and 2 wearing the devices with immediate visual feedback showing them their current heart rate displayed on a screen.
Students will take part in a planned P.E. class in the SPARK Curriculum. The students will not be doing any activities they would not normally do in P.E. They will wear the heart rate monitors and accelerometers throughout 8 lessons and the data on their activity levels will be recorded for later review and analysis.

**6. WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS OF THE STUDY?**
The risks are that of regular exercise and physical education classes. The students will be active in the P.E. class and may experience fatigue but this is to be expected from P.E. classes. There is very low risk to participation in the study, as students will all be doing the same lessons as part of the study as those who choose not to be part of the study.

**7. WHAT ARE THE BENEFITS OF THE STYDY?**
There is the possibility that students will achieve higher levels of activity through these lessons. The heart rate monitor use may result in higher activity and thus higher fitness levels in participants. Additionally your participation may help researchers gain an understanding that can help more students attain more MVPA down the road.

**8. DO YOU HAVE TO PARTICIPATE?**
Your participation is voluntary. You can drop out at any time without penalty. Participation or choosing not to participate will not affect grades in P.E.

**9. IS THERE A COST TO PARTICIPATING?**
There are no costs as a participant in the study.

**10. WHAT ARE OUR RIGHTS TO CONFIDENTIALITY?**
The participant's names and data are confidential. At no point will one's data be given out with their name to anyone. If this study is publically published your name will not be included and the data will not be identifiable to any individuals. The only people able to see names of participants are those conducting the research.

**11. WHAT ARE THE OTHER OPTIONS IF I OR MY CHILD CHOOSE NOT TO PARTICIPATE?**
Those children who are not participants in the investigation will take PE classes as usual at Crucifixion. They will be a part of the classes as normal, they will just not wear any of the activity monitoring devices throughout the unit.

**12. WHO DO I OR MY CHILD CONTACT WITH QUESTIONS OR CONCERNS ABOUT THE STUDY?**
If you an/or your child have question regarding the study, please direct questions to Brandi Pettit by phone at (716) 912-6618 or by email at pettit.brandi@uwlax.edu or her advisor Jooyeon Jin Ph.D. (608) 785-8182 or by email at jjin@uwlax.edu. If you and/or your child have questions about your rights or protection of human subjects, please contact the UW-La Crosse Institutional Review Board (IRB) Office, at 608-785-8124 or by email at IRB@uwlax.edu.

**11. WHAT DOES MY SIGNATURE ON THIS CONSENT FORM MEAN?**
Your signature indicates that this study has been explained to you, that your questions have been answered, and that you agree to take part in this study.

Your Child's Name (printed): ________________________________________________

________________________________________ ____________________
(Parent/Guardian/ Legally Authorized Representative) (Date)

________________________________________ ____________________
(Signature of Person Obtaining Consent) (Date)

# APPENDIX C

# CHILD HEALTH QUESTIONNAIRE

**Questionnaire**

Despite having countless health benefits, many children do not achieve the recommended amount of daily moderate to vigorous physical activity (at least 60 minutes per day). We hope to find a way in increase children's time in MVPA while in PE through use of technology (accelerometers and heart rate monitors).

Please fully read each question below and fill out the information asked. This information will be used in the study to both set up the devices to match your child and to help sort out data for analytic purposes.

1. How old is your child?

________ Years

2. What is your child current height?

________Feet ___________ Inches

3. Which gender is your child?

☐ Male

☐ Female

4. What is your child's current weight?

________ Pounds

5. How much does your child partake in physical activity per week after school (including weekend)?

☐ 0-1 hours ☐ 2-3 hours ☐ 4-5ours ☐ 6+ hours

6. How would you describe your child's general health?

☐ Poor ☐ Fair ☐ Good ☐ Very Good ☐ Excellent

Participant's ID ___________ (researcher use)

# APPENDIX D

# REVIEW OF RELATED LITERATURE

## Review of Related Literature

### Introduction

Physical educators work hard to get students engaged in physical activity (PA), including fitness activity as an effort to help students develop and maintain healthy lifestyles. Although the role of school physical education (PE) is pivotal to achieve the national PA recommendation that children and adolescents should have 60 minutes of moderate to vigorous physical activity (MVPA) everyday (CDC, 2008), many schools do not have daily PE and certainly not for 60 minutes. Thus, the role of physical educators becomes more critical to provide quality PE lessons. Physical educators have made efforts in various ways, such as changing curriculum, implement new teaching strategies and integrating technology, to increase the amount of students' PA during PE classes.

Particularly, technology is becoming a big part of the world and is making its way into the PE field as well. For instance, the Polar GoFit program is state of the art heart rate monitoring technology. This program tracks and displays the user's heart rate in different zones (e.g., healthy heart and performance zones) and progress toward the goal time in MVPA on a screen when connected to a projector. If students have an understanding of how the display works, it has the potential to help increase their time spent in MVPA in the PE class. To better understand potential technologies to promote student PA, different topics are addressed in this literature review as follows: (a) activity time in PE, (b) PA levels using subjective and objective measures, (c) ways to promote PA in PE and (d) using technologies in PE promotion.

### Activity time in PE

A large part of the populations in North America and Europe are not meeting the PA recommendations (Biddle, Gorely & Stensel. 2004). What's worse is that the amount of PA children achieve decreases with age (Nader, Bradley, Houts, McRitchie & O'Brien, 2008). Slingerland and Borghouts (2011) reviewed several studies that attempted to increase PA in PE over the years. They found that studies have been able to find direct results of changes in PA in school exist through use of various programs, however, evidence of out of school PA lacks. The United States Department of Health and Human Services initiative *Healthy People 2010* called for a minimum of 50% of PE class time be spent in MVPA. But this is not the reality for most school PE programs.

Tracking student time spent in MVPA has allowed PE professionals to better understand how they can accurate measure student PA and how well they are helping their students reach the recommendations. Some studies have suggested that the only time in MVPA students receive in a week come while they are in their PE classes (Tudor-Locke, Ainsworth, Adair, Du & Poplin, 2003; Trudeau & Shephard, 2005). Trudeau and Shephard (2005) also revealed that most students were not getting adequate time in MVPA outside of school. This study reviewed several studies that utilized questionnaires to understand PA levels of students, including Chinese, Canadian, the U.S. and Swedish.

### PA levels using subjective measures

Tudor-Locke et al. (2003) evaluated the activity levels of students via the China Health and Nutrition Survey from 1989, 1991, 1993 and 1997. This self-report longitudinal survey showed that only 8% of students participated in MVPA outside of school. The majority of MVPA for students came from commuting to and from school and activity in school. Irving et al. (2003) conducted a similar study in Canada using the 1997, 1999, and 2001 Ontario Student Drug Use Survey for students enrolled in grades 7, 9, 11 and 13 in Ontario public schools. The study showed that only two thirds of the students in Ontario reached the PA recommendation. In both studies students were falling significantly below recommendations for healthy living.

Gordon-Larsen, McMurray, and Poplin (2000) used the National Longitudinal Study of Adolescent Health for adolescents in grades 7 through 12 in the United States. The study found correlation between the amount of participation in PA students reported and the amount of PE they received indicating that PE was only source of PA for some adolescents.

Sweden also issued a survey to its student to determine the difference in the amount of PA students in different school received (Westerstahl, Barnekow-Berqkvist, and Jansson, 2005). The survey consisted of questions about the amount of PA students achieved daily, based on duration of activity and energy expenditure. This survey concluded that 30% of 16-year-old Swedish students get all of their PA from their PE classes. Each of these studies showed that students were not accumulating adequate amounts of MVPA as recommended by the governing bodies. The studies also show that PE plays a large part in the accumulation of student time in MVPA.

The aforementioned studies done in China, Canada, the United States and Sweden all utilized surveys to collect data on student PA. However, the surveys cannot be considered completely reliable as subjective methods are reliant on the participants' memory and thus they can easily underestimate or overestimate their PA levels. Studies utilizing more objective methods of data collection offer a more reliable record of student

PA (Nadler et al., 2008; Avery and Brandt, 2010).

## Objective Measures

To objectively measure students' time in MVPA technologies have become a major part of physical educators' equipment rooms. Mears (2013) evaluates the different technology options available and useful in the PE field as they provide individualized data on each student throughout the class period.  Each type of technology offers different benefits and drawbacks for professionals looking to implement them into their classroom. Mears used three key factors to highlight the highs and lows of each device: (a) accuracy of measurement, (b) the type measurement desired, and (c) the ease of implementation.

Mears (2013) first addressed pedometers, which are certainly the cheapest option when looking to implement technology into a whole class. Depending on the quality and accuracy of the pedometers the devices cost about $400 for a class set. Pedometers are easy to implement and students just clip them on to their shorts in the beginning of class and away they go. Some devices allow users to set the stride length which can easily be measured and set to the device as well. The drawback to pedometers is that they cannot measure PA intensity over PA amount (steps taken by students).

Costing around $750 for the class set, Mears (2013) next addresses accelerometers. These are a more expensive option than pedometers but off more valuable activity measures. Accelerometers can be used to measure not only steps and distance but also step frequency and thus can determine minutes in MVPA. Accelerometers uses peizoelectric crystal to better react individuals' movement and considered a more advanced form of a pedometer. They work in a similar fashion to pedometers and are attached to the persons in the hip region. They are another easily implemented device in a classroom setting because of the smaller size than pedometers, and give more information than the traditional pedometers.

Finally, Mears (2013) described heart rate monitors, which are the most expensive option to implement into a classroom setting. These devices cost $40-$100 per unit depending on the sophistication of the monitor. Strapless are the fastest to implement but do not offer all the features of chest strap models. Chest strap models can record continuous data throughout the class period for the teacher to reflect on, while the strapless models only give in-the-moment reading and do not hold on to data for later use. The chest strap modes such as those from the Polar USA (New York, USA) company offer online software that allows for the downloading of data for analysis and later use. Implementation of technology to monitor and track student activity levels is a valuable tool in PE and the objective measures are more reliable than subjective measures.

Avery and Brandt (2010) discussed the use of pedometers to measure PA in the Lincoln Nebraska public schools. The district was given money through the Carol M. White Physical Education Program (PEP) grant. As part of the PEP grant the district monitored their students' time in MVPA. To do this they measured step counts via pedometers. Seventeen district schools monitored the MVPA steps of their fourth graders for a week straight at home and in school. The results showed that the students were well below MVPA goals at home and at school. Overall the students only acquired an average of 19 minutes of MVPA per day and 10 minutes at school.

Nadler et al. (2008) also employed accelerometers to determine the amount of MVPA children were receiving in a longitudinal study. Starting in the year 2000 when the children were 9 years old until they turned 15 accelerometers were used to track the daily PA. During activities when wearing an accelerometer was not possible such as swimming and contact sports, activity logs were used to account for this data. There was an evident change on activity levels as the children aged. At age 9 almost all children (99.6%) were achieving on average 60+ minutes of MVPA per weekday and 97.6% of the children were over 60 minutes per day on the weekends. However, by age 15 only 30.6% of children were reaching 60 minutes of MVPA on weekdays and 16.6% on weekends.

Each of these studies, either subjectively or objectively measured, has shown that students are not achieving enough time in MVPA. Students are lacking in the amount of MVPA they achieve both in and out of school. As student age the amount of MVPA they attain decreases. This is not a national problem, but a global problem. Studies in China, Canada, Sweden and the US have shown a lack of MVPA in school aged children. So what can be done to improve students' motivation and participation in PE?

**Improving student activity time**

Slingerland and Borghouts (2011) reviewed several studies that attempted to increase PA levels in PE. There were several studies that have been done to implement new techniques, curriculum and/or teaching models in order to increase PA in the students. Many of the studies aimed to not only increase student PA time, but also to improve overall health through nutrition interventions and out of school activity as well.

Three studies were published in 1996 that followed very similar protocol in their aim to increase the health of children through nutritional and physical education interventions. The first of these studies was done by Donnelly et al. in 1996 as they sought to reduce obesity while promoting fitness through a nutrition and PA program.

The study was done over a 2-year period in Nebraska schools with children in grades 3 through 5. The study is similar to the ones conducted by Luepker et al. (1996) and McKenzie et al. in 1996 with the CATCH program. Each study implemented nutritional standards in the school cafeterias on top of changing the methodologies in the PE settings to increase student health.

Donnelly et al. (1996) implemented Physical Best which is designed to increase energy expenditure and decrease time-off-task through aerobic activities easy to incorporate in individual lifestyle, aimed at large muscle groups, 30–40 min., 3 times per week. The lessons and design were not specified but the students time on task was evaluated with the System for Observing Fitness and Instruction Time (SOFIT) to determine the student time-on-task (Donnelly et al. 1996). The Luepker et al. (1996) and McKenzie et al. (1996) studies used CATCH-PE which is designed to promote student participation and enjoyment of MVPA during PE, as well as students' participation in PA outside of school (Slingerland and Borghouts, 2011). Each study included both nutritional intervention in the cafeteria as well as PE interventions however the results were not as similar as the programs.

Each used the SOFIT to evaluate student time in MVPA throughout the lessons. Donnelly et al. (1996) studied 200 children over the course of 2 years. The result was shown to be statistically significant but there is a lack of baseline data to show this change. There was a modest increase in PA in the intervention school but that was offset by decreased activity out of school. Thus this intervention did not show much successful data in the realm of PA. However, Leupker et al. (1996) and McKenzie et al. (1996) showed significant increases in PA using the CATCH-PE model. These studies each took place over 2.5 years and looked at 5,106 students. The results showed that over the 2.5 years students' activity levels rose 39% in the intervention schools and 23% in the control schools. Leupker et al. (1996) noted that total activity minutes were not significantly different between control and intervention, but the minutes in vigorous activity (students reported breathing hard) was significantly higher in intervention schools. Perhaps the more structured lessons over a broader range of students created the increase in MVPA for students in the Leupker et al. and McKenzie et al. studies over the Donnelly et al. study.

Following these studies Sallis et al. (1997) used Sport, Play and Active Recreation for Kids (SPARK) in his intervention study. The SPARK curriculum is developed for specific ages and is designed to promote high levels of PA, teach movement skills and be enjoyable. Recommended frequency was 3 times a week 30 minutes (15 minutes health activity, 15 minutes skill-fitness activity) (Slingerland and Borghouts, 2011). This study implemented an intervention for 2 years in 955 students between the ages of 9 and 10 years old and used SOFIT to evaluate in class activity time like the previous studies. The results showed that the control groups had significantly less active time in PE than the intervention group. However, there was no baseline data to show activity levels before intervention. Specialist-led classes resulted in twice as much MVPA time and twice as many calories expended during PE each week as control students. The intervention groups led by non-specialist teachers was in between. The large increase in activity time that SPARK provided over the traditional model used in the control curriculum made it a stand out curriculum.

The SPARK program was identified by the Centers for Disease Control and

Prevention (CDC) as a national model for programs designed to increase PA and combat childhood obesity in their report written by the Partnership for Prevention (2008) (Avery & Brandt, 2010). Avery and Brandt (2010) shared about how their school used their PEP grant to purchase SPARK curriculum and train their staff to properly implement the SPARK curriculum in their districts. SPARK curriculum also became the base for several studies looking to increase their student time in activity (McKenzie et al., 1997; Caballero, 2003; Verstraete et al., 2007). For example,Verstraete et al. (2007) used curriculum based in SPARK to determine how using the curriculum would affect students' activity in school much like the previous studies. The study used 810 students from ages 9 to 11 over 2 years. SPARK curriculum was implemented as well as health education curriculum and extracurricular PA program to help increase overall PA and health of students. Accelerometers and SOFIT were used in class while questionnaires supplied data for leisure time activities. It was found that the intervention was effective in increasing the time spent on MVPA and in reducing the decrease in time spent on vigorous intensity activities the data supported the findings of Sallis et al. (1997) showing the SPARK was capable of significantly increase student MVPA in PE.

Various other studies have also attempted to increase student activity time through various methods. Ideas such as Move it Groove it (MIGI) studied by van Beurden et al. (2003) and Middle-School Physical Activity and Nutrition (M-SPAN**)** done by McKenzie et al. (2004) focused on changing the curriculum patterns to change the MVPA time. Fairclough and Stratton (2005), Young, Phillips, Yu, and Haythornthwaite (2006) and Webber et al. (2008) also sought to increase student time in MVPA through various methods. These studies saw increase in the MVPA levels as they focused to increase it but overall did not see the same level of success as the previous curriculum studies. Wilkinson and Hunter (2008) discussed using the sport education curriculum model as a method to increase student motivation and activity time. The article discussesed the ideas behind the model and its ideas but does not show any instances on implementing the model and the success of using it. These studies focused in the implementation of new teaching methods, strategies and curriculum. Most of which saw success in their attempts to increase the student motivation and participation, but as times have changed and technology is becoming a big part of the world, some studies are beginning to suggest that the use of technology can also help increase and measure student time in MVPA.

## Using technology in PE

In order to improve activity time we need to know what we need to be aiming to do. Scruggs and his colleagues conducted a number of studies to quantify the amount of MVPA students were receiving in PE via pedometers. The studies found the number of steps needed per minute in order for students to obtain adequate time in MVPA throughout a PE class.

Scruggs (2007) used pedometers to quantify PE activity time in 5$^{th}$ and 6$^{th}$ graders. The study used objective measures to determine the number of steps needed to adequately, objectively, and reliably attain MVPA time in PE. Previous studies by Scruggs et al. (2003; 2005) determined the adequate steps for achieving MVPA in PE. Scruggs et al. (2003) determined that students in 1$^{st}$ and 2$^{nd}$ grade need to average 60-63 steps per minute in order to achieve MVPA for one third of a 30 minute PE class. Scruggs et al. (2005) calculated that 3$^{rd}$ and 4$^{th}$ graders needed to achieve 58-61 steps per minute to achieve the same amount of MVPA. Ten minutes was used as the researchers found that current recommendations at the time suggested one third of the class time should be in MVPA. For $5^{th}$ and $6^{th}$ graders Scruggs (2007) suggests 60-62 steps per minute to achieve the one third of class time goal. These findings quantify the number of steps needed to achieve adequate MVPA time. These numbers can provide physical educators with guidelines to objectively measure students MVPA with pedometers. Other researchers (Avery and Brandt, 2010) have used these guidelines to measure the PA time their students accumulate in PE.

Zan et al. (2010) used accelerometers in PE to validate the findings of studies looking at MVPA via pedometers such as those done by Scruggs and his colleagues. The results showed a decline in PA time over the middle school years. The study found that 85.5% of students achieved 50% of PE time in MVPA as measured by accelerometers and this was validated using pedometer data that followed the guidelines set by Scruggs and researchers in the previously mentioned studies.

Pedometers are a tool that many schools have and use frequently. These devices measure steps taken and from this using the methods of Scruggs and researchers teachers can determine if their students are achieving adequate levels of MVPA. As mentioned before several studies used technology in their classrooms and with their students to track the amount of PA they attained. Avery and Brandt (2010) used pedometers to track MVPA in and out of school while Nadler et al. (2008) used accelerometers. Also, as previously mentioned, Mears (2010) reviewed various types of activity trackers and their practicality for use in schools. All of the devices offer effective objective monitoring of PA and provide immediate feedback to the students. It is important for students to have this feedback as it offers a tangible cue to motivate and remind students to participate (President's Council on Physical Fitness and Sport, 2002). There are several studies that support the use technology and activity trackers to help improve student activity and motivation.

**Technology to motivate**

Nichols, Davis, McCord, Schmidt and Slezak (2009) specifically evaluated heart rate monitor use in the classroom. They stated that heart rate monitors help assess whether students have exercised in the appropriate heart rate zones. This ensures that they are not working too hard and wearing themselves out while also measuring if the student is not working hard enough to put their heart in the target zone. The researchers found that objective measures increase student motivation and participation.

Brewer, Leubbers and Shane (2009) made several suggestions in their article to help increase student motivation and PA time. One suggestion is to implement technology through the use of pedometers to track and promote PA. Partridge, King, and Bian (2011), implemented heart rate monitors into the classroom to evaluate student participation and to help determine grades for students. There were varying levels of student satisfaction and enjoyment with the devices depending on the implementation and enthusiasm from the teachers. However, the results showed that heart rate monitors might help teachers to motivate students that otherwise have difficulty connecting with PE. The study found that depending on the use of the technology the resulting motivation levels varied. Using the heart rate monitor for determining grades resulted in lower motivation levels, however when the focus was self-improvement through the heart rate monitors, students motivation improved.

Hollander (2012) evaluated the ability of biofeedback to influence the brain and motivate athletes. Using an activity tracker such as a pedometer or heart rate monitor makes a person aware of their activity and this can result in increased motivation. How? The awareness stimulates their desire to reach an end goal and when they reach the goal they are rewarded and satisfied. But, in order for this feedback to work as motivation the user must have competence, autonomy and relatedness. Competence is gained when the user of the device is able to reach a goal, such as a heart rate zone. The user understands what to do to get the desired results on the device. Autonomy comes when the user gets to choose how to reach the goal such as running, dancing, or other forms of exercise. When the user feels more in control and connected to the task and goal they are more highly motivated. Relatedness is when the user feel they are cared for as well as are caring for themselves. The user feels that the goals are helping them reach levels they desire. All of this together results in increased motivation through the use of feedback devices.

## Summary

It is evident that physical educators need to provide quality PE lessons to increase students' PA levels because of limited time allocated to PE. From changes in curriculum and teaching styles to implementing technology there are various options to help increase student time in MVPA, but various studies showed that technology such as activity tracking through pedometers, accelerometers and heart rate monitors can help increase the motivation and participation in MVPA. However, there have been no research efforts to show how the heart rate sensors and Polar Gofit work on students' time spent in MVPA during PE lessons. Therefore, a study is warranted to provide the evidence.

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