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Analysis of a Heart Rate Measurement System on Student Motivation and Parent Satisfaction

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Abstract The purpose of this study was to investigate the effect of a heart rate measurement system on student motivation and parent satisfaction of the information obtained. Participants (n=27) either took a survey as a parent/guardian (n=11) or were interviewed as a student (n=16). The survey was based on a qualitative measure and used to determine the parents' view of the importance of physical activity and physical education (PE) as an academic course. Additionally, feedback that parents received from PE teachers and what feedback they would like to receive in the future was analyzed. The student interview gauged the participants' views on motivation, including if they were motivated intrinsically or extrinsically. Questions were also asked regarding physical activity, the use of a heart rate measurement system in PE classes, and the use of heart rate monitors outside of PE. The results showed that all parental participants completing the survey believed PE to be an important class for their child. However, 64% stated that they received no or little feedback regarding their child's progress in their PE classes. During the interview, 63% of the student participants viewed motivation to be more internal. When asked if they were more concerned with their own heart rate or another student's heart rate, 69% determined that they were solely concerned with their own heart rate. Findings revealed that the use of a heart rate measurement system had an overall positive impact on students' view of physical activity. Students believed it would be beneficial to perform more activities with a heart rate measurement system, and parents viewed PE positively, but would like to receive more feedback and information about the activities being performed.

Keywords: *physical activity, heart rate monitors, elementary, motivation, parent satisfaction*

1. Introduction

Every decision that is made by an individual can be traced back to some sort of motivation that drives that person (Baert, 2011). Often children are motivated by a different set of factors than adults (Alderman, Beighle, & Pangazi, 2006). It is important to discover these motivational factors to encourage children to instill a lifelong healthy lifestyle. Being physically active can help reduce chronic health problems and health risk potential (Chase, Sui, & Blair, 2008). These habits need to be established at an early age and understanding the motivational factors for a physically active lifestyle is imperative.

Research has shown various motivational theories that can be contributed to the reasoning behind one's actions (Weiss, 2000; Alderman, Beighle, & Pangrazi, 2006; Beam, 2015). These theories can be based around the idea that children are influenced externally, internally, or a combination of both. The Self-Determination Theory (SDT) is concerned with the fundamental needs for competence, autonomy, and relatedness (Deci & Ryan, 1985). Competence is related to whether an individual believes they have the ability to do something. Autonomy represents a desire to initiate and control their behavior while relatedness reflects a desire to belong or have a connectedness to others. An individual's motivation and overall wellness can be positively impacted if these needs are addressed. As a motivational theory, SDT influences a child's willingness to participate in the learning process (Beam, 2015). Motivation can occur both extrinsically and intrinsically. An individual is influenced extrinsically when there is a potential reward. These rewards can include gifts, trophies, recognition, etc. Intrinsic motivation occurs because the individual derives satisfaction from participating and finds the activity enjoyable (Deci & Ryan, 1985, 2000). The current study seeks to determine if heart rate monitors can be a motivational factor on students' decision to be physically active.

Research has shown that elementary-aged students often perform physical activities because of sheer enjoyment (Baert, 2011). Children tend to act in a positive manner when they view an activity as beneficial to themselves or believe that activity will be fun. Additionally, it was found that children will perform physical activities due to some innate desire that exists within that pushes them to be active

(Alderman, Beighle, & Pangazi, 2006). This shows that children pay more attention to what they enjoy doing as opposed to an outside source influencing their physical activity patterns. To build on this, studies have found that intrinsically motivated children are more likely to perceive physical activity experiences as positive (Weiss, 2000; Ntoumanis, 2001; Jaakkola et. al, 2017). Motivated children find pure enjoyment out of activity and seek to become the best person through their own actions. Extrinsically motivated children find joy when competing against others or having an outside source as their driving factor for competing.

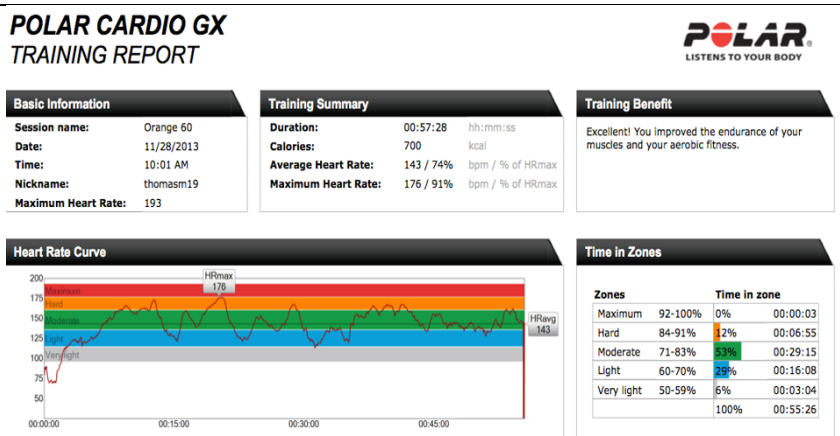
One source of motivation for children is technology (Bice, Ball, & McClaran, 2016). With the continual development of technological devices, information can easily be obtained by teachers to better inform their instruction and provide information to students and parents. To keep in line with current trends the educational system has begun to adapt by implementing these instruments to aid and enhance the learning process (Baert, 2011; Eberline & Richards, 2013; Juniu, Shonfield, & Ganot, 2013). An examination of PE studies indicates that the use of technological devices, such as heart rate monitors, have been examined in the classroom (Le Masurier, 2004; Clapham, Sullivan, & Ciccomascolo, 2015). PE, and other non-tested subjects, have been limited with implementing technology due to the time required and the available resources for purchasing expensive equipment. However, to support student learning and the trend of technology in the classroom, instructional approaches incorporating technology need to be adopted. Additionally, administration need to be informed of the benefits to provide continual support to PE programs.

PE assessments allow a teacher to evaluate student learning and the effectiveness of their curriculum and instruction. With advanced technologies, assessments can now take place through an objective manner, making the measurements of student performance more reliable and more valid (Eberline & Richards, 2013). Heart-rate monitors, for example, could measure the physical output (effort) of a student, allowing the child to keep track of this information by observing their displayed heart rate during class. This type of information also provides feedback to the instructor of the course as well as parent/guardians (Baert, 2011). Heart rate monitors also allow students to receive a printout providing them with the duration of their activity, calories burned, maximum and average heart rate. Students will also know how much time was spent in each heart rate zone during class (See Table 1). This is important because research shows that children should be attaining 60 minutes of moderate to vigorous physical activity (MVPA) each day (Laguna, Ruiz, Lara, & Aznar, 2013).

Studies on the use of heart rate monitors have provided some positive results (Ignico & Corson, 2006; Clapham, Sullivan, & Ciccomascolo, 2015). Ignico and Corson (2006) provided 175 students (4th & 5th grade) instruction on using heart rate monitors and understanding the different heart rate zones. Each student wore their heart rate monitor during PE while the control group did not. Results indicated that students in the experimental group performed better in the one-mile run. In a similar study, Clapham, Sullivan, and Ciccomascolo (2015) examined the impact of a supportive curriculum when combined with the use of a technological device (heart rate monitor or pedometer). The supportive curriculum was designed to provide students with important information regarding the use of a heart rate monitor or pedometer. Results indicated an increase in physical activity among 4th and 5th grade students (N=106) when a supportive curriculum was combined with a technological device.

Research has shown that parental encouragement and support positively impacts and has a direct correlation with physical activity levels of children (Weiss, 2000; Gustafson & Rhodes, 2006; Edwardson & Gorely, 2010; Morrissey, Wenthe, Letuchy, Levy, & Hanz, 2012; and Voss & Sandercock, 2014). Weiss (2000) showed that influential adults, such as parents and PE teachers, are in a role to enhance each child's beliefs, self-esteem, and values as they relate to physical activity. Influential adults can help to manipulate a situation and motivate a child to perform physical activity and to do so with a positive manner and outlook. Parental influence can be important for physical

Table 1. Training Report



activity and the varying levels (Edwardson & Gorely, 2010). Direct parental involvement plays a positive role in a child's physical activity participation for MVPA and leisure time physical activity.

For organized physical activity (such as playing on a team), parental encouragement tended to be the leading factor in their child's physical activity participation and level of physical activity. Gustafson and Rhodes (2006) determined that there was a significant correlation between parental involvement and support and their child's physical activity levels. Voss and Sandercock (2014) added that it can also impact the perceived activity levels of the parents. If at least one parent is perceived as having an active lifestyle by their child, their child is more likely "to meet health-related standards" (Voss & Sandercock, 2014). These findings suggest nurture over nature, meaning that physical activity behavioral patterns are influenced by social factors rather than genetic factors. Lastly, in a study conducted by Morrissey et al. (2012), data collected from an accelerometer determined factors that influenced physical activity levels away from a school setting. The study backed the thought that family involvement continues to be a significantly important factor in influencing physical activity levels in children.

These studies support a correlation between parental involvement and their child's physical activity levels. Depending on the type of physical activity the child is participating in determines the kind of influence the parent would need to have to maximize their child's physical activity level. For activities that tend to be less structured (non-team sports, leisure activities), parental involvement is a significant factor for a child's increase in these kinds of physical activities (Pharr, J. et. al, 2018) while the significant factor for activities that tend to be more structured (sports and team sports) is parental support. It is also interesting that even if a parent is neither totally involved nor totally supportive, if they give off the perception to their child that they are, then the child will have an increase in physical activity participation. Parental influences can carry over throughout all forms of physical activity, varying in the ways of support.

For parents to provide encouragement and support for physical activity, it is important that they are satisfied with the PE program. A recent survey (Education and Health in Schools, 2013) found parents were not satisfied with the amount of support for physical activity from their child's school. Of parents surveyed, 25% indicated that there was little emphasis on PE. In addition, only 25% of responses indicated that their school was providing the suggested daily PE instruction (CDC, 2013). While this data shows parents desire for more physical activity and PE instruction, research examining parent satisfaction of PE programs is scarce. In fact, only two recent studies pertaining to parent satisfaction of PE were found. These studies discussed parent satisfaction regarding adapted PE services (Columna et al., 2014; Lee, Haegele, & Chang, 2017). Therefore, based on the previous studies, the purpose of this study was to determine the effect of a heart rate measurement system on student motivation and parent satisfaction of the information obtained. This study aimed to answer what motivates children to perform physical activities and how motivation affects their overall physical output (effort) and performance. Also, the study aimed to gain an insight on the parental view of PE and feedback they receive from their teacher. In addition, parents shared what type of feedback they would like to receive from the PE teacher.

2. Method

2.1. Participant and Setting

The participants in this study were 16 fourth grade students (male=8; female=8) and 11 parents (male=4; female=7) from two PE classes in the southeastern United States. Parents provided informed consent for their child to participate in a group interview and parents completed a survey regarding a previous study conducted concerning visible heart rates in the classroom. In addition, the students in this study had PE once a week for a 50-minute session. During the time of this study, the students were participating in a jump rope unit.

2.2. Protection of the Human Subject

Approval was obtained from the Institutional Review Board (IRB) of the university from which the study was conducted and a consent form for each participant was required prior to survey completion or participating in the interview. All data was audio recorded and transcribed onto the investigator's computer for analysis. The data was retained on the investigator's computer for one year from the date the data was first obtained. For individual data, names were recorded during the interview as a measure to connect the student interviewee with their parent/guardian. However, during transcription, names were erased and assigned variables during transcription

2.3. Instrumentation and Procedure

Each participant and their parent/guardian received an invitation to participate in the study. In the first phase, those parents/guardians who elected to participate completed either an electronic or paper survey designed to determine satisfaction with the current PE program and the feedback they were receiving from the class (See Table 2). To help achieve face and content validity three experts in the field of PE examined the survey for approval. A deadline was given for the survey and reminders were sent home through the teachers at the school. Personal information was obtained from all survey participants to assist with the categorization of the results. The parental survey included a cluster of seven questions, with many being open answered questions. The first set of questions was related to demographic information, such as sex and age. The next section was related to their opinion of PE and the possible benefit/ non-benefit it is for their child.

Table 2. Parent Survey

1.	Your Gender:
2.	Your Age:
3.	Do you believe Physical Education is an important subject for Elementary students? Why or why not?
4.	How much feedback do you receive regarding your child's progress in Physical Education?
5.	Do you believe the feedback regarding your child's heart rate levels during Physical Education (Polar Cardio GX system) is beneficial? Why or why not?
6.	What did this feedback tell you about your child?
7.	What other types of feedback would you like to receive regarding your child's participation in Physical Education?

After this, the last part of the survey dealt with how much feedback they receive from the PE course, if they liked the feedback received from the heart rate study, and what other feedback they would like to receive. All answers were coded and grouped into similar categories for analysis. This coding process was created to group the answers to the questions of the survey and the interview into common themes. The coding "1" was designated to answers that were viewed as positive or supportive, or given to those answers that deemed that the participant understood the question, such as yes/no questions. The coding "2" was given to answers that were either neutral in nature, or to non-responses. The coding "3" was designated to responses that were deemed as negative or unsupportive, or to those responses that deemed that the participant did not understand the question.

For the next phase, those students who elected to participate in a group interview were placed with one to four other students. The interview was intended to determine the children's motivational factors as well as the role a heart rate measurement system played in their physical output during PE classes and in the future. Similar to the parental survey, three experts in the field of PE examined the survey to ensure validity. The heart rate system that was used in the study was the Polar cardio GX system. Students wore a monitor around their chest during PE class for the duration of the study. Their heart rate was projected onto the wall for students to monitor. Students were identified by a number to keep information confidential. At the end of the study, parents were provided with a training report (See Table 1) that provided information regarding their physical output for each class. The questions of the interview were based around their participation. The students were asked a series of nine questions (See Table 3), with each student taking turns delivering their answer to the best of their knowledge. These questions asked for information that was opinion based. Each student had an opportunity to opt out of the interview at any time. The first cluster dealt strictly with motivation and their perception of motivation. The next set of questions dealt with their perception of the heart rate color and why, or why not, they tried to achieve a certain color. The last section dealt with whether they believed that having a visible heart rate in PE classes would be fun and/or beneficial. The students were also asked if they would enjoy having a visible heart rate in other physical activities.

Table 3. Student Interview Questions

1.	In your own words, what is motivation?
2.	Are you motivated to be physically active? Why or why not?
3.	How did you respond when you saw your heart rate on the wall?
4.	Were you trying to achieve a certain heart rate during each class period?
5.	Were you competing against another classmate to see who could have a higher heart rate? Or, were you more concerned with your own heart rate?
6.	What did the different colors represent?
7.	What color did you try to achieve? Why or why not?
8.	Do you think a visible heart rate would motivate you in other activities? Why or why not?
9.	Do you think PE would be more enjoyable if you could use the Polar Heart Rate device every day? Why or why not?

These answers were coded and grouped based on their coding of similar answers for analysis. The open-ended answers were recorded to provide further analysis

2.4. Data Analysis

Quantitative data was collected in the form of 'Yes/No' questions on the parental survey. Qualitative data was collected through student interviews and open-ended questions on the parental survey.

Student interviews and parent surveys were recorded and transcribed verbatim and analyzed using a model of comparison and analytical induction methods (Walker, 1985). First, the data was transcribed and then grouped by common themes and patterns, which was given a code accordingly. The goal of grouping these common themes was to give each group a singular focus or topic that each was related. If the data did not fit into the previously created categories, a new category would be created. Next, the created categories were analyzed and compared to one another to recognize the differences between the themes.

3. Results

3.1. Survey

Data revealed that all participants believed PE is an important subject for elementary students. Of these participants, eight provided positive reasoning as to why they believed their answer to be true. One theme that emerged was that PE allows the students to be active/live a healthy lifestyle. Other responses included that it instilled positive values, allowed the students to make healthy nutritional choices, and creates activities that they can continue into their adult lives. Data showed, however, that seven parents received little to no feedback from the school regarding their child's progress in PE.

Regarding their child's heart rate and the use of a heart rate measurement system, all participants viewed the feedback (Training Report; See Table 1) regarding their child's heart rate levels during PE as beneficial. When asked why, six parents had positive remarks. Some responses included that they liked knowing their child's participation levels, the benefit of seeing how active their child was, and it allowed them to see the overall health of their child.

When asked what other types of feedback they would like to receive regarding their child's participation in PE, only three parents responded with answers. All described that they would like to know what is being taught and what exercises/activities their child is performing in their PE classes

3.2. Interview

Data revealed that ten students viewed motivation as intrinsic, while six viewed motivation to come from extrinsic sources. The main factor for intrinsic was that participants enjoyed what they were doing and wanted to be their best version. The main factor for extrinsic was to make their parent(s)/guardian(s) proud of themselves. When asked if they were motivated to be physically fit, 87% (n=14) responded in a positive manner. One student stated "yes, because I know that in order to be healthy, I must stay physically active."

When discussing the visible heart rate, 75% (n=12) revealed that they had a positive reaction to this visualization. Participants' factors for positive responses included that it showed them how hard they were working, and they thought it was interesting to see what exercises made them work harder. Data revealed, however, that only five participants were trying to achieve a certain heart rate during each class session.

Data showed that 69% (n=11) were more concerned about their own heart rate as opposed to the heart rate of another classmate, whether directly or indirectly competing. A student stated, "I wasn't competing against anyone else. I was more concerned with my own than anybody else." Another student said, "I would look to see what everyone else had, but it didn't make me do more or less. I was just interested to see how everyone else was doing."

Lastly, the participants aimed for increased levels of heart rate for long periods of time in each session. Nine students stated that they were aiming for red (175-200 BPM) throughout each class session, while two were aiming for at least orange (150-175 BPM). Five students were not aiming for a specific heart rate. When asked if a visible heart rate would motivate you in other activities, data showed that twelve responded in a positive manner to this question. One student noted, "Yes, because it would allow me to see how much I am doing and would help me to reach my goals." Another student stated that "it would motivate me to work harder if I wasn't working hard."

4. Discussion

The purpose of this study was to determine the effect of a heart rate measurement system on student motivation and parent satisfaction of the information obtained. Results revealed that: (1) the use of a heart rate measurement system had an overall positive impact on children views of physical activity and impacted their motivation to perform physical activity, (2) students find that it would be beneficial to perform more activities with a heart rate measurement system, and (3) parents view PE positively, but would like to receive more feedback and information about the activities being performed.

Parental involvement can positively impact the motivation of children and their performance. Student effort, concentration, and attention can improve when parents are involved and provide support to their child (Gonzalez-DeHass, Willems, & Holbein, 2005). Barnard (2004) discovered that parental involvement and an interest in the progress of their child can be associated with higher educational attainment. However, there is a lack of research in PE regarding the reporting of progress of students. As this study and prior research shows (Beam, 2015), parents typically understand and are aware of the benefits of physical activity for children. Parents can play a vital role in the healthy choices that students make and the benefits it can provide (Active Schools). However, they are unaware of exactly what the curriculum entails and what activities are occurring in the classroom. Often, grades are given in PE based on attendance. This causes a problem when creating feedback and progress reports that the parents and students can look at to see where they stand, what they are learning, and how they are progressing (Melograno, 2007). Parents are unaware if their child is learning skills that they can use throughout life to stay physically fit, which is one of the main concerns that was discussed in the survey responses. Providing parents visual progressions that show what activities their child is performing, and their learning progression would be deemed as beneficial in the field of PE.

Based on the interviews conducted, students stated that the use of a heart rate measurement system was a positive experience and created a positive atmosphere for physical activity. The students enjoyed seeing their name and heart rate, with a color code, displayed on the wall. This allowed them to see when they were performing at a high activity level and when they were at a resting heart rate. When the students saw that they were at a resting heart rate during times when they were in activity, this tended to push or motivate them to work more diligently and to perform more physical activity in order to attain their desired heart rate (Baert, 2011).

A surprising discovery from these interviews was that while most students stated that there was not a specific heart rate that they were trying to achieve during each class session, most of the students did in fact have a color they were trying to achieve. This shows that the students understood what each zone meant in relation to their level of physical activity, but were not concerned with the actual number itself, only the zone. Having a visual color coding system that represents their physical activity output proved to be beneficial for the students when measuring their heart rate and physical output.

Another interesting finding was that most students stated that there was some kind of intrinsic factor that motivated them (Self-Determination Theory), even though research supports this idea (Alderman, Beighle, & Pangazi, 2006). However, the color coding for their specific heart rate zone

did impact their level of physical output. The reasoning for this could be because the students stated that they were mostly concerned with their heart rate as opposed to the heart rates of the other students. This supports the findings of previous studies (Ignico &Corson, 2006; Clapham, Sullivan, & Ciccomascolo, 2015) indicating that instructing students on understanding heart rate zones could be beneficial. The students were attempting to perform the best that they could possibly perform, so their motivation came from within (intrinsically) by way of an outside source. The interview showed that this may be true with the students' responses to whether they believed that using a heart rate measurement system would be beneficial in other activities. Seventy-five percent of students interviewed believed that the use of this system would motivate them in other activities in a similar way that it motivated them in their PE classes. It was repeatedly stated that having a visible heart rate would promote more moderate to vigorous activities in their everyday lives.

A limitation of this study was the small sample size of participants in this study due to a limited amount of equipment. However, the amount of data that was collected was both useful and beneficial in analyzing students' thoughts regarding the use of heart rate monitors. Future research should consider having a greater amount of heart rate devices in order to attain a greater amount of data. Another limitation regarding the small sample size was the wide range of variables regarding the parents. Factors such as age, educational background, and personal views of PE and activity could have impacted the consistency of results. Future studies should categorize the results based on these variables to provide a more detailed discussion of the findings. Finally, future research with heart rate monitors should be simplified due to the fact that many monitors are no longer required to be placed near the heart. In fact, many simply require students to place the monitor on their wrist or forearm. Students can now enter PE and have an activated monitor in a few seconds. During this study, adjusting straps and ensuring that monitors were correctly working was a time-consuming process.

5. Conclusion

Physical activity is important to perform throughout life for various reasons. Most of these habits are started in the foundational phase of a child's life. Elementary PE has an opportunity to positively influence the creation and maintenance of quality physical activity habits. Creating positive habits at an early age and learning what activities to perform can create lasting impressions. The use of a heart rate measurement system, or similar systems, would be beneficial to use when performing physical activities to show individuals their activity output and to show their average heart rate over the course of a specific time.

Combining this with what the target average heart rate should be for someone their age would be beneficial. This would allow the individual student and their parent/guardian to know if they are performing enough physical activity in their daily lives and if any corrective measures need to take place. The negative to this is the initial cost of a heart rate measurement system. While having a visual heart rate and reports would be beneficial, there needs to be a way to create this at a cost-efficient price point. However, the cost should not matter when compared to the benefit that a heart rate measurement system can provide. This system can allow teachers and parents to monitor a child's overall physical activity levels and can use this to create a plan to aid the child in living a healthy life. Children begin forming habits at an early age and this is something that a child could carry with them throughout their life. A child's health and safety cannot be taken lightly, and we must do everything possible to ensure we are providing the greatest amount of resources to allow them to be healthy. At the end of the day, our focus should be on health and well-being of a child.

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