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THE EFFECTS OF WALKING AND GEOCACHING ON HIGH SCHOOL PHYSICAL EDUCATION STUDENTS' HEART RATE

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Catherine A. Egan

College of Science and Health
Adventure Education

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THE EFFECTS OF WALKING AND GEOCACHING ON HIGH SCHOOL PHYSICAL EDUCATION STUDENTS' HEART RATE

By: Catherine Egan

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Jeffrey P. Steffen, Ph.D. — Date: 4-19-11
Thesis Committee Chairperson

Eugene Asola, Ph.D. — Date: 4-19-11
Thesis Committee Member

Richard P. Mikat, Ph. D. — Date: 4-19-11
Thesis Committee Member

Soojin Yoo Ph. D. — Date: 4/19/11
Thesis Committee Member

Thesis accepted

Vijendra K. Agarwal, Ph.D. — Date: 5/23/11
Associate Vice Chancellor for Academic Affairs

ABSTRACT

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Physical education teachers are looking for new ideas that will help their students learn how to be lifelong movers. The purpose of this study was to examine the effects of adolescent students' heart rate while walking and while geocaching. 25 subjects were taught how to use Polar heart rate monitors and Garmin eTrex Legend H Global Positioning system (GPS). The subjects completed a 30 minute timed self paced walking course and a30 minute timed geocaching course. Heart rates were recorded continuously during both parts of the study. The study found the mean heart rates as percentage of heart rate reserve for walking and for geocaching showed a significant difference ($p = .04$), and the overall means and standard deviation were .60±.06 walking and .63±.07 geocaching. The study also that found percent peak HRR for geocaching and walking, showed no significant difference ($p=.06$), and the overall means and standard deviation were .79±.12 for walking and .85±.14 for geocaching. The results suggest that the subjects worked at a higher frequency and for a longer duration while geocaching verse self regulated walking. The percent of peak HRR showed that there was no significant difference.

Key terms: geocaching, heart rate monitors, high school students, physical education

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I want to thank each and every person who has helped me get through this process. It has been a long and a tough road, but at-last the journey is complete. I am proud to say I have come out a more educated and well rounded person. I am a better teacher and a stronger person. I have redefined the words cold, snow, and winter, and in the wise words of a professor I am smarter now than I will ever be again: It is all downhill from here.

Most importantly, I would like to thank my mother and my father for making this journey possible for me. For as long as I remember, you both have pushed me to the best that I can be. You have taught me how to love and how to work hard. You have taught me how to be committed to accomplishing my goals and to reach farther than I ever imagined possible. You have taught me to be me and to be the best that I can be; for that I am eternally grateful. I love you both and thank you for supporting my seemingly never ending educational career.

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INTRODUCTON

Getting students active, involved, and teaching students lifelong skills that will help them stay physically active are some of the many goals that physical education teachers have. Physical education teachers also strive to teach as many cross-curricular activities as possible. This type of curriculum enhances physical education's role in the k-12 school system (Lapere & Yates, 2008). One might ask how a teacher can incorporate topics such as Math, Science, Geography, Technology and English into a physical education class? One method may be to use geocaching.

Geocaching is a rapidly growing sport that already has over one million active participants worldwide (Geocaching, 2010). Geocaching is a worldwide game of hide and seek. Geocachers (persons seeking treasures) log into www.geocaching.com and find geocaches (hidden treasures) in their area. The GPS unit will bring the geocacher within six to 20 feet of the cache, using latitude and longitude coordinates. Geocaches can be hidden under rocks, logs, in trees, and the more difficult caches can be found underwater or in rock cliffs. Once the cache is found, the geocachers sign a log book hidden within the cache, take an item from the cache, and replace the item with something of greater or equal value. The item(s) usually relate to the area in which the cache is located. Once the geocacher is done with the cache they place it back exactly where it was hidden, and then document and log their find on the website (Geocaching, 2010).

Geocaching can be a very appropriate activity in physical education. Geocaching gets people active through hiking and walking. It can also be a lifelong activity that is

accessible to people with a wide variety of abilities and skills. Geocaching GPS units can often be rented out for little to no charge, and can be found in well paved and accessible areas.

It is important for physical education teachers to meet the standards set by the National Association for Sport and Physical Education (NASPE, 2004). The six NASPE standards (NASPE, 2004) are displayed in Table 1.

Table 1. NASPE Standards

Standard	Definition
1	Demonstrates competency in motor skills and movement patterns needed to perform a variety of physical activities
2	Demonstrates understandings of movement concepts, principles, strategies, and tactics as they apply to the learning/performance of physical activities
3	Participates regularly in physical activity
4	Achieves and maintains a health-enhancing level of physical fitness
5	Exhibits responsible personal and social behavior that respects self and others in physical activity settings
6	Values physical activity for health, enjoyment, challenge, self-expression, and or social interaction

By teaching a geocaching unit, the physical education teacher may address standards one, two, and five and under some circumstances also meet standards three, four, and six.

Some physical education teachers have questioned whether geocaching an aerobic activity? While geocaching do students' heart rate stay within the target heart rate zone? There have been studies that examined heart rates while geocaching in elementary aged subjects and heart rates while geocaching in college aged subjects, but no studies have examined the effects on high school subjects (Minulto, 2010 & Stratton, 2008). Lubans et. al. (2009) examined the relationship between heart rate intensity and pedometer step counts. They found that 130 steps per minute is equal to 65-75 % MHR in low-fit

adolescents and that adolescents should try and achieve 130 steps per minute. This could be used as an initial goal to improve the fitness of beginners and/or persons with lower levels of physical fitness (Lubans et al., 2009).

Getting students motivated to participate in physical education classes is a challenge. When students reach secondary schools, they are often bored with traditional physical education activities and ready for new and different challenges (Siegel, 2007). If the physical education teacher can, "[enhance] student attitudes toward physical education, especially enjoyment, will foster immediate engagement and long-term participation in physical activity" (Siegel, 2007). Outdoor physical education has been one answer to improving subjects' attitudes towards physical education and geocaching is an activity that is rooted in outdoor education (Siegel, 2007).

Geocaching is a growing sport that has the potential to meet national standards, bring technology into the gymnasium, meet cross-curricular goals, and geocaching fits into the ever growing outdoor physical education curriculum. Minulto, 2010 conducted a study that suggests heart rates during geocaching and self paced walking were greater than heart rates taught during units in physical education, and that there was no statistically significant difference between elementary aged students while walking and while geocaching. In a study on geocaching heart rates in college aged students, conducted by Stratton, 2008, it is suggested that there were significant differences in the effects on heart rate while recreational geocaching and competitively geocaching, and both forms of geocaching could be considered moderate to vigorous physical activity. It is not known if geocaching provides adolescents with moderate to vigorous physical activity. The purpose of this study is determine the effects of heart rate on a high school

students' heart rate while walking and while geocaching, and the results will help to determine geocachings place in physical education.

METHODS

Subjects

Thirty two physical education students from a Midwest public high school volunteered to be participants in this study. All subjects were enrolled in a required freshman physical education class, and signed assent/consent forms before taking part in this study. These forms as well as the protocol for the study were approved by the University of Wisconsin-La Crosse Intuitional Review Board for Protection of human Subjects before the study began. The physical education teacher at the school as well as the principal researcher implemented the study during each subject's normally scheduled physical education class. Of the 32 subjects who participated in the study, 25 recorded usable data and of those 25 subjects, 15 were male and 10 were female. The subjects were between the ages of 14 and 15 (see table 2).

Table 2. Height, Weight, and Age of Subjects (mean ± SD)

Gender	Height (in.)	Weight (lbs)	Age (years)
Female	63 ± 4	118 ± 20	14 ± 0
Male	68 ± 3	145 ± 32	14 ± 0
Total	**66 ± 4**	**134 ± 31**	**14 ± 0**

Instrumentation

Heart rate's were the chief dependent variable for this study and were measured using Polar heart rate monitors. These units included a wristwatch that collected the heart rate data that was transmitted by telemetry from a strap worn just below each subject's

chest. At the beginning of the study, each participant was shown how to wear and operate the device and each subject's data was downloaded after each trial using a Polar docking station. Once downloaded, data were imported into Microsoft Excel 2007 and PASW 18 for statistical analysis. The heart rate monitors were introduced to the subjects, and the subjects had time to practice using the monitors prior to the beginning of this study. This ensured that the subjects had time to become comfortable using the monitors, which allowed them to obtain the most accurate reading possible during the study. All testing was completed on the school grounds. The fields and ropes course area were used for the geocaching course and walking course. Each subject wore a heart rate monitor and was responsible for starting and stopping the watch when instructed. Geocaching locations were determined with Garmin eTrex Legend H handheld GPS devices. These units were specifically designed for geocaching. Groups of no more than five participated in the geocaching portion of the study and each group had one geocaching unit and one set of information sheets on geocaching.

Both trials lasted 30 minutes. All subjects started and stopped their watches at the same time. The researcher examined the first 30 minutes of data on the heart rate monitors only. The primary researcher created waypoints for the geocaching portion of the study. The primary researcher was proficient at using the GPS. The primary researcher ensured each group was proficient in using the GPS units prior to the geocaching portion of the study. This ensured the subjects were successful in finding their caches.

Procedures

The study began with an orientation session. During this session, subjects were instructed on the purpose of the study, the use of Polar heart rate monitors, and the use of the Garmin GPS devices. Subjects had an opportunity to ask questions in this session. The session concluded with each subject being assigned a number and with the collection of demographic information from each subject including height, weight, age, gender, and resting heart rate.

Once subjects had gone through the orientation and had signed their consent forms, they were divided into two groups of 16. One of these groups was randomly selected to complete their geocaching trial before their non-geocaching trial. The other group was assigned the opposite order. Each group's trials were on alternating days so the entire data collection period lasted for a total of four days.

Data for this study was collected over a four day period. There were 32 walkers and geocachers in this study. The 32 walkers and geocachers were divided into two groups of 16, and these groups completed the study on two consecutive days. The first day was the walking section of the study, and the second day was the geocaching section of this study. The first group completed the study on November 11 and 12 2010, and the second group completed the study on November 15 and 16, 2010 On the first day of the study, the subjects were introduced to the primary researcher, had an opportunity to ask questions, and filled out demographic information cards. This information included Height, Weight, Age, Gender, and Resting Heart Rate. The subjects were then assigned a number and that number corresponded with the Heart Rate Monitor that they used on both days of the study. The primary researcher did not know the subjects name, as the

teacher assigned the numbers and kept that information in a secure location. On each day of testing, each subject was issued a heart rate monitor and was reminded how to use and wear it. Assistance was given to any subject who needed help. The subjects were then instructed to start their watches, sit as still and quiet as possible, and listen to a five-minute lecture on geocaching and heart rate monitors. At the end of the lecture, the students stopped their watches and recorded their last measured heart rate as their resting heart rate on their demographic information cards.

The subjects followed their teacher and the primary researcher of this study outside to the athletic fields. They were instructed to start their watches again and the teacher and primary researcher led the subjects on a timed 30-minute walking route through the school's athletic fields and ropes course. At the end of the 30-minute period, the students were asked to stop their watches. The subjects then took off their heart rate monitors and placed the monitors and watches into their designated heart rate monitor box. All boxes and watches were labeled with corresponding number also the students ensured they used the same watch each day of the study. After all heart rate monitors were returned, the students were instructed how to geocache and practiced geocaching through a practice course.

On the second day of testing, the subjects put on their heart rate monitors. The instructor and primary researcher were available for assistance. The subjects were then assigned to groups for geocaching. The subjects were in groups of no more than five. Each group had one GPS unit, each subject had their own heart rate monitor, and each group had a sheet of information regarding the GPS Units and geocaching course (SEE APPENDIX). There were poker cards placed in each one of the geocaching boxes. The

cards were placed individually in sealed envelopes. The envelopes were labeled with the cache number to ensure each group only took one card from each cache. The groups were instructed to take one envelope from each cache that they found. The group with the best poker hand at the end of the course won a small prize. There was a question and answer time provided for the subjects. The instructor and primary researcher then led the subjects outside to the athletic fields and the subjects were instructed to turn on their GPS units. They were instructed to load their first cache. Then the primary researcher instructed the subjects to start their watches on the signal and start geocaching. The instructor and primary researcher roamed the geocaching course to answer questions and solve any technical difficulties. At the end of the 30 minute time period a bull horn was blown and all subjects stopped geocaching and made their way back to the primary researcher. When all subjects had arrived back, the primary researcher instructed the subjects to stop their watches.

The subjects started their watch at the same time during the walking and geocaching portion of the testing. Their watches were stopped at the same time. The researcher examined the first 30 minutes of data collected on the heart rate monitors. Furthermore, all subjects hiked along the same course. The geocaching course was the same for all subjects, but the groups moved along the course in different orders to ensure no group was at the same cache at the same time. . The instructor provided written directions for geocaching and the use of the heart rate monitors; the information sheets accompanied each group as they moved along the course. The subjects were instructed to find as many caches as possible during the 30 minute geocaching portion of the study. After all heart rate monitors were placed back in their appropriate boxes, the primary

researcher examined each groups poker cards to determine the winner. The first place group got their choice of five small prizes, the second place group 3 small prizes, and all other groups received one prize. Prizes included: Bouncy Ball, Silly Bands, Snack Size Cheezits, Snack Size Rice Krispe treats, Caribeaners, 5 packs of Gum, and Mechanical Pencils.

Preparation for Trials: Walking and Geocaching

- Ensure all Heart Rate Monitors have working batteries and are cleared of all data
- Ensure all Heart Rate Monitors are labeled and in corresponding boxes with three pieces, Watch, Strap, and Chest Piece
- Create Demographic Information Cards
- Create Map of Geocaching Course with caches labeled for use by Instructor and Primary Researcher (See Appendix G)
- Hide caches and mark waypoints for 6 GPS units
- Ensure each cache has sign in sheet, pencil, and poker cards in sealed marked envelopes
- Create Specific Sequence for Geocaching groups (see table 3 below)

Table 3: Specific Sequence for Each Group to Follow While Finding the Caches

Group	Cache	Cache	Cache	Cache	Cache	Cache	Cache Bonus
One	5	3	6	7	4	1	2
Two	4	1	7	3	6	5	2
Three	6	4	1	5	3	7	2
Four	3	7	5	4	1	6	2
Five	1	5	3	6	7	4	2
Six	7	6	4	1	5	3	2

- In between the walking and geocaching portion of the study the researcher downloaded the data from the watches with Polar Precision Performance Software SW and imported the data into Microsoft Excel Spreadsheets onto a personal laptop. Two files were imported for each subject resting heart rate and walking data
- The data was imported the same way after the geocaching section for each subject
- The researcher erased all data of the watches in-between the first and second portions of the test, cleaned all pieces of equipment using disinfecting wipes, and ensured all heart rate monitors were in working condition and correct boxes.

Statistical Analysis

The heart rate monitor's data was collected and downloaded to a personal laptop. The data was imported using Polar Precision Performance Software SW, and from there the data was exported into Notepad. Each subject had three sections of data in Notepad, resting heart rate, walking heart rates, and geocaching heart rates. The data was then imported manually into Microsoft Excel. The researcher manually entered the demographic information based on the demographic cards into a spreadsheet. Resting Heart Rate (RHR), Maximum Heart Rate (MHR), Minimum Heart Rate (MIN HR), Heart Rate Reserve (HRR), and mean heart rate (AVE HR) were measured in the study for walking and geocaching. The percent of HRR was calculated for walking and geocaching along with the percent of HRR peak for walking and geocaching. A one-tailed repeated measures ANOVA was used to examine differences between groups. Alpha was set at .05.

RESULTS

The results showed for the one- tailed repeated measures ANOVA that was run for the mean heart rates as percentage of heart rate reserve for walking and for geocaching showed a significant difference ($p = .04$), and the overall means and standard deviation were $.60 \pm .06$ walking and $.63 \pm .07$ geocaching (See Figure 1). The results showed for the one- tailed repeated measures ANOVA, that was run for the percent peak HRR for geocaching and walking, showed no significant difference ($p=.06$), and the overall means and standard deviation were $.79 \pm .12$ for walking and $.85 \pm .14$ for geocaching (See Figure 2). The error bars on Figure 1 and 2 represent one standard deviation.

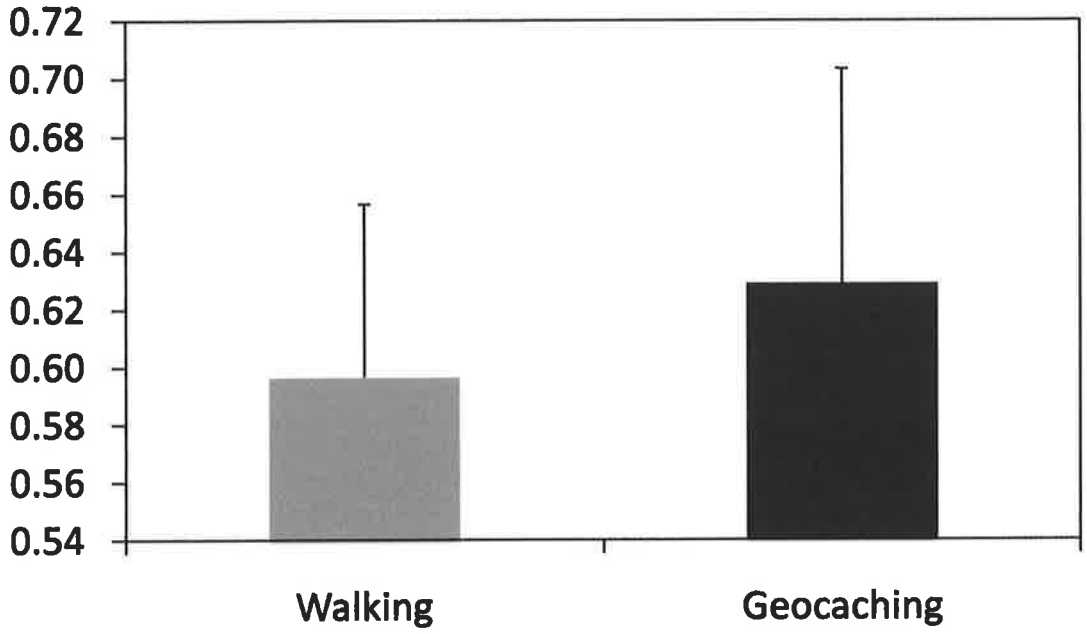

Figure 1. Mean Heart Rates as Percentage of Heart Rate Reserve.

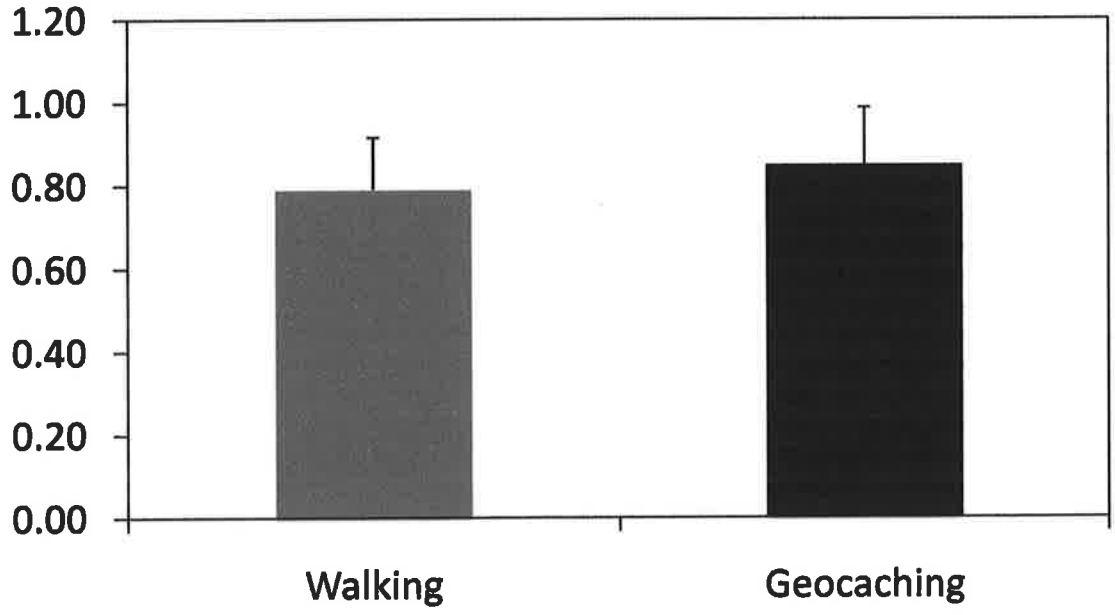

Figure 2. Peak Heart Rate as Percentage of Heart Rate Reserve.

DISCUSSION

The results from this study showed that there was a significant statistical difference in mean percent heart rate reserve for self paced walking and geocaching. To determine the mean percent heart rate reserve for each subject the RHR for each subject was recorded and the maximum heart rate was determined using a new formula for adolescent aged subjects the formula is MHR= 208 -(.7 x age) (Tanaka, H., Monahan, K. & Seals, D., 2001). Then the HRR was calculated using Karvonen's method: MHR=[208-(.7 x age) – RHR] ((Tanaka et al 2001). Using these results, the percent mean HRR was calculated by the following formula: Mean HR/ (RHR + HRR). The results suggest that the subjects worked at a higher frequency and for a longer duration while geocaching verse self regulated walking. The percent of peak HRR, which was determined by the formula: Peak HR/ (RHR + HRR), showed that there was no significant difference. This result suggests that during self regulated walking and geocaching there are similar short bouts of exercise intensity.

This study suggests that persons geocaching work at a higher intensity and for a longer duration while geocaching. The research suggests that geocaching has the potential to meet standards 1, 3 and 6 of the NASPE national standards (NASPE, 2004). Based on NASPE national standards, geocaching is a sport that should be taught in secondary physical education classes.

Getting students actively involved in physical education is one of many goals that physical educators have. However, providing students with the tools that they need to be

physically active for a lifetime is perhaps one of the main goals of physical education. This has led the field of physical education to explore new curriculums that include activities for students based in adventure and outdoor pursuits. Some of these activities include fishing, archery, rock climbing, and adventure based ropes course programming. The new curriculums in physical education have helped to solve a long time problem of motivation and student attitudes towards physical education (Siegel, 2007). By getting the students motivated, they are more likely to be involved in physical education and more actively involved as adults. This research suggests that students have more motivation to work at a higher intensity while geocaching. If students are motivated to work harder and geocaching is a lifelong activity, then physical educators should implement geocaching into their curriculums.

To use geocaching as an activity to promote physical fitness and as a means to improve a student's physical fitness the teacher should consider designing a geocaching course with specific time requirements, measured distances, and student motivation. A study completed by Lubans et. al (2009), suggest that 130 steps per minute are needed to improve physical fitness levels. The teacher should take step count, distances, and time into consideration when implementing geocaching. To address student motivation to complete the course Wright et al (2006) suggest that a teacher should design lessons for students that are both ego driven and task driven. The researchers suggest that some students (ego driven) always wants to compete and are always trying to win everything that they do, while a task driven student is one who is someone who is more intrinsically motivated (Wright et al. 2006). The results from this study suggest students will work at a higher intensity while geocaching compared to walking. Geocaching for improvement of

physical fitness may be more appropriate for students who are ego driven while geocaching as a lifelong activity may fit the needs of more intrinsically motivated students. Geocaching is already designed to fit both types of needs in physical education. There is a recreational version of geocaching that was explored in a study completed by Stratton (2008) and Stratton's study also examined competitive geocaching. Stratton (2008) found that there was a statistically significant difference between recreational and competitive geocaching, and the subjects' heart rate was higher while competitively geocaching verse recreationally geocaching. Other research has found that elementary aged students participating in a geocaching lesson will have a higher heart rate than they would have in other traditional physical education units (Minutolo, 2008). Stratton (2008), Minutolo (2010), and this study all suggest that geocaching fits into the physical education curriculum based on elevated heart rates in students from primary school through college.

CONCLUSION

This study examined the relationship between heart rates while walking and while geocaching in adolescents. The study examined 32 subjects and the subjects heart rates were monitored during a 30 minute self paced walking session and a 30 minute geocaching session. Only 25 of the subjects recorded usable data. The results from the data suggest that the subjects work at higher level and for a longer duration while geocaching as it is compared to self paced walking. There was no statistical significance between the percent of peak HRR, while walking and while geocaching. Thus, this research suggests that participants will experience similar short bouts of exercise intensity while geocaching and self paced walking.

Geocaching fits cross-curricular needs in physical education, meets NASPE national standards, and has the potential to teach students a sport that will lead them into a lifelong activity. Geocaching also fits into outdoor pursuits curriculums which are being introduced into physical education to improve student motivation. Geocaching also has the potential to improve physical fitness in students. During a geocaching lesson, students will be moving with a purpose and will be learning an activity that could help them be lifelong movers. Overall, geocaching is a valuable activity that meets the needs of all students in physical education. Teachers and schools should consider implementing geocaching into their curriculums.

RECOMMENDATIONS AND LIMITATIONS

This study completes a series of studies examining the relationships between heart rate and geocaching for students in primary, secondary, and college levels of education (Minulto, 2010 & Stratton, 2008). However, the effects of motivation and geocaching may need to be researched. Minulto 2010, did not find statistically significant differences between self paced walking and geocaching in elementary aged students. However, this study did, and Stratton (2008) found statistically significant differences between heart rates while geocaching and while competitive geocaching for college aged students. Thus, there were different motivational factors present in all three of the studies. The most similar motivational factors were found in this study and Stratton (2008). Therefore, a suggestion for further research would be to examine motivation and its relation to geocaching

Limitations to this study include subject's age, weather, and students' motivation to participate in a non graded activity. Limitations should be considered when examining the results of this study.

REFERENCES

Geocaching. (2010). The Official Global GPS Cache Hunt Site http://www.geocaching.com/

Lapere, D., Mummery, W., & Yates, K. (2008). Identifying Cross Curricular Linkages of a Class-Based Walking Challenge: An Exploratory Study. *ACHPER Australia Healthy Lifestyles Journal*, 55(1), 11-17. Retrieved from http://www.achper.org.au/publications/asia-pacific-journal-of-health-sport-and-physical-education

Lubans, D. R., Morgan, P. J., Collins, C. E., Boreham, C. A., & Callister, R. (2009). The relationship between heart rate intensity and pedometer step counts in adolescents. *Journal of Sport Sciences,* April 2009, 27(6): 591-597. Retrieved from http://www.jssm.org/#

Minutolo, S. (2010). *The Effect of Geocaching on Heart Rates of Elementary Students*. (Unpublished Masters Thesis). University of Wisconsin La Crosse. La Crosse, WI.

National Association for Sport and Physical Education (2004). *Moving into the Future National Standards for Physical Education Second Edition.* Retrieved from http://www.aahperd.org/naspe/standards/nationalStandards/PEstandards.cfm

Siegel, D. (2007). Research Works: Middle School Students' Attitudes about Physical Education. *JOPERD: The Journal of Physical Education, Recreation & Dance*, *78*(9), 9.Retrieved from http://www.aahperd.org/publications/journals/joperd/joperdissues.cfm

Stratton, C (2008). *A comparison of the Effects of Recreational Geocaching verse Competitive Geocaching*. (Unpublished Masters Thesis). University of Wisconsin La Crosse. La Crosse, WI.

Tanaka, H, Monahan, K, Seals, D.(2005). " Age-predicted Maximal HR revisited", *Journal of the American College of Cardiology*, 37 (1),153-2011.Retrived from http://content.onlinejacc.org/archive/

Wright, R.W. & Karp, G.G. (2006). The effect of four instructional formats on aerobic fitness of junior-high school students. *Physical Educator*, 63(3). 143-153. Retrieved from http://journalseek.net/cgibin/journalseek/journalsearch.cgi?field=issn&query=0031-8981

APPENDIX A

REVIEW OF LITERATURE

INTRODUCTION

Providing students with the tools they need to become physically active for their life is one of the main goals of physical education. After all, this generation of students is the first generation that is predicated to have a shorter lifespan than their parents (Carmona, 2007). Educators have a huge impact on students and have a responsibility to inspire their students to become physically active for life and to make healthy life choices. This responsibility is deeply rooted in physical education and, it is our job as physical educators to provide our students with the tools they need to live a healthy, active life.

In the past physical education has been known as the training grounds for the athletically inclined and gifted. Gym class was where students were trained to play interscholastic sports. However, this did not reach out to all the students and did not teach students how to be physically active for their life. Physical Education only reached students that were most likely already inclined to live a healthy, active life. However, in physical education we have a duty to reach all students and provide all students with the tools and knowledge they need to make healthy life choices. Furthermore, only 6%o of people continue playing sports once they graduate high school. So if 6% percent of the population enters adulthood and continues to play sports, than why has physical

education traditionally been about sports? We as educators are not reaching 94% of the population.

In order to reverse this trend, the National Association of Sport and Physical Education has set forth standards for physical education that ensures that students are receiving a well rounded physical education experience. The students are taught through all three domains: psychomotor, cognitive and affective (NASPE, 2004). Furthermore, different curriculums have been introduced to physical education. Movement and Skill Themes have been introduced especially in the elementary schools. This focuses on how to move, and how to manipulate objects. This type of curriculum does not necessarily teach sports, but instead teaches students a variety of movement forms that give students the tools they need to be lifelong movers. Also, fitness education has been introduced. Fitness education focus on making students aware of how their body works as it related to heart rate, muscles, and different types of fitness. Another curriculum introduced into physical education focuses on outdoor pursuits and adventure education. All three curriculums have the potential to meet the NASPE national standards for physical education.

The curriculums that this review is focused on are Outdoor Pursuits as well as Fitness. The idea of outdoor pursuits is to introduce students to activities that they can do in their community. So a school located on the coast may teach surfing. While a school in the mountains, may choose to teach mountain biking and hiking. These types of classes introduce the students to physical activities that they can do in their community and for the rest of their life. Outdoor pursuits are tied into fitness, because it gets people moving

with a purpose. Geocaching is one such outdoor pursuit, and may have the potential to fit into the fitness curriculum.

Geocaching is a worldwide sport that was started in 2000. Today there are 1, 251, 809 active geocaches in the world with 4-5 million people participating in the outdoor pursuit (Geocaching, 2010). Geocaching is essentially a worldwide game of treasure hunting that uses Global Position Systems (GPS) to seek and hide treasure. People hide treasures (caches) in towns, forests, underwater, and in trees and then log the cache's coordinates online. Geocachers then log into the website, take those coordinates and plug them into GPS units. From there, geocachers use their GPS to find the caches. This sport is fun for people of all ages, accessible to all, and people can participate with family, friends or individually. Geocaching gets people outside in their community and gets participants moving with a purpose (Geocaching, 2010).

Many schools are introducing geocaching as a part of their outdoor pursuit's curriculums. Research has been done on the effects of heart rate on elementary aged students while geocaching (Minutolo, 2010). Furthermore, Stratton (2008) researched the effects of recreation geocaching verses Competitive Geocaching on college students. However, the effects of heart rate while geocaching for adolescent students has not been researched.

This review of literature will focus on the aspects, outdoor pursuits, fitness, and motivation as it relates to physical education and outdoor pursuits. Specifically, this review of literature will focus on the use of heart rate monitors in physical education, GPS and orienteering as well as exercise in physical education, the motivation to

participate in physical education, outdoor physical education and the NASPE national standards.

The Use of Heart Rate Monitors in Physical Education

The use of heart rate monitors on adolescents is a quantitative way to measure children's physical activity (Janz et al., 1992). This allows for researchers to measure adolescents' activity with numbers instead of relying on questionnaires, which can be inaccurate and allow for falsification of data (Janz et al., 1992) Furthermore, according to Janz (2006), "activity monitors have been used with increasing regularity." Thus, "The increase in activity monitor use is most likely due to both their demonstrated success and the decline in cost of this technology;" also, "activity monitor diffusion has been supported by several international conferences with published proceedings" (Janz, 2006). Heart rate monitors are a tool that is enabling researchers to find objective, valuable and new information regarding people of all ages' physical activity levels. This data can be linked to research about a person's physical well being.

The use of heart rate monitors for school aged children can be traced back to the early 1970's. Researchers began using heart rate monitors to study the relationships between heart rate and oxygen uptake. However, there were many limitations in the early years of heart rate monitoring. For example, heart rates could only be measured in controlled settings such as a lab. Therefore, the data was collected in controlled settings. The heart rate monitors were also intrusive which affected how the person was performing during the physical activity. These monitors included electrodes that were connected to an ECG machine. A heart rate monitor was introduced in the late 70's that

had an "optimized cable-connected chest belt and in 1983 the first wireless heart rate monitor using electric field data transfer was introduced" (Laukkanen et al., 1998). Today heart rate monitors are low cost, unobtrusive, and the newest models are easy to use. (Luakkanen et al., 1998) writes, "polar heart rate monitors have been recognized as the most accurate tools for heart rate monitoring and registering in the field. Extensive research and development work has also resulted in high-quality devices for the analysis of heart rate data." With the new and improved technology available to researchers regarding heart rate monitors, the amount of research in the field has grown exponentially.

Janz et al., (1992), conducted a study in Muscatine, IA. There were 934 students randomly selected from the local school district, and from the 934 students, 85 were selected to wear heart rate monitors. The subjects were between the ages of 6-17 and their heart rate was examined as well as other factors including VO2, body fat analysis, and maturation. Only 76 of these subjects wore the heart rate monitors for at least 8 hours and the goal was to have the subjects wear the heart rate monitors for at least 12 hours a day between the months of July-August. Each subject was assigned a heart rate monitor that was programmed and downloaded by an investigator in the study. The investigator downloaded the information to a personal computer and an average heart rate during physical activity was developed for each day that the subject wore the heart rate monitor. Furthermore, the subjects were administered a validated physical activity questionnaire within twelve hours of the physical activity that was measured. After a baseline heart rate was developed for each subject, the researchers determined the subject's measured physical activity for the day by the equation: heart rate minus- baseline heart rate divided

by the number of minutes monitored. The study's purpose was to determine if heart rate monitoring could be used as a quantitative measure of physical activity for children and adolescents. The results showed a positive and important relationship between heart rate monitoring and previously validated physical activity questionnaires (Janz et al., 1992). This positive correlation helped pave the way for future research in the field of heart rate monitors. This is important to physical education because one of the main goals of physical education is to teach children how to be physical active for life (NASPE, 2004). If heart rate monitors provide quantitative data as it relates to physical activity, then physical educators can use heart rate monitors to determine how physically active their students are in physical education class.

One study that used heart rate monitors in physical education to determine activity levels of students was conducted in 1993 by Strand and Reeder. Their study was conducted in a middle school physical education class and they write:

> As can be noted, ALT-PE research is concerned with student engagement time, and practice trials and practice achievement research is concerned with skill acquisition. To date the most popular technique for determining student achievement in terms of fitness acquisition has dealt with the end product. Measures typically include timed mns, distance runs, push-ups, pull-ups, and situps and inform us where students rank in relation to norms but not how they attained that ranking. (Strand et. al, 1993)

Their study investigated and correlated the use of heart rate intensity as the focus of instruction. This study was done "to demonstrate the use of heart rate monitors in fitness research … and to investigate heart rate intensity levels of middle school students while they participated" (Strand et. al, 1993). The study was conducted for the duration of one year. The results found that the majority of students achieved their target training heart

rate zone. However, the majority of these students were not in their target zone for more than 15 consecutive minutes (Strand et al., 1993).

This study is very important in the field of physical education because it was one of the first studies conducted using heart rate monitors in physical education classrooms to measure fitness levels. The researchers laid a foundation for research related to the use of heart rate monitors in physical education and posed many important thoughts for further research such as:

> Further study investigating heart rate intensity levels should be experimental in nature and focus on items such as teaching styles; teaching models; training and fitness protocols; active learning time; comparisons of students with different body types, fitness levels, sex, and skills; and comparisons (Strand et al., 1993).

The suggestions for further research posed by Strand and Reeder contributed to the continued research in physical education and the use of heart rate monitors. This has lead to the implementation of heart rate monitors in physical education across the country. (Nichols et al., 2009) writes "heart rate monitors help specifically to assess whether students in physical education classes have exercised in the appropriate heart rate zones in order to achieve a training effect for cardiovascular endurance."

Furthermore, technology is something that teachers in every area of education are trying to incorporate in their classrooms. Physical education is no exception and heart rate monitors provide the physical educator with a valuable piece of technology that can be used to teach students about their heart and how it works, measure students' progress, and asses how much time students are spending in their target heart rate zone. Furthermore, "heart rate monitors provide the motivation for students to move" (Nichols et. al, 2009).

A study conducted by Duncan, Badland and Schofield (2009), used a new style of heart rate monitors that had an integrated GPS system within the heart rate monitor. They measured the energy expenditure for children's movement during a 50 minutes free play time (Duncan et al., 2009). They found that the subjects displayed periods of high bursts of speed and even more periods of lower bursts speed (Duncan et al., 2009). This new technology of GPS tracking capability in heart rate monitors could be a huge benefit in physical education. Teachers could not only examine students' heart rate, but the distance covered by the student and the speed that the student was traveling. This could lead to the teacher developing more personalized work out plans for students, record keeping of student progress as well as optimal training zones for each individual student.

Furthermore, a study was done that looked at the relationship between step count and heart rate intensity. The study used heart rate monitors and pedometers. The study included both male and female students, average age 14.2 years. The subjects completed the Queens College Step Test and were classified as having low, moderate, or high fitness levels (Lubans, Morgan, Collins, Boreham, & Callister, 2008). The subjects wore pedometers and heart rate monitors during a ten minute treadmill trial and were instructed to maintain their heart rate between 65% and 75% of their maximum heart rate, while running or walking on the treadmill (Lubans et al., 2008). "The results of this study suggest that a step rate of 130 steps per minute be used as an initial goal to improve fitness" (Lubans et al., 2008).

Therefore, we know that heart rate monitors can be used to quantify physical activities and how long persons wearing heart rate monitors are in a particular fitness zone. Thus, heart rate monitors can be introduced into physical education as technology

and provide cross curricular instruction opportunities. Furthermore, heart rate monitors can be equipped with GPS technology, and 130 steps per minute can be use as an initial goal to improve physical fitness (Lubans et. al, 2008). As a result, the heart rate monitor with GPS technology could be used to improved physical fitness in students by examining their speed and distance covered. This could be compared to 130 steps being taken per minute to see if the student is meeting an initial goal to improve fitness.

If the physical education teacher had students geocaching while wearing heart rate monitors, the students would be moving with a purpose and learning an outdoor pursuit. Furthermore, the teacher could track the students' step counts per minute to determine if the students are meeting basic fitness goals. Thus, heart rate monitors prove to be a valuable to tool that can be used in physical education because "allowing the implementation of effective technology tools [will] supplement quality physical education programs in public schools and assist students in achieving individual fitness goals" (Mears, 2010).

GPS and Orienteering in Physical Education

Orienteering with adventure components provides an enjoyable experience for students, while connecting the four domains of physical education: cognitive, psychomotor, affective, and health related physical fitness (Claxton, Grube, & Young, 2001). Orienteering has been taught in physical education for many years. The original purpose was to teach students about navigation, but orienteering has evolved into an outdoor pursuit. This outdoor pursuit can now be found within many global competitions such as Adventure Racing, ECO Racing, and competitive geocaching. Furthermore, the outdoor pursuit is used by many as a recreational activity such as geocaching. Whether

students use the skills needed to go orienteering for competition or recreation, the outdoor pursuit is a valuable part of the outdoor pursuit and adventure curriculum.

One study conducted by Le Faucheur, Abrham, Jaquinandi, Bouye, Saumet, & Noury-Desvaux, (2007), examined human outdoor walking with a low cost GPS. The purpose of the study was "to determine whether a low-cost, commercially available global positioning system (GPS) can be used to study outdoor walking of healthy subjects, allowing the detection of walking and resting (nonwalking) periods and the accurate estimation of speed and distance of each walking periods" (Le Faucheur et al., 2007). The study had 6 healthy subjects that went through a walking test on an outdoor athletic track 21 times. Low cost Garmin GPS systems were used to determine the subjects' walking and non-walking bouts. The second part of the study included 10 healthy individuals who performed the same walking test, but at an outdoor park. Finally, the third part of the study included "speed and distance calculated by the GPS receiver during series of 100–400 m on an outdoor athletic track" (Le Faucheur et al., (2007). The results of this study concluded that "Low-cost, commercially available GPS may be accurate in studying outdoor walking, provided that simple data processing is applied" (Le Faucheur et al., 2007). The simple data processing that the study refers to is a spreadsheet, and the following is the spreadsheet used by Le Faucheur et al., (2007).

downloaded GPS data according to the covered distance; the typical error of the measurement (TEM) and the coefficient of variation (CV) are presented.

	Walking Distance (N = 251 Bouts)		Walking Speed N = 161 Bouts)	
Distance (m)	*TEM*	*CV*	*TEM*	*CV*
100	3.00	2.91	0.22	3.40
200	5.60	2.7	4 0.16	2.47
300	4.59	1.50	0.08	1.31
400	5.23	1.28	0.06	0.99
2000	19.16	0.94	0.06	20.84

TEE is expressed in meters and in kilometers per hour for walking distance and walking speed, respectively

So if GPS can accurately depict a person's walking speed and distance then an orienteering course could be designed to cover a certain amount of distance in a certain amount of time. This course would reflect the walking speed that would be desirable for obtaining physical fitness, or the subject's heart rate could be monitored to determine if the person was in their target heart rate zone.

Incorporating Geocaching or orienteering into physical education may be easier than one may think. Geocaching GPS systems are relatively inexpensive and cost around $100 a unit (Geocaching 2010). Additionally, smart phones such as the IPHONE, Blackberry, and Androids have applications for purchase. The applications cost around $10 and this is a onetime only charge. Furthermore, GPS units used for navigation such as Garmin and TomTom can be used for geocaching (Geocaching, 2010). One benefit of the GPS units is that a GPS unit for every student is not needed because geocaching can be done in groups: up to six students could use a GPS unit at one time and still be acitively involved. Furthermore, logging on to the geocaching website is free of charge. One simply needs to create a free account and they have access to caches all over the world (Geocaching, 2010).

Laubauch (1998) writes, "[orienteering] is a fun sport that combines physical conditioning and thinking." While orienteering, or the sports' more modern form, geocaching, is designed to be a fun sport and with over one million users, Geocaching (2010), one would have to agree that people enjoy the sport. However, we truly do not know what the fitness benefits may be from the sport because there is little research regarding heart rate or step counts while a person geocaches.

However, Minutolo, (2010) completed a study on the effects of heart rate on elementary aged students while geocaching. She used 58 students in grades 3-6 and measured their heart rate while walking in the first trial and geocaching in the second trial. The students walked for 40 minutes during each trial. The subjects' heart rate was recorded continuously using a Polar heart monitor during both trials. The students were taught how to use the heart rate monitors and GPS geocaching devices (Minutolo, 2010). Minutolo (2010) designed a walking and geocaching course that would take the subjects 40 minutes to complete. The subjects completed both trials within their grade level. Minutolo (2010) found that there was no significant difference between walking and geocaching exercises; thus, both walking and geocaching have similar exercise demands.

Walking can be considered a fitness activity as long as there is a medium to brisk pace set and the walker walks for at least a 20 minute duration. So a physical education teacher looking to implement geocaching into their curriculum as a means to work on fitness would need to consider the pace of the students and the duration of the activity. This study is a valuable piece of information for physical educators considering a geocaching unit; however, it is limited to elementary aged students. There is no known research that examines the relationship between adolescent heart rate while walking and while geocaching. However, there is a study that examines the effects recreational verses competitive geocaching (Stratton, 2008).

Stratton (2008) examined the heart rate of college aged students while recreationally and competitively geocaching. The subjects completed a three part trial each lasting one hour. The first part was a training session, the second part was recreationally geocaching and third part was competitively geocaching. The subjects

wore heart rate monitors throughout all three parts of the study and their heart rates were continuously recorded using Polar heart rate monitors (Stratton, 2008). The researcher found " significant differences in average heart rates, percentages of average heart rates, maximum heart rates, and percentage of maximum heart rate between recreational and competitive geocaching," using four paired t-tests (Stratton, 2008).

This does provide insightful information into how heart rate can be affected by different variations of the outdoor pursuit of geocaching. We know from Minutolo, (2010) that geocaching is a similar physical activity to walking for elementary aged students. Furthermore, Stratton (2010) shows the relationship between recreational geocaching and competitive geocaching as it relates to heart rate in college aged students, but where do all the students in the middle fit?

If we look at the progression of most sports and activities, the fundamentals are taught in elementary school, and then in high school those skills are refined and students choose which sports that they want to pursue as lifelong activities. Therefore, Minutolo and Stratton's findings would support physical education goals of introducing activities to younger students and developing those skills throughout the students' K-12 education. This gives students the skills and knowledge they need to maintain a health enhancing level of physical fitness. Thus, if geocaching is similar to walking for elementary school students Minutolo, (2010) and Stratton (2008) suggests that geocaching is a physical activity that can be used for fitness in the college aged population then we must figure out the relationship between heart rates while walking and while geocaching in adolescents. Hence, high school aged students are the missing piece of research regarding geocaching as a physical fitness activity.

Geocaching is worthy of being taught in physical education because it has the ability to get students moving with a purpose, it introduces technology into the classroom, and teaches students a potential lifelong activity that is accessible to all people around the world (Geocaching, 2010). However, the fitness component of teaching geocaching to adolescent students is not known. Beighle & Darst (2004) state this clearly:

> Orienteering is a life-long enjoyable activity that creates an awareness of one's surrounding, a sense of direction, and a degree of physical fitness. By using some creativity and making physical education activities enjoyable, educators can help motivate students to develop physically active lifestyles

Thus, the purpose of this study is to turn the term "degree" into quantitative data regarding the degree of physical fitness that geocaching can provide to high school aged students.

Motivation to Participate in Physical Education

Physical educators face many challenges just like other teachers in the public school system. One challenge that is cross-disciplinary would be that of student motivation. How do we get students active, involved and participating in physical education? How do we get them to carry the motivation to move with a purpose with them into their daily lives? Many studies and research have been done to answer these questions.

One such study was completed by Gehris, Kress, & Swalm (2010). These researchers investigated "10th –grade students' views concerning the physical effects of an adventure-physical education curriculum and the potential of such a curriculum to enhance components of a multidimensional model of physical self-concept" (Gehris et al., 2010).

The researchers observed a unit of adventure education that lasted 21 days. The researchers interviewed students during their adventure education classes and after the adventure education unit was completed. The researchers observed the class and selected students based on their participation in the class. Selection was in turn validated by the physical education teacher. Students who were actively involved, students who were quiet and reserved, and students who showed signs of disengagement were all selected to take part in the interviews. Each student's interview was videotaped to ensure accuracy in compiling data. The researchers asked pre-determined questions to each of the participants. The questions were open-ended and allowed the student to express their true feelings on the matter (Gehris et al., 2010). Open coding was used to compile the results of the interviews. The coding was done by examining the interviews line by line and grouping student's responses into similar categories using phrases or words that the students used. The data was then analyzed and the researchers found that:

> Students viewed adventure activities as an alternative way to be physically active that was more fun and motivating than traditional forms of exercise. Students expressed how the adventure activities helped them build strength and endurance particularly in their arms and legs. Students felt seven components (body fat, coordination, endurance/fitness, flexibility, physical activity, sports competence, and strength) of physical self-concept were relevant to adventure-physical education and two components (appearance and health) were not (Gehris et al., 2010)

This research is important for physical educators because it suggests that an adventure curriculum can increase motivation in adolescent students. Adventure education is different than outdoor pursuits. However, the two curriculums can be taught in an interwoven approach to physical education, and in most schools they are taught this way. For example, a ropes course is part of an adventure curriculum. However, if

students are taken to a rock face in the outdoors to practice the skills they learned on the ropes course then the actual climbing done on the rock face would be considered an outdoor pursuit. Therefore, outdoor pursuits may be motivation for students to perform in physical education.

Another study examining motivation in physical education was completed by Weidong, Wright, Rukavina, & Pickering (2008). This study measured "students' perception of personal and social responsibility and the relationship to intrinsic motivation in urban physical education" (Weidong et al., 2008). The study consisted of 253 participants that were in middle school, and Weidong et al., (2008) states:

> The purpose of the current study was to test the validity and reliability of a two factor model of the Personal and Social Responsibility Questionnaire (PSRQ) and examine the relationships between perceptions of personal and social responsibility and intrinsic motivation in physical education.

The PRSQ was modified for this study to fit the needs of the middle school students and the validity of the modified questionnaire was verified by a panel of experts. These panel members were considered experts in the field and all belonged to the TPSR advisory board. "The PSRQ consists of two factors (personal responsibility and social responsibility) with seven items for each factor" Weidong et al., (2008). The data collection portion of this study took 3 days and the students filled out the questionnaires in their school cafeteria with trained graduate students present to help with any questions. The entire process took about 15 minutes to complete. Students were encouraged to ask questions and to answer the questionnaire honestly.

The data was then analyzed using a SAS code program. Furthermore, the "multiple fit indices including the comparative fit index (CFI), the Bentler–Bonett non-

normed fit index (NNFI), and the root mean square error of approximation" were used to determine the validity of the PRSQ and to determine the adequacy of the measurement models (Weidong et al., 2008).

The results of the study suggests "that the PSRQ is a valid and reliable tool for assessing students' personal and social responsibility in the physical education setting" (Weidong et al, 2008) Furthermore, Weidong et al., (2008) state:

> The correlation analysis suggests that participants with higher levels of personal and social responsibility were likely to enjoy physical education more. An important implication for teaching practice is that, to encourage physical education teachers need to empower students with choices and voices, focus them on effort and self-direction in physical education, and create a respectful and caring learning environment.

One of the purposes of adventure education is to place an "individual in an unfamiliar environment that creates disequilibria, and focuses learning on problem solving" (Hammes, 2007 & Rohnnke & Butler, 1995) as well as providing students with self direction. This can create a sense of self efficacy. Therefore, students learn about self worth, teamwork, initiative, problem solving, physical coordination, and this can improve a student's overall sense of belonging to a group (Rohnke, 1995). All of this is accomplished through implementing an adventure based curriculum into physical education.

As discussed previously, adventure education and outdoor pursuits can be linked in an interwoven approach to teaching physical education and, Weidong et al., (2008), suggests that teachers should provide students with choices, problem solving skills, and create self direction for the students in physical education. Adventure education and outdoor pursuits are a curriculum designed to give students the power to take learning

into their own hands. Thus, this type of curriculum is one way to improve motivation to participate in physical education. Furthermore, introducing students to activities that they can do in their local community can give students the tools they need to make active living choices once they leave high school.

Physical educators have a responsibility to teach their students how to move with a purpose and give students the tools they need to live a healthy active life. Teaching traditional sports and games may not be enough, and this type of curriculum may only reach the athletically inclined students. However, adventure activities and outdoor pursuits have the potential to reach students in the affective domain. The sense of self efficacy gained from adventure and outdoor pursuit's activities may serve more of the student population than the traditional sport curriculums of physical education. However, too much of one thing may lead to burnout and disinterest from students. Therefore, if physical educators teach a wide variety of subjects this may lead to a more well rounded physically educated student. An example may be teaching dance, sports, outdoor pursuits, adventure and fitness to students throughout the duration of their physical education classes. This exposes students to a wide variety of activities, and gives students the knowledge and physical ability to choose which avenue of physical activity works best for them.

Outdoor Physical Education and National Standards

"As our society becomes more technologically advanced, people are spending more time indoors in artificial environments and less time in natural settings" (Stenger-Ramsey & Curl 2010). This disturbing trend has led to the phenomenon of children staying indoors watching television, playing video games, or surfing the internet. There

has been research conducted regarding this issues, and Richard Louv (2006), coined the phrase "nature defiect disorder." He believes that children are spending too much time indoors, and the time that they do have to play is diminished when scheduled with music lessons, organized sports, and other extracurricular activities. Children just don't have time to be kids. Their schedules are often as jam packed as adults and these schedules have led to a major health crisis. According to Louv (2006):

> The obesity epidemic has coincided with the greatest increase in organized sports for children in history. What are kids missing that soccer and Little League cannot provide? Generalized, hour-to-hour physical activity is the likely absent ingredient. The physical and emotional exercise that children enjoy when they play in nature is more varied and less time bound than organized sports.

This has lead to the implementation of more outdoor education programs in schools across the United States. Schools have started implementing programs such as Archery, Hiking, Canoeing, Orienteering, and Fishing (Stenger-Ramsey et al., 2010). Furthermore, physical education teacher programs have expanded their teacher education programs to include environmentally based instruction such as Project WILD. (Stenger-Ramsey et. al., 2010) Project WILD is a program designed to give educators a curriculum to teach environmental education to students. The curriculum features hands on learning activities such as games and projects for the students to complete. The curriculum is cross disciplinary and teaches students in all three domains: cognitive, affective, and psychomotor (Project WILD, 2001). Teaching physical education outside introduces students to activities that they can do at home in their backyards, in their communities, and the activities do not have to be organized into time-slots like most organized sports programs (Louv, 2006).

Communities are also getting behind the idea of outdoor or adventure opportunities Moorman, Schlatter & Hurd (2007) write,

> Schools are building ropes and challenge courses for physical education programs; city parks and recreation departments are constructing whitewater parks for canoeing and kayaking enthusiasts; county park departments are transforming portions of their greenways into mountain bike trails; and communities are beginning to see the potential of large rocks for bouldering activities.

This type of infrastructure is huge for physical education. If communities are providing more space and facilities for outdoor recreational purposes, then why not teach students how to go outdoors and be active? Physical educators would be providing students the tools they need to go out and do what is available in their own community if they "take physical education out of the gym"(Stenger-Ramsey et al., 2010).

Outdoor physical education can be referred to as "the new P.E." (Lambert, 2000), and this curriculum focuses "more on individual health and fitness and less on the acquisition of athletic skills (Lambert, 2000; Moorman et al., 2007). So if the physical educator takes physical education outside of the gym, will they still be meeting the national standards set for by NASPE? According to NASPE (2004), the standards for physical education are:

Table 4: NASPE Standards

Standard	Definition
1	Demonstrates competency in motor skills and movement patterns needed to perform a variety of physical activities
2	Demonstrates understandings of movement concepts, principles, strategies, and tactics as they apply to the learning/performance of physical activities
3	Participates regularly in physical activity
4	Achieves and maintains a health-enhancing level of physical fitness
5	Exhibits responsible personal and social behavior that respects self and others in physical activity settings
6	Values physical activity for health, enjoyment, challenge, self-expression, and or social interaction

Looking at the standards above, outdoor physical education could easily meet standards 1 and 2, and if physical educators teach outdoor pursuits that are available to their students in the local community the teacher would be providing the students with the opportunity to meet standard 3, "participates regularly in physical activity" (NASPE, 2004). Standards 4, 5, 6 have the potential to be met by outdoor physical education (OPE); especially, if teaching OPE is incorporated into a curriculum that also involves adventure education.

However, when looking at physical education from an objective standpoint "following national standards alone will not ensure a quality program," and "although many programs are using the standards to create innovative, coherent, learning-focused programs, the field of physical education, like any other field, is driven as much by tradition as by innovation" (Lambert, 2000). Lambert makes a valid point by arguing that following the NASPE National Standards does not ensure a quality physical education program. The teachers of outdoor physical education need to make certain that they are providing a solid framework, curriculum, and assessments to guarantee that they are

providing a quality physical education program to their students. In order to make certain quality physical education is occurring, there are many objective analysis systems available to physical education teachers. These objective analysis tools can examine the students, teachers, and curriculum based on which tool you choose. Some examples include: PETAI, SOPHIT, ECOVE, and The Physical Education Teacher Evaluation Tool.

The purpose of this review is not to examine whether or not OPE, outdoor pursuits, or adventure education meets national standards or quality physical education expectations. However, they are important to the overall research available about geocaching. Geocaching is an outdoor pursuit that fits into the category of OPE. OPE is a beneficial curriculum for physical educators, especially in the secondary setting. Outdoor Physical Education is a change for the traditional sports taught in physical education. When students reach secondary schools, they are often bored of physical education and ready for new and different challenges (Siegel, 2007). If the physical education teacher can, "[enhance] student attitudes toward physical education, especially enjoyment, will foster immediate engagement and long-term participation in physical activity" (Siegel, 2007). Fostering "long-term participation in physical activity", is one of the main objectives of physical education and one of the many reasons why physical educators should be examining new and exciting activities to teach their students (Siegel, 2007). Many answers for new and exciting activities lie in outdoor physical education. Geocaching is a perfect example of ideas to teach within the outdoor physical education, adventure education, and outdoor pursuit curriculums.

Conclusion

This review of literature examined geocaching as an outdoor pursuit, the role of outdoor pursuits in physical education, the use of heart rate monitors to measure physical activity, and students' motivations in physical education. It has been established that geocaching is an outdoor pursuit that is enjoyed by people throughout the world, and many schools are starting to integrate orienteering's modern form of geocaching into their curriculums. The sport is growing in popularity and offers physical educators a way to introduce technology into the gymnasium. However, there is very little information known about the effects of geocaching on a person's physical fitness.

The use of heart rate monitors has proved a quantitative way to measures a person's physical activity level. The information that a heart rate monitor can provide is valid and can help a physical educator understand how physically active their students are during physical education class. Furthermore, the use of heart rate monitors in physical education helps students understand how their body works and how their body responds to physical activity. The use of heart rate monitors in this study will help researchers understand the relationship between an adolescents' heart rate while walking and while geocaching. This will help better determine geocaching place in the physical education curriculum as well as help researchers to understand which national standards geocaching meets. Furthermore, geocaching fits into a new curriculum, outdoor physical education. This curriculum has been designed to spark a renewed interest in physical education and motivate students to be active movers both inside and outside of the gym.

New curriculums and new ideas in physical education are more important than ever because the United States is amidst a national health crisis. Physical educators are leaders in helping to combat childhood obesity and other sedentary life style diseases. Physical educators are constantly looking for new ways to reach their students, and inspire their students to be lifelong movers. Outdoor physical education is an approach to teaching physical education outside of the gym and moves away from the more traditional athletic activities taught in physical education. This type of curriculum offers students avenues to be active movers in their community, and helps improve student motivation to participate in physical education. Geocaching is a sport that fits into the outdoor physical education curriculum, and provides students with knowledge and skills needed to pursue geocaching as a lifelong physical activity.

This study will help researchers and professionals to better understand the relationship of adolescents' heart rate while walking and while geocaching. This research will help us all to better understand the aerobic benefits of geocaching. One thing will still be true at the end of this study and that is that geocaching is a world-wide sport that is growing day by day. Geocaching has the ability to get people moving with a purpose, and may help motivate students to get more involved in their physical education class.

REFERENCES

Beighle, A., & Darst, P. (2004). Fitness scavenger hunts for middle school students. *Strategies: A Journal for Physical and Sport Educators*, *17*(6), 13-15. Retrieved from http://www.aahperd.org/naspe/publications/journals/strategies/

Carmona, Richard. (2007). The Growing Epidemic of Childhood Obesity. *Office of the Surgeon General Testimony*, (1). Retrieved from http://www. surgeongeneral.gov/news/testimony/obesity07162003.htm

Claxton, D., Grube, D., & Young, J. (2001). Using initiative games to build community, cooperation and trust. *Strategies: A Journal for Physical and Sport Educators*, *15*(1), 35- 37. Retrieved from http://www.aahperd.org/naspe / publications/journals/strategies/

Duncan, S., Badland, H., Schofield, G. (2009). Combining GPS with heart rate monitoring to measure physical activity in children: A feasibility study. *Journal of Science and Medicine in Sport*, 12: 583-585. Retrieved from http://www.jssm.org/#

Gehris, J., Kress, J., & Swalm, R. (2010). Students' Views on Physical Development and Physical Self-Concept in Adventure-Physical Education. *Journal of Teaching in Physical Education*, *29*(2), 146-166. Retrieved from http://journals.humankinetics.com/jtpe

Geocaching. (2010). The Official Global GPS Cache Hunt Site Retrieved from: http://www.geocaching.com/

Hammes, R. (2007). Orienteering with Adventure Education New Games for 21st Century. *Strategies: A Journal for Physical and Sport Educators*, 20(5), 7-13. Retrieved from http://www.aahperd.org/naspe /publications/ journals/strategies/

Janz, K., Golden, J., Hansen J., & Mahoney, L. (1992). Heart monitoring of physical activity in children and adolescents: the Muscatine study. *Pediatrics*, 89256-261. Retrieved from http://www.jpeds.com/issues

Janz, K. (2007). Physical activity in epidemiology: moving from questionnaire to objective measurement. *British Journal of Sports Medicine,* 40 (3): 191-192. Retrieved from http://bjsm.bmj.com/content/by/year

Lambert, L. T. (2000). The new physical education. *Educational Leadership, 57*(6), 34-38. Retrieved from http://www.ascd.org/publications/educational-leadership.aspx

Laukkanen, R., & Virtanen, P. (1998). Heart rate monitors: State of the art. *Journal of Sports Sciences*, *163*-7. Retrieved from http://www.tandf.co.uk/journals/titles/0264-0414.asp

Le Faucheur, A., Abraham, P., Jaquinandi, V., Bouyé, P., Saumet, J., & Noury-Desvaux, B. (2007). Study of Human Outdoor Walking with a Low-Cost GPS and Simple Spreadsheet Analysis. *Medicine & Science in Sports & Exercise*, *39*(9), 1570-1578. doi:10.1249/mss.0b013e3180cc20c7

Louv, R.(2006). *Last Child in the Woods Saving Our Children from Nature-Deficit Disorder*. Chapel Hill, NC: Algonquin Books of Chapel Hill.

Lubans, D. R., Morgan, P. J., Collins, C. E., Boreham, C. A., & Callister, R. (2009). The relationship between heart rate intensity and pedometer step counts in adolescents. *Journal of Sport Sciences,* April 2009, 27(6): 591-597. Retrieved from http://www.jssm.org/#

Mears, D. (2010). Technology in Physical Education Article #6 in a 6-Part Series Physical Activity Monitoring: Gadgets and Uses. *Strategies: A Journal for Physical and Sport Educators*, January/February 2010,23(3): 28-31. Retrieved from http://www.aahperd.org/naspe/publications/journals/strategies/

Minutolo, S. (2010). T*he Effect of Geocaching on Heart Rates of Elementary Students*. (Unpublished Masters Thesis). University of Wisconsin La Crosse. La Crosse, WI.

Moorman, M., Schlatter, B., & Hurd, A. (2007). Adventure Recreation: Coming Soon to Your Community. *JOPERD: The Journal of Physical Education, Recreation & Dance*, *78*(9), 22-26. Retrieved from http://www.aahperd.org/publications/journals/joperd/joperdissues.cfm

Project Wild. (2001). *Project Wild K-12 Curriculum & Activity Guide*. Houston, Texas: Project WILD & Council for Environmental Education.

National Association for Sport and Physical Education (2004). *Moving into the Future National Standards for Physical Education Second Edition*. Retrieved from http://www.aahperd.org/naspe/standards/nationalStandards/PEstandards.cfm

Nichols, R., Davis, K. L., McCord, T., Schmidt, D., & Slezak, A. (2009) The Use of Heart Rate Monitors in Physical Education. Strategies: A Journal for Physical and Sport Educators, July/August 2009, 22(6): 19-23. Retrieved from http://www.aahperd. org/naspe/publications/journals/strategies/

Rohnke, K., & Butler, S. (1995). *Quicksilver: Adventure games, initiative problems, trust activities, and a guide to effective leadership*. Dubuque, IA: Kendall/Hunt.

Rohnke, K. (1984). *Silver Bullets: A guide to initiative problems, adventure games, students and trust activities*. Hamilton, MA: Project Adventure.

Siegel, D. (2007). Research Works: Middle School Students' Attitudes about Physical Education. *JOPERD: The Journal of Physical Education, Recreation & Dance*, *78*(9), 9.Retrieved from http://www.aahperd.org/publications/journals/joperd/joperdissues.cfm

Stenger-Ramsey, T., & Curl, L. (2010). Leave No Child Inside: Taking Physical Education Out of the Gym. *Kentucky Newsletter for Health, Physical Education, Recreation & Dance*, *47*(1), 15-17. Retrieved from http://www.kahperd.com/index_main.asp

Strand, B., & Reeder, S. (1993). *RESEARCH NOTE: Using Heart Rate Monitors in Research on Fitness Levels of Children in Physical Education. Journal of Teaching in Physical Education*, *12*(2): 215-220. Retrieved from http://journals.humankinetics.com/jtpe

Stratton, C (2008). *A comparison of the Effects of Recreational Geocaching verse Competitive Geocaching*. (Unpublished Masters Thesis). University of Wisconsin La Crosse. La Crosse, WI.

Weidong, L., Wright, P., Rukavina, P., & Pickering, M. (2008). Measuring Students' Perceptions of Personal and Social Responsibility and the Relationship to Intrinsic Motivation in Urban Physical Education. *Journal of Teaching in Physical Education*, *27*(2), 167-178. Retrieved from http://journals.humankinetics.com/jtpe

APPENDIX B

ASCENT FORM

Research Ascent Form
University of Wisconsin Lacrosse
1725 State Street, La Crosse Wi, 54601, USA.

Protocol Title: The effects of hiking and geocaching on high school physical education students' heart rate.

Principal Investigator: Cate Egan
2140 Cass Street
La Crosse, WI 54601
(770) 639-3953

Emergency Contract: Dr. Jeff Steffen
218 Mitchell Hall
University of Wisconsin- La Crosse
(608) 785-6535

Purpose and Procedure:

- The purpose of this study is to determine the effect of hiking and geocaching on adolescents' heart rate
- My participation will involve one hour of instruction, one hour of hiking, and one hour of geocaching. During this time, I will be using polar heart rate monitors and GPS units.
- Testing will take place at school during class time.
- During the test, I will wear a heart rate monitor and watch. During the second test, I will wear a heart rate monitor and may be asked to use a GPS unit. I will use the GPS to find geocaches preset by the researcher.
- Date taken by the heart rate monitors will be analyzed at the end of testing.

Potential Risks:

- I understand working with technology, that there is a risk of technology failure.
- There may be slight dizziness, shortness of breath, muscle soreness or fatigue
- The risk of serious life threatening complications, for healthy individuals, like myself, is near zero.

Rights and Confidentiality

- My participation is voluntary.
- I can withdraw from the study at any time for any reason without penalty.

- The results of this study may be published in scientific literature or presented at professional meetings.
- All information will be kept confidential through the use of number codes. My data will not be linked with any personally identifiable information.

Possible Benefits (for use if there is any direct benefits to the participant)

- Subjects will be introduced to a new lifelong activity. They will be introduced to learning about their heart rate and different ways to monitor heart rate. Subjects will become aware of how their body responds to physical activity. This study will provide physical educators knowledge of heart rate during geocaching. This study will help me to learn a lifelong skill and also how to conduct a research study. Ti is hoped that information learned from this study will benefit you and others.

Questions regarding this study and procedures

- Questions will be directed to Cate Egan (770) 639-3953, the principal investigator, or the study advisor Dr. Jeffery Steffen, Department of Exercise and Sport Science, UW-L (608) 785-6535. Questions regarding the protection of human subjects may be addressed to the UW- La Crosse institutional Review Board for the Protection of Human Subjects. (608) 785-8124 or irb@uwlax.edu

APPENDIX C

INFORMED ASCENT/CONSENT FORM

Informed Ascent/Consent Form

Protocol Title: The effects of hiking and geocaching on high school physical education students' heart rate.

Why have you been asked to take part in this research?

This study is evaluating how an adolescents' heart rate is affected by hiking and by geocaching. The heart rates will be compared to see if they are similar aerobic activities. You have been invited to participate in this study because you are in the right age group that we are interested in studying. You also are enrolled in physical education class which is the class in which we will be teaching the geocaching unit. Participating in this study is voluntary, and you may quit the study at any time. Please do not hesitate to ask questions about this consent form or the procedures if you do not understand something.

How many people will be in this study and how long will it last?

There will be approximately 30-40 people in this study. All people will be enrolled in physical education class at the High School level, and between the ages of 14-18. The study will last approximately 2 days, and will take place during the physical education class that you are enrolled in.

What will happen if you agree to be part of this study?

If you agree to be a part of this study, you will be taught how to geocache using GPS technology. You will also be taught how to use a Polar Heart Rate monitor.

You will also be asked to hike on a course around the school campus wearing a heart rate monitor for 40 minutes. This will allow us to understand how many beats per minute your heart is beating before, during, and after exercising.

You will also hike a similar course for forty minutes, but you will geocache along the way. You will be asked to wear the heart rate monitor during this test as well. The same data will be collected as was collected during the walking test.

What are the possible risks discomforts from this study?

Similar to any form of exercise, you may get tired and your muscles may get sore. However, the effects will be temporary. There is a very low risk of serious injury or complications in apparently healthy individuals. Wearing a heart rate monitor is similar to wearing a watch. It fits on your wrist.

How will you benefit from participating in this study?

There is a possibility that you will know more about your physical fitness level and learn about your resting heart rate, target heart rate zone, and maximum heart rate as it relates to exercising. As well as learn about the popular sport geocaching. Additionally,

you will help other researchers understand the effects of hiking and geocaching on high schools student's heart rate.

Do you have to participate?

Participation in this study is voluntary and you may stop participating at any point without penalty.

If you choose not to participate in the study you will still be taught how to geocache as part of your physical education class curriculum. Thus, you will not be wearing a heart rate monitor during the test. Your grade will not be affected by choosing not to participate in the study.

What are the costs of participating?

There are no costs for you to participate in this study.

What are your rights and confidentiality during this study?

All of the data will be kept confidential. The data will be kept through the use of number codes, so in no way will your name be linked to the data. If this study is published or presented for scientists or teachers, your data will not be personally identifiable.

Questions regarding the requirements for this study

Will be answered by Cate Egan, (770) 639-3953, or her advisor Dr. Jeff Steffen (608) 785-6535. Questions regarding the protection of human subjects may be addressed to the UW-La Crosse Institutional Review Board for the Protection of Human Subjects (608) - 785-8124.

Child/Adolescent Understands:

Have all your questions regarding how the research study might affect you been answered? Yes / No (Circle one)

If you want to be part of the study, please sign your name. If you do not want to be part of the study, then do not sign your name. **You can say no to being in the study, and you will not be disliked or treated differently.**

Child/Adolescent's Signature	Date of Signature	Printed Name of Subject

Parent's/Court-Appointed Guardian Understands:

Have all your questions about how the research study is going to affect your child and/or yourself been answered? Yes/No (Circle one)

I believe my child is fully informed and is willing to participate in this study.

Parent's/Court-Appointed Guardian's Signature

Date of Signature

Investigator/Presenter

I have discussed this study and the possible risks and benefits of the study with the child, and I believe he/she is fully informed and is willing to participate in this study.

Presenter's Signature
(Investigator or Designee)

Date of Presentation

What does signing this consent form mean?

A signature indicates that:

- You or your child have read the above.
- You or your child have freely decided to take part in the research study described above.
- The studies general purposes, details of involvement and possible risks and discomforts have been explained to you and your child

Principal Investigator:

Cate Egan
2140 Cass Street
La Crosse, WI 54601
(770) 639-3953

Emergency Contract:

Dr. Jeff Steffen
218 Mitchell Hall
University of Wisconsin- La Crosse
(608) 785-6535

APPENDIX D

PERMISSION TO RESEARCH AT SCHOOL

Physical Education Teacher: Charles Boeke
1001 McHugh Road
Holmen, Wisconsin 54636
(608) 526-3372

Researcher:
Catherine Anne Egan
2140 Cass Street
La Crosse, WI 54601

I Charles Boeke allow researcher Catherine Egan to conduct research at Holmen High School in physical education classes. I will allow students to take part in the research study as long as they provide informed consent/assent. I have been made aware of the risks, procedures, and benefits of this research study. If you have any further questions, please contact me at (262) 719-4938.

Sincerely,

_____
Charles Boeke
Physical Education Teacher

_____
Catherine Egan
Researcher

APPENDIX E

GPS INSTRUCTIONS

Getting Started:

1. Turn on the GPS by pushing Power Button
2. Push the menu until the Main Menu Appears (page with icons that are mark and find go)
3. Use the thumb/joy stick and scroll over to Find N Go and push down on the stick
4. Scroll to Waypoints using the thumb/joy stick and push down on the thumb/joy stick selecting waypoints
5. Push down on the thumb/joy stick selecting nearest
6. Scroll to the waypoint that you want to go to and push down on the Thumb/Joy Stick
7. A screen with a flag appears, scroll to go to in bottom left corner and press down on Thumb/Joy stick
8. A compass appears in the left hand side of the screen follow the arrow to your waypoint. On the right side of the screen you will see distance to geocache.
9. **When you find geocache go to step 2 and repeat to find next cache.**

Helpful Hints:

- When you get close to cache a box appears in bottom of screen telling you that you have arrived
- You will be approximately 20-70 feet from cache so look all around
- Once box has appeared telling you that you have arrived, pay less attention to arrow and search surrounding area
- Look at Clues to help you figure out where cache is
- If you find all six cache's you may go to the bonus cache (Viking 2)

Teaching Cues:

- Keep GPS unit secured with wrist band at all times
- Hold GPS out in front of you and make slight movements at times wait a few seconds for arrow to adjust
- Make sure everyone gets a chance to use GPS
- Make sure you place cache back exactly where you found it
- Make sure you sign log and take one envelope from the box
- When you hear one sound of the Air-horn start making your way back to the starting point

Group	Cache	Cache	Cache	Cache	Cache	Cache	Cache
One	5	3	6	7	4	1	2
Two	4	1	7	3	6	5	2
Three	6	4	1	5	3	7	2
Four	3	7	5	4	1	6	2
Five	1	5	3	6	7	4	2
Six	7	6	4	1	5	3	2

Cache #	Hint
1	Power Up
2	Bonus
3	If you let it slip, you will pay me a visit
4	A shady place to watch me climb
5	Just downhill from the Whomping Willow
6	Charlie Brown Christmas
7	Watch me build a sandcastle

Heart Rate Monitors:

- Place chest piece just below chest muscles
- Make sure it is securely fastened but not too tight
- Make sure you press start when the instructor tells you to and do not touch your watch again until the instructor tells you to press stop on the watch

Please allow for personal space as your heart rate monitor may not record properly if you are too close to someone else

How to Make a Waypoint

1. Press and hold the Power Button until the unit sounds on.
2. Press the Page Button 4 times or until you see a screen that says (Mark, Find 'n Go)
3. Using the Thumb Stick press down (↓) to highlight the "Mark" Icon.
4. Press the Thumb Stick into the machine to enter and your screen should change to a man putting a flag into the ground. You have now created a waypoint. (Skip to step 7 if you do not want to name the Waypoint)
5. To name the waypoint use the Thumb Stick and press up (↑) 2 times this will highlight the number of your way point. (Ex 005)
6. Press the Thumb Stick into the machine to enter. A series of letters and numbers should come up on the screen. Select the name you would like for your waypoint by highlighting the numbers and pressing the thumb stick to enter. When done select OK.
7. Now that you have named your Waypoint highlight the OK button in the Lower Right Hand corner of the screen and press enter with the Thumb Stick.

How to Go To a Waypoint

1. If the Unit is off use steps 1 and 2 from "How to make a Waypoint".
2. Now at the Mark and Find 'n Go screen, highlight the **Find 'n Go Icon** by using the **Thumb Stick** and press into the machine to enter.
3. On the new screen press **enter** again when the **waypoints** option is highlighted.
4. Select "**Nearest**"
5. Using the Thumb Stick highlight the Waypoint you would like to travel to and press enter.
6. The man with the flag should be on your screen with the name of the waypoint you selected. In the Lower Left corner the **GoTo** button should be highlighted press enter when that button is highlighted.
7. This should take you to a compass. Press the **Page** button 4 times or until you get to a screen that shows your position as a triangle in the middle of the screen with a line drawn to your GoTo Waypoint. To zoom in or out press the **Zoom Button**, then move the Thumb Stick up or down to make the screen more clear.
8. Start walking towards your designated waypoint. The long point of the triangle shows what direction you are going. Follow the line on the screen until you arrive at your waypoint.

► If at any time you get lost on the screens press the **Page Button** until you get to the main screen. You can then start over with the instructions.

APPENDIX F

GEOCACHE LOG

Group Number	Names

APPENDIX G

DATA FROM WALKING PHASES

	Particpant Number																									
	1	4	5	6	7	8	9	10	11	13	14	15	16	19	20	21	22	23	24	26	27	28	29	30	31
1	100	81	109	152	88	87	91	116	108	98	92	105	78	97	91	102	103	97	76	93	99	177	105	121	99
2	101	118	112	113	122	89	97	116	118	120	89	117	98	88	95	95	110	104	89	93	99	124	111	128	110
3	110	0	114	121	126	114	112	116	125	117	98	136	110	81	90	109	115	104	111	130	0	97	116	122	105
4	100	114	115	116	129	114	118	111	126	114	105	99	107	70	97	117	104	123	91	105	167	99	117	124	105
5	102	112	119	112	153	191	118	114	119	117	85	99	104	85	93	113	105	106	97	119	111	103	128	127	100
6	105	130	172	118	134	122	118	119	114	114	104	135	106	79	97	114	107	95	94	119	0	104	126	125	100
7	107	117	127	109	140	122	152	132	141	134	121	126	117	97	93	112	103	130	104	195	95	103	119	131	100
8	103	127	119	125	130	111	130	136	122	112	114	118	116	95	105	112	101	91	106	195	110	110	126	131	192
9	143	124	106	123	125	121	136	115	119	113	117	110	0	92	99	111	97	100	98	195	124	117	122	132	0
10	186	136	141	121	129	122	188	116	121	119	120	110	113	109	94	121	90	119	106	129	132	134	130	128	108
11	131	124	123	113	130	103	131	129	135	117	138	147	110	94	110	121	89	125	100	129	137	108	127	125	117
12	140	125	120	111	124	117	137	132	130	120	119	133	103	84	100	178	99	101	110	149	145	147	130	139	154
13	141	117	121	115	134	106	133	122	124	122	120	124	111	86	110	178	103	106	126	149	140	108	145	151	125
14	156	117	117	115	123	105	127	122	125	134	123	131	0	91	95	139	105	104	101	149	140	126	128	133	118
15	124	122	112	107	115	107	134	123	126	122	123	125	123	98	96	134	117	158	109	149	134	120	127	141	107
16	141	140	113	108	116	104	130	123	123	121	121	109	116	92	102	119	117	175	127	167	125	109	134	138	112
17	0	134	122	119	123	127	131	121	120	121	121	121	105	91	93	146	101	180	117	167	125	123	139	138	112
18	115	124	114	113	119	122	125	122	118	116	119	117	108	99	95	154	116	127	107	167	125	138	138	132	114
19	110	120	117	115	122	108	127	122	128	111	114	109	116	84	102	144	116	115	106	155	134	113	137	137	131
20	127	116	115	117	131	108	142	124	133	116	117	123	132	98	100	139	116	113	109	155	137	137	133	130	115
21	115	126	125	121	132	118	134	128	137	123	118	120	0	92	96	127	112	117	151	155	122	119	128	127	112
22	132	127	121	111	130	117	123	129	133	110	116	111	109	97	96	99	107	118	162	155	109	125	128	134	117
23	104	135	117	108	118	106	145	128	134	106	116	127	116	88	101	140	123	105	167	155	113	126	132	129	117
24	104	134	129	108	123	118	156	125	125	111	124	118	118	101	108	130	123	103	129	146	143	132	129	133	125
25	109	129	126	135	129	111	145	139	131	119	127	118	99	105	109	130	118	79	119	168	160	138	127	137	113
26	110	121	125	121	129	108	145	132	128	118	124	126	120	80	111	131	116	66	119	150	112	134	130	133	112
27	117	0	120	103	129	108	123	126	120	124	125	123	119	91	99	133	120	86	118	182	124	123	138	142	135
28	129	0	116	111	128	112	156	130	123	123	118	120	121	96	114	148	118	90	118	155	139	137	128	135	120

	Particpant Number																								
	1	4	5	6	7	8	9	10	11	13	14	15	16	19	20	21	22	23	24	26	27	28	29	30	31
29	128	120	118	113	128	107	123	126	123	99	122	111	116	98	125	134	110	80	111	163	143	123	131	145	115
30	120	119	120	110	126	99	144	120	124	113	123	113	118	90	109	140	116	111	115	171	0	132	133	144	151

APPENDIX H

DATA FROM GEOCACHING PHASES

	Participant Number																									
	1	4	5	6	7	8	9	10	11	13	14	15	16	19	20	21	22	23	24	26	27	28	29	30	31
1	145	106	98	81	99	0	96	103	144	97	97	148	80	99	100	92	83	99	81	71	139	127	114	78	81
2	165	109	94	155	112	108	96	143	143	142	105	126	90	92	101	107	99	112	81	68	109	139	98	113	130
3	174	108	95	135	109	216	96	145	129	138	113	131	85	116	100	104	68	78	140	78	130	115	97	108	198
4	176	100	105	114	139	192	76	127	121	137	125	90	78	220	106	102	65	79	110	89	122	126	103	113	102
5	134	0	93	151	109	134	76	92	99	108	130	129	78	100	111	90	103	80	95	123	101	130	169	109	216
6	145	98	112	93	130	211	73	97	112	116	128	134	89	101	108	87	95	191	76	127	102	133	148	112	144
7	156	94	121	124	122	211	124	97	130	121	147	104	82	100	117	118	86	148	69	128	124	138	124	110	112
8	155	98	130	145	101	131	156	109	109	110	149	113	82	106	141	132	100	95	79	132	163	109	125	97	194
9	137	98	135	127	102	141	165	114	114	113	149	110	101	111	138	120	104	76	97	119	128	127	135	119	133
10	121	123	136	89	124	141	148	123	105	218	139	178	91	108	135	115	105	81	89	105	108	119	123	139	125
11	138	0	104	90	163	187	150	134	136	140	139	88	99	117	135	105	95	134	96	101	107	132	0	130	120
12	138	105	112	76	128	163	149	134	162	140	139	132	76	141	114	140	139	156	78	97	115	126	155	125	124
13	153	93	124	78	108	151	157	140	144	147	142	160	75	138	109	102	139	175	95	124	102	135	139	117	120
14	124	89	123	90	107	161	152	145	130	160	139	121	110	135	104	93	91	103	111	127	184	129	139	129	128
15	108	98	117	109	115	134	152	147	120	132	154	116	123	135	66	93	123	125	103	145	162	125	132	132	126
16	158	90	112	112	102	126	155	149	124	112	134	144	126	114	146	107	134	168	80	147	133	127	125	129	125
17	165	129	118	114	184	147	164	167	169	152	143	132	145	109	152	98	145	125	91	124	113	140	149	127	132
18	165	96	118	115	162	140	169	167	149	125	147	144	145	104	105	111	157	131	80	106	132	149	113	123	118
19	174	109	128	114	133	154	139	156	139	142	128	164	134	0	101	108	165	94	104	104	101	156	145	125	125
20	174	104	106	113	113	174	158	156	134	164	143	164	129	146	116	106	164	159	94	104	122	137	134	127	121
21	171	106	129	122	132	174	161	145	139	164	143	156	145	152	102	115	161	181	94	101	118	124	140	121	127
22	162	111	128	132	101	166	158	134	148	161	143	131	147	105	117	111	145	131	92	99	124	144	133	117	118
23	165	120	109	132	122	137	138	137	137	119	149	143	149	101	105	122	138	87	91	96	128	157	131	119	122
24	165	104	108	122	118	133	136	122	145	150	142	108	134	116	116	113	138	129	99	137	114	129	136	124	110
25	164	111	116	124	124	136	135	125	155	120	148	142	134	102	112	101	134	139	109	138	119	127	140	139	162
26	162	107	119	127	128	142	160	134	132	138	143	133	145	117	108	106	132	185	90	139	112	123	137	132	138
27	167	113	123	129	114	137	155	147	143	125	138	174	144	105	112	99	129	154	82	124	125	130	143	123	129
28	168	106	120	129	119	175	155	155	152	169	135	159	122	116	112	102	129	115	100	110	123	141	149	124	123

	Participant Number																									
	1	4	5	6	7	8	9	10	11	13	14	15	16	19	20	21	22	23	24	26	27	28	29	30	31
29	0	112	125	143	112	173	166	157	147	159	141	160	132	112	105	112	117	168	76	99	108	147	131	132	117
30	173	107	107	154	143	157	141	162	159	137	128	165	127	108	112	117	111	115	86	97	117	129	130	123	124