INSTRUCTIONAL GEOCACHING:

AN ANALYSIS OF GPS RECEIVERS AS TOOLS FOR TECHNOLOGY INTEGRATION

INTO A MIDDLE SCHOOL CLASSROOM

By

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A DISSERTATION

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ABSTRACT

The purpose of this study was to investigate how the instructional use of GPS through instructional geocaching activities engages students and promotes achievement in a middle school social studies classroom. The impact of instructional geocaching on addressing the needs of students with various learning styles was also examined. In addition, the researcher identified student perceptions of geocaching activities and differences between recreational geocaching and instructional uses of geocaching.

Pretest and posttest scores were used to collect quantitative data in two phases of the study. The experimental groups, who participated in the instructional geocaching activity to learn the content, and control groups, who participated in a traditional classroom activity to learn the content, were reversed in each phase. Findings revealed that the instructional geocaching activity produced significant achievement gains in the second phase of the study. However, no significant differences in achievement were found between students with different learning styles in either the experimental or control groups.

In the third phase, a survey instrument was used to collect quantitative and qualitative data on student perceptions and engagement during an instructional geocaching activity. A significant difference in engagement during the GPS activity was found between kinesthetic and visual learners. However, student engagement was not found to be a significant predictor for student achievement during this study. From the survey data, three factors were determined to represent the student perceptions of the GPS activity: fun, perception of learning, and motivation.

Furthermore, the qualitative data revealed that students enjoyed the hands-on and active learning experience that was provided by the instructional geocaching activity.

Implications for educators who plan to integrate instructional geocaching activities into the curriculum are discussed. Recommendations for similar research with larger populations, longer treatment periods, and other subject areas are made. Suggestions are also included for future research on the relationship of instructional geocaching activities to other learning style theories and critical thinking skills.

DEDICATION

To Mom, the best teacher I've ever had. To my family, past, present, and future, you are my inspiration, and to Jenny, my big dog.

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CHAPTER I

INTRODUCTION

In the fast-paced, information age society in which we live, new technologies seem to emerge on a daily basis. It began with terms such as dot com, online, and e-mail and has progressed to YouTube, Twitter, iPhone, Blackberry, "apps," and social networks. As these new technologies become aspects of everyday life, it is essential for educators to integrate them into their curriculum (Solomon & Schrum, 2007). Students in the classrooms of today are digital natives (Prensky, 2001) who rely on technology for communication, information, and entertainment (Lenhart, Madden, & Hitlin, 2005). Students are seeking different approaches to the teaching and learning process (Solomon, 2005). Furthermore, these teaching and learning processes should encourage critical thinking and problem-solving skills as well as the 21st century skills necessary to succeed in the "Digital Age" (ISTE, 2008b).

One technology that has emerged with the potential to engage the digital native student is the Global Positioning System (GPS) receiver. GPS is a system of satellites that communicates latitude, longitude, elevation, and velocity from any location on Earth to devices that can receive this transmission (Lucking & Christmann, 2002). The general public was given unscrambled access to the GPS by the US Department of Defense in May 2000, and many industries began experimenting with the new possibilities (Gram-Hansen, 2009). Gilroy (2009) reported that a 2009 Forrester Research study revealed that 31% of adults in North America own a portable navigation device that provides access to the global positioning system. Holzberg (2006) described the real-world implications of GPS receivers in that the system of satellites is used by

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"anyone who needs precise reference points for location, navigation, tracking, mapping, and time" (p. 44). This includes occupations such as scientist, surveyor, delivery driver, fire fighter, pilot, and farmer. Recreational enthusiasts such as hikers, hunters, fishermen, and cyclists also quickly adopted the use of GPS because location is often key to their success in these pursuits (Shaunessy & Page, 2006).

A method of infusing the pervasive technology of GPS into the curriculum as an educational, informational, and entertaining tool is geocaching (Lary, 2004). This technique, also referred to as a high-tech scavenger hunt for GPS users, is steadily growing as an international phenomenon. The basic concept of geocaching involves a GPS user hiding a container, also known as a geocache, and then recording the coordinates of the container with a GPS receiver. The GPS user will then access the official geocaching web site, www.geocaching.com, to post this location along with a description and clues about the geocache. When other GPS users access the web site, they can download or print the coordinates and descriptions of geocaches for which they want to search. When a GPS user finds a geocache, there are three basic rules according to Groundspeak (2010). They are as follows: 1) if a GPS user takes something from the cache, he or she should leave something of equal or greater value; 2) the GPS user should sign the logbook; and 3) the GPS user should log his or her experience at www.geocaching.com. Geocaches, or caches, vary in size and shape and may not be hidden within 528 feet of another cache in order to prevent saturation (Groundspeak, 2010). Caches are as large as five-gallon buckets or as small as film canisters (Schlatter & Hurd, 2005). Caches, depending on the size, typically contain a log book for finders to sign, an instrument for writing, and trinkets to trade. According to Groundspeak (2010), there are currently 1,092,192 active geocaches in the world, and in the 30 days prior to the writing of this manuscript, there were over 4.1 million new logs

submitted about geocaching adventures to www.geocaching.com. These statistics alone indicate that geocaching is a significant recreational activity similar to hiking, golfing, hunting, or fishing.

While the growth in instructional uses has been slow, the activity of geocaching has tremendous potential as a method to integrate technology into the classrooms of today (Christie, 2007). Students are increasingly exposed to GPS technology via cell phones, in automobiles, and on television. When educators use this technology as a tool for teaching their subject, students are exposed to both a life-long learning skill as well as the curricular content. The sport or hobby of geocaching provides a framework for educators to follow as they develop lessons for using GPS technology in the classroom. However, there have only been a few studies conducted regarding instructional geocaching or geocaching in an educational setting. Most have focused on identifying geocaching as an instructional tool and describing methods of using it with students. According to Buck (2009), GPS receivers can be a motivating tool for teachers in many subject areas like mathematics, science, and social studies. Broda and Baxter (2003) also reported that lessons involving GPS receivers produce positive student attitudes. As Christie (2007) stated, geocaching can be used to transform classrooms "from teacher-centered environments to exciting, empowering, exploratory environments that focus on student engagement in the learning process" (p. 1). It is for this reason, along with the pervasiveness of GPS technology in our society, that this study was conducted.

With GPS technology involving the elements of latitude and longitude, there is a natural relationship to geography content in education. The geography component of the seventh-grade social studies curriculum in the state of Alabama directly addresses student knowledge of GPS. The first course of study objective states that students should be able to "describe the world in

spatial terms using maps, major physical and human features, and urban and rural land-use patterns" including "Global Positioning System (GPS)" (Alabama State Department of Education, 2004). The National Council for the Social Studies (1994) stated that programs should incorporate learning activities that study the relationships between science, technology, and society. As Matherson, Wright, Inman, and Wilson (2008) suggested, geocaching is a method to help address these standards as well as to help incorporate an innovative teaching and learning strategy.

Overview of Instructional Geocaching

Instructional geocaching is the practice of applying the basic principles of geocaching as a strategy to integrate technology into the curriculum as well as to engage students in the learning process (Christie, 2007). In broader terms, instructional geocaching is an adaptation of the sport of geocaching for educational purposes. A typical instructional geocaching activity may take place on school grounds, during a field trip, or at any other area such as a park near the school. The location of the instructional geocaching activity is predetermined by the educator conducting the activity. In an instructional geocaching activity, the educator selects the topic, creates the tasks or assignments for the caches, creates the caches, hides the caches, records the coordinates, provides the coordinates for the students, and then allows the students to use the GPS to find the caches and complete the tasks. The cache contents are designed to relate to the subject or concept that the students are studying at the time of the activity. An instructional geocache may contain questions for students to answer, tasks for students to perform, or problems for students to solve. However, the concepts of using a GPS receiver and coordinates to locate a hidden container are the underlying components to both instructional and recreational geocaching.

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There are three main characteristics that differentiate instructional geocaching from recreational geocaching. The first is that the requirement of recreational geocaches to be placed at least 528 feet apart does not apply to instructional geocaching due to size limitations of school campuses. Christie (2007) suggested 100 yards as a distance requirement for separating caches on school grounds, but the researcher has successfully designed more than 25 instructional geocaching courses using 100 feet as a distance of separation. The distance of the caches should be guided by the concerns of supervision and safety of students (Shaunessy & Page, 2006).

The second important difference between instructional geocaching and recreational geocaching is that the geocaches do not have to be published on the geocaching web site. Instructional geocaches are only for student use and are not for the general public. Shaunessy and Page (2006) advised this for the safety of the students and the caches. However, it is also feasible to use caches placed for recreational purposes as instructional tools as outlined in the studies of Dixon (2007), Lary (2004), Schlatter and Hurd (2005), and Shaunessy and Page (2006).

The third difference between instructional and recreational geocaching relates directly to the caches and their contents. In recreational geocaching, the containers are required to have at least a log sheet, and the focus of the activity is to find the container to sign the log. However, with instructional geocaching, one motivating factor for students is to find the container, but the primary focus is on the content of the lesson placed inside the container rather than simply signing the log and trading items. Instructional geocaching containers may contain any educational element that is relevant to the topic being studied. Instructional geocaching techniques often do not include a container at all. Instead, educators may place information on cards and post these cards around the school campus by taping them to objects such as trees,

posts, or walls. In each case, the focus remains on the content that the students are learning instead of the GPS technology or the finding of the geocaches.

Statement of the Problem

Research has demonstrated that the majority of students have a positive attitude toward the use of technology in the learning process (Al-Mujaini, 2006; Becta, 2006; Mouza, 2006; Ruthven, Hennessy, & Brindley, 2004; Vale & Leder, 2004). However, in the data-driven climate of the educational system, the need for empirical evidence of the positive influence of technology on student achievement is exceedingly evident (Kingsley & Boone, 2008; Schrum, Thompson, Sprague, Maddux, McAnear, Bell, & Bull, 2005). More specifically, researchers have called for further study of the influence of technology integration into the achievement of students in the middle school classroom (Diem, 2000; Saye & Brush, 2002; Whitworth & Berson, 2003). Geocaching presents an opportunity to implement an innovative teaching and learning strategy. However, limited research has been conducted on the effects of geocaching on student achievement and its instructional value in the classroom.

Purpose of Study

The purpose of this study was to investigate how the instructional use of GPS through instructional geocaching activities engages students and promotes achievement in a middle school social studies classroom. The impact of instructional geocaching on addressing the needs of students with various learning styles was also examined. In addition, the researcher identified student perceptions of geocaching activities and differences between recreational geocaching and instructional uses of geocaching. To date, recreational geocaching has grown exponentially among GPS users worldwide. However, the potential of instructional uses of geocaching has yet

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to be fully explored. Therefore, this researcher also provided an overview of instructional uses of geocaching.

Research Questions

The research questions explored in this study included:

1. Is there a significant difference in pretest and posttest scores between students who received the instructional geocaching treatment and students who did not receive the instructional geocaching treatment?

2. Is there a significant difference between the pretest and posttest scores of students with different learning styles who received the geocaching treatment?

3. Is there a significant difference between the pretest and posttest scores of students with different learning styles who did not receive the geocaching treatment?

4. Is there a significant difference in student engagement during the geocaching activity based on learning style?

5. Is there a significant relationship between student engagement and student achievement during the instructional geocaching treatment?

6. What are students' perceptions toward geocaching activities for learning?

Significance

This study contributes to a body of literature that is currently lacking in how student achievement through the use or non-use of technology is being assessed. Furthermore, this study offers insight into student attitudes of their use of the innovative technology, geocaching, and their understanding of the technology. Therefore, the study's results can assist teacher educators and current teachers improve their technology integration strategies. Other benefits of this study

are a better understanding of how innovative technologies can motivate and engage students to learn.

Since the year 2000 when GPS access was given to the general public, very little has been done in the area of using GPS in education. Activities such as geocaching, which utilize GPS, offer educators a viable teaching method. However, very little research has assessed its potential or impact in the classroom (Buck, 2009; Christie, 2007; Matherson et al., 2008). In fact, the only study found to address student achievement was that of Buck (2009), in which the effects of GPS integration on math achievement were investigated. There is no empirical data on achievement in the subject area of social studies where GPS is specifically addressed in both national and state courses of study.

Assumptions

The following assumptions were made in this study:

1. The participants constituted a representative sample of seventh grade students at a middle school in a small town in Alabama.

2. Participants knew how to use a GPS receiver. This assumption was made because the teacher routinely uses GPS activities in instruction.

3. Because the classes had the same teacher, it was assumed that the teacher engaged in the same classroom behavior and used the same general classroom management strategies.

4. The students understood and honestly answered all items on questionnaires and tests related to the study.

5. The teacher provided accurate documentation of student assessments.

Definition of Terms

Global Positioning System: According to Christie (2007), the Global Positioning System is a network of at least twenty-four navigational satellites that broadcast location and time information to receivers on earth. This system is maintained by the U.S. Department of Defense.

Global Positioning System (GPS) Receiver: A GPS receiver is a hand-held technology device that receives signals from the Global Positioning Satellites to determine the exact location of the user. The GPS receiver displays this location to the user using latitude and longitude coordinates. Many GPS receivers also report elevation and speed.

Recreational Geocaching: According to Groundspeak (2010), the Official Geocaching Web Site, recreational geocaching is "geocaching is a high-tech treasure hunting game played throughout the world by adventure seekers equipped with GPS devices" (¶ 1). The basic idea is to locate hidden containers, called geocaches, outdoors and then share your experiences online. Geocaching is enjoyed by people from all age groups, with a strong sense of community and support for the environment (Groundspeak, 2010).

Instructional Geocaching: Instructional geocaching is an educational adaptation of recreational geocaching. Instructional geocaching is the practice of applying the basic principles of geocaching as a strategy to integrate technology into the curriculum as well as to engage students in the learning process. Lary (2004) reported that instructional geocaching provides coordinates, clues, GPS usage, and the hunting experience similar to that of real geocaching. Christie (2007) explained that instructional geocaching should occur on the school grounds or at an outdoor location near the school.

Geocache or Cache: The terms geocache and cache can be used interchangeably. Either term refers to the container that has been hidden for GPS users to locate. It is a combination of

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the prefix geo, which relates to earth, and cache, which is a container (McNamara, 2004). Caches in recreational geocaching contain a log sheet for finders to sign as well as items for finders to trade. Caches used in instructional geocaching may contain items such as questions to be answered, tasks to be performed, or problems to solve.

Waypoints: Groundspeak (2010) defines a waypoint as "a reference point for a physical location on Earth. Waypoints are defined by a set of coordinates that typically include longitude and latitude" (¶ 58).

Coordinates: Coordinates are the numeric representation of a GPS user's position on earth. The coordinates are measured in latitude and longitude and are stated in degrees, minutes, and seconds. "The standard geographic coordinate system of the world involves latitudes north or south of the Equator and longitudes east or west of the Prime Reference Meridian of Greenwich" (Map, 2009, p.17).

Emerging Technology: An emerging technology is any new hardware, software, or application that has the potential for strengthening the teaching and learning process (Richardson, 2006; Roblyer & Edwards, 2000). Serim and Schrock (2008) stated "If it's out of the engineering lab, but not yet widely in use or widely known, we consider it an emerging technology" (p.13).

Technology Integration: Technology integration consists of instructional strategies that use technology tools to facilitate learning experiences for students in the classroom and in online environments (ISTE, 2008a).

Traditional Classroom Activity: A traditional classroom activity is lead by the teacher. Students in a traditional classroom environment typically listen to lectures, take notes from the

board or presentation software, and read textbooks to learn about a topic (Debevec, Shih, & Kashyap, 2006).

Limitations

1. The complexity of the topics of the units in which geocaching activities were implemented was different.

2. The classes selected were comprised of a sample of convenience, and no two groups of students can be alike in academic ability. Therefore, external validity of the study to other schools may not be possible.

3. This study may also be limited by the number of students in the sample of convenience. The sample size consisted of 104 students, which comprised approximately 19% of the student population in one small town middle school.

4. The weather may have limited the accuracy of the GPS receivers during these activities. Cloud cover and extreme temperatures often decrease accuracy of GPS receivers, and there was not a procedure to control for differences in environmental factors.

5. The class periods at the school were only 55 minutes in length, and with the time that it took for the students to walk to the athletic fields from the school, only 45 minutes of instructional time was spent on the geocaching activity.

Organization of Study

This study is organized into five chapters. Chapter I contains an introductory material, the statement of the problem, the purpose of the study, questions for research, operational definitions, and the significance of the study. In addition, assumptions and limitations of the study were presented. Chapter II reviews the professional literature relevant to this study. In Chapter III, the research design, data collection methods, and the instruments to be used for data

collection are described. Chapter IV presents an analysis of the data. Chapter V discusses the results of the data analysis and presents conclusions regarding the research questions as well as implications and recommendations for further study.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

This review of literature presents the theoretical framework upon which this study is based. In this chapter, information about technology integration in education is provided, including an overview of the connections between technological pedagogical content knowledge (TPACK), 21st century learning skills, the 21st century middle school student, and technology integration in the middle school classroom. This chapter also provides a discussion of geocaching, a high-tech scavenger hunt for Global Positioning System (GPS) users, as an instructional strategy for classroom teachers that helps to address various learning styles. This discussion helps to establish the framework for research on the influence of technology integration strategies such as instructional geocaching on student achievement and motivation.

Technology Integration in Education

"The goal of technology integration is to use technology seamlessly so that the technology itself becomes a transparent and integral tool to teach core curriculum" (Digital Learning Environments, 2008, ¶ 1). Over the past decade, the importance of technology in education, specifically in K-12, has broadened due to national efforts such as the National Educational Technology Standards (NETS), The Department of Education's *Preparing Tomorrow's Teachers to Use Technology* (PT3), and various state initiatives (Davis, Yoo, & Pan, 2005; Finley & Hartman, 2004; ISTE, 2007; ISTE, 2008a; Taylor & Duran, 2006). These efforts have included a revision of technology standards across the curriculum at both national and state

levels. The needs of professional development in the area of technology integration for teachers and the strategies to help address these standards have also evolved with the introduction of 21st century skills to the educational technology spectrum (Partnership for 21st Century Skills, 2006).

Several frameworks have helped guide this evolution including technological pedagogical content knowledge (TPACK), which focuses on the importance of the interweaving of technology, pedagogy, and content knowledge. TPACK places an emphasis on teachers learning the technology as needed and when needed within the context of instructional design (Mishra & Koehler, 2006). This learn-by-design model does not focus on teaching skills or step-by-step instructions on using the technology (Mishra & Koehler, 2006). In an examination of TPACK in the social studies curriculum, Hammond and Manfra (2009) asserted that "the pedagogy should lead the technology, not technology lead the pedagogy" (p. 163). Furthermore, TPACK is described as the basis of good teaching with technology (Hammond & Manfra, 2009). TPACK connects technology, curriculum content, and pedagogical strategies to produce effective teaching with educational technologies (Harris, Mishra, & Koehler, 2009). Mishra and Koehler (2009) further described TPACK as a repurposing of technology for educational purposes. They stated that technologies such as office productivity software, blogs, wikis, and GPS systems were not created for educational purposes, and for these technologies to be effective as educational tools, teachers must create new ways to use them.

<div align="center">21st Century Learning Skills</div>

In the fast-paced, information age society in which we live, new technologies seem to emerge on a daily basis. As these new technologies become aspects of everyday life, it is essential for educators to integrate them into their curriculum (Solomon & Schrum, 2007; Spires, Lee, Turner, & Johnson, 2008). Students in the classrooms of today are digital natives (Prensky,

<div align="center">14</div>

2001), who rely on technology for communication, information, and entertainment (Lenhart, Madden, & Hitlin, 2005). Students are seeking different approaches to the teaching and learning process (Solomon, 2005). Furthermore, these teaching and learning processes should encourage critical thinking and problem-solving skills as well as the skills necessary to succeed in the Digital Age (ISTE, 2008b). According to the Partnership for 21st Century Skills (P21) (2008), 21st century skills are the keys to success in school, life, and work. Furthermore, the P21 suggests that the success of the entire educational system depends on student acquisition of technological skills due to changes in education, international competition, and workplace jobs and skills.

In 2002, the P21 was formed by education leaders and policymakers and the business community to provide a vision for 21st century education (Ullman, 2007). The P21 (2009) developed a framework for learning in the new century based on the critical skills that students will need to succeed as citizens and workers in the new century. The organization stated that there are six primary elements represented in the framework. The five student-focused elements included learning and thinking skills (creativity and innovation, critical thinking and problem solving); information, media, and technology skills; core subjects (English, reading, or language arts, mathematics, science, foreign languages, civics, government, economics, arts, history, and geography); 21st century content (global awareness, financial literacy); and life and career skills (initiative and self-direction). The sixth element is described as 21st century assessment, which provides a measurement of the first five elements (P21, 2009).

Many of the new tools and strategies being used to engage students with 21st century skills include Web 2.0 tools and other emerging technologies like GPS receivers that focus on experiential learning. Solomon and Schrum (2007) presented the argument that the use of these emerging technology tools will provide educators with the ability to transform the learning

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experience into one that is relevant and exciting for students who "think, work, and play differently from previous generations" (p. 27). They further illustrated this point by stating that students know about the potential of these new tools and are comfortable using them. These students desire for learning at school to be more like the learning that they accomplish on their own (Solomon & Schrum, 2007).

<center>*The 21st Century Middle School Student*</center>

As stated previously, the students of today have been described as digital natives by Prensky (2001). These students were born into a rapidly changing technological world and are engaged in digital lives outside of the school. Lenhart, Purcell, Smith, and Zickuhr (2010) found that the average student owns 3.5 gadgets such as cell phones, mp3 players, computers, game consoles, and portable gaming devices. Today's students are "native speakers of technology, fluent in the digital language of computers, video games, and the Internet" (Prensky, 2006, p. 9). Prensky (2006) also stated that students are not engaged or motivated by traditional teaching and learning processes in school. Furthermore, Prensky (2006) described three distinct types of students in today's classrooms: those who are self-motivated, those who are going through the motions, and those who are tuning out the teacher. He elaborated on these three types of students by stating that today's schools can manage the first two types, but the third type presents an enormous challenge. Lee and Spires (2009) suggested that for learning to become engaging and meaningful to these students, middle school teachers must bridge the gap between student uses of technology in and out of school. Furthermore, Lee and Spires (2009), in summarizing three studies on middle school student attitudes toward technology in school, proposed that for teachers to meet the challenge of today's middle school students, they must develop creative and

flexible attitudes toward technology, an awareness of current technology tools and devices, and pedagogical strategies to tap into the students' 21st century skills.

The 21st century middle school student desires classroom activities that are actively engaging, provide for social learning experiences, offer continuous feedback, and have real world applications (Huffaker, 2003). Doolittle and Hicks (2003) further explained the learning activities that engage today's students as technology-enriched authentic and active experiences that can be transferred to useful and real-life settings. Dede (2000) suggested that digital technology tools such as computers, hand-held devices, and cell phones should be used for active and community-based learning experiences. Hagevik (2003) found that middle school students are motivated to achieve by interactive and exploratory environments. In the study by Hagevik (2003), students participated in a geographic information system (GIS) activity that was directed at helping the community. Students were reported to be active and engaged participants in the learning activity that involved real-world implications as well as technology integration.

The P21 (2005) reported that schools need to "bridge the gap between how students live and how they learn" (p. 4). Spires et al. (2008) surveyed 4,000 middle school students in North Carolina on their technology use outside of school and discovered that 83% used digital music, 76% played computer games, and 71% used cell phones. In a report by Lenhart et al. (2010), 75% of teens from ages 12-17 were found to own cell phones. More specific data reported by Lenhart et al. revealed as of September 2009, 58% of 12 year olds and 73% of 13 year olds, the age groups represented in middle school, owned a cell phone. However, 86% of teens stated that they cannot use the phones at school because either the school banned them altogether or just banned them in the classroom. This is echoed by several studies that reported that the students of today are often described as having to "unplug" when they are in the classroom because they are

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prohibited from bringing technology devices to school (Dede, Korte, Nelson, Valdez, & Ward, 2005; Levy & Murnane, 2004; Spires, et al., 2008). These factors, along with studies that have reported that students find social studies boring and irrelevant (Ciborowski, 2005; Stetson & Williams, 2005), project a negative forecast for achievement and engagement for the middle school social studies student. In addition, other studies (Higgins, Boone, & Lovitt, 2002; Lounsbury, 1988; Shaughnessy & Haladyna, 1985) have revealed that social studies and history are two of the least liked subjects in school, with English being rated the lowest.

Motivating Students to Achieve with Technology

Although today's middle school student is typically characterized as disinterested and disengaged at school due to being unplugged and bored (Marks, 2000), studies have shown that proper integration of technology into classroom practice can engage and motivate students to learn (Ullman, 2007). Spires et al. (2008), in the previously mentioned study of the perspectives on school, technology, and engagement of middle school students in North Carolina, found that students believed technology to be an important factor in motivating them to perform better in school. The study further reported that students responded that learning was more fun when technology was involved at school. When students ranked the learning activities they preferred on a scale of one equaling least favored and six equaling most favored, Spires et al. (2008) found the means of technology activities such as using computers (5.39) and doing research on the internet (4.87) to be higher than the means of traditional activities such as listening to the teacher lecture (3.71) and doing worksheets (3.23).

Spires et al. (2008) also conducted student focus group sessions with six groups across the state of North Carolina. Each group consisted of eight to ten students who had previously participated in the survey. From the hour-long focus group sessions, Spires et al. (2008)

discovered four perspectives that were most prevalent to the students. The theme "Do U Know

Us?" was described as students expressing a desire for more technology to be used in the

learning process at school. The students also described the technology that was actually being

used in school as boring because the activities were traditional such as word processing, taking

tests, or conducting research. The students revealed that they used technology for social

communication and entertainment outside of school. The theme "Engage Us" was described as

the need for students to be engaged and stimulated in school activities. Spires et al. reported that

the students in the focus groups wanted to use technology to learn new information instead of

taking a test on information that they already have studied. In the theme, "Prepare Us for Jobs of

the Future," Spires et al. reported that students wanted the technology experiences in school to be

related to future careers and occupations. The students were described with the ability to

understand the important role that technology plays in the professional arena in which they will

be a participant in the future. The theme "Let's Not Get Left Behind" revealed that students

would like to have more technology in their schools. Spires et al. (2008) pointed to student

concern for the out of date technological infrastructure and curriculum in their schools. In

synthesizing the study, Spires et al. (2008) described the middle school student of today as one

who is motivated by technological environments and opportunities that are relative to their

current out of school lives and their future lives in the real world.

Lee and Spires (2009), in an article that summarized the findings of Spires et al. (2008),

reported that the students want the technology experiences at school to be more like the

experiences they have outside of school in their everyday lives with technology. The students in

the study expressed an interest in using technology not just for communication and entertainment

but for creative and meaningful purposes (Lee & Spires, 2009). Lee and Spires (2009) also found

that students were motivated by smaller handheld and gaming devices, which were more common outside of school, but were not being used for educational purposes by their teachers.

In a dissertation by McNew (2008), middle school students who used handheld computers in mathematics scored significantly higher than students who did not use handheld computers to learn mathematics. The study analyzed the raw scores, scale scores, and national performance level scores of 286 middle school students with 154 students using handheld computers for a semester and 132 with no access to handheld computers. For the raw test scores on the TerraNova®, students in the experimental group had a mean score of 43.79 compared to those in the control group who had a mean score of 38.99. For the scale test scores, students in the experimental group had a mean score of 694.03 compared to those in the control group who had a mean score of 676.41. On national performance level test scores, students in the experimental group had a mean score of 69.01 compared to those in the control group who had a mean score of 59.48. McNew (2008) used t-tests to determine statistical significance higher means for each set of scores for the students who used handheld computers. McNew (2008) concluded that student achievement can be increased with the creation of a technology-infused mathematics learning environment.

Swan, van 't Hooft, Kratcoski, and Unger (2005) reported that the use of mobile computing devices, which are common for 21st century learning environments and representative of the GPS receiver genre, "may increase student motivation to learn and increase their engagement in learning activities, which in turn could lead to an increase in time spent on learning activities and higher quality work" (p. 110). In the study, Swan et al. (2005) examined the effects of mobile computing devices on student motivation to learn, engagement in learning activities, and support for the learning process in four elementary and two seventh grade science

classes. Teachers who were interviewed for the project reported that their students were more motivated and engaged in learning activities, which provided increased student productivity and a higher quality of student work. The interviews of students reported by Swan et al. (2005) revealed that students thought the mobile computing devices made school work easier and more fun.

The results in the area of achievement from the study by Swan et al. (2005) revealed that mobile computing devices can increase the achievement level of regular and special needs students. Swan et al. (2005) conducted an analysis of conceptual understanding from sample student work. The results provided statistical evidence of increased student learning with the ratings of conceptual understanding for the students using the mobile computing devices averaging four points higher than students who did not use the mobile computing devices. The interviews conducted in the study by Swan et al. (2005) also revealed that both teachers and students perceived an increase in achievement.

Rigby, Deci, Patrick, and Ryan (1992) reported that there is a relationship between motivation and student achievement. Their study further explained that the more students are engaged in the topic of instruction, the more easily students understand new knowledge. Wang and Reeves (2007) added that successfully motivating students should increase involvement in learning tasks, and therefore, promote student achievement. Furthermore, the study by Wang and Reeves (2007) revealed that students in a high school science class were cognitively engaged and enthused by a technology-based unit on fossilization. The results of their study of 27 tenth-grade students provided evidence of student perception of technology as positively influencing the quality of the learning experience and quantity of knowledge acquired. The survey results also indicated that the technology-based lesson increased the interest and motivation of students in

learning science. However, the study only measured perceptions and did not measure if the increase in motivation due to technology integration had any effect on student achievement.

Hsieh, Cho, Liu, and Schallert (2008) found that middle school science achievement scores increased significantly and motivational levels increased slightly in a technology-enhanced classroom environment. This study examined changes in the self-efficacy in terms of motivation and science achievement levels of 549 middle school students after participating in a technology-enhanced classroom environment. Using a pretest-posttest model, the researchers discovered that the average score in science achievement rose from 46.89 to 70.13. The average response for students regarding motivational levels rose slightly from 3.94 to 4.06 on a scale of five. The study also found that students' science achievement correlated positively with students' motivation levels on both the pretest and posttest. Hsieh et al. (2008) concluded that a technology-rich environment can provide a positive effect on achievement and motivation of middle school students.

In examining technology as a tool to increase science achievement in the middle school classroom, Olsen (2007) found that special education students in technology-enriched classrooms improved at higher percentages than those in regular classrooms. The study involved classrooms using the Great Explorations in Math and Science Space Science Curriculum Sequence. Software modules were used to supplement the regular classroom instruction for the experimental group, and the control group participated in activities that did not involve technology integration. Regular education students in a regular classroom environment showed an 8% average gain from pretest to posttest, and special education students showed a 7% decrease. On the other hand, regular education students in the technology-enhanced environment averaged a 9% gain from their pretest to posttest scores, and special education students averaged

a 7% gain. However, the study did not report if these gains were statistically significant. Olsen (2007) concluded that technology-enhanced instruction can benefit students with special needs. She also reported that the teachers involved in the study found that the technology-enhanced curriculum increased motivation and engagement in both special needs and regular middle school students.

A study conducted by Deaney, Ruthven, and Hennessy (2003) revealed that students perceive technology-enhanced lessons to be more relaxed yet more involved. The study also illustrated that students perceived technology lessons to be less boring than traditional classroom activities. Students in the eighth, tenth, and twelfth grade levels at six different schools were interviewed, and the majority of those interviewed associated technology lessons with increased interest and motivation. The interviews also revealed that the practical challenges and learning opportunities provided by technology-based activities encouraged an increased work ethic and engagement factor among the students. Deaney et al. (2003) concluded that teachers should create lessons that harness the power of technology to meet specific learning goals and objectives. Furthermore, they suggested that the technology should be used to create interactive learning experiences for students that encourage critical thinking and exploration.

Tuzun, Yilmaz-Soylu, Karakus, Inal, and Kizilkaya (2009) examined the influence of a computer gaming environment on the achievement and motivation of students in a geography classroom in Turkey. The study used a pretest-posttest model and used an educational computer game with a 3D environment to deliver the geography content to the students over a three-week period of time. Tuzun et al. (2009) reported that the students made statistically significant gains in achievement from the pretest (M = 6.2) to the posttest (M = 8.6). The study also measured student motivation related to the gaming environment versus the traditional school context via a

Likert scale questionnaire. Tuzun et al. (2009) discovered the mean scores for student motivation in the gaming environment were higher than the mean score for the traditional school context. Interviews of the students conducted after the study revealed that students wanted to study other topics in the gaming environment. Tuzun et al. (2009) also found that students perceived the experiential learning experience provided by the gaming environment to be fun and engaging. Tuzun et al. (2009) concluded that students, who explore, interact, collaborate, and immerse themselves in technology-rich environments, experience positive gains in motivation and achievement in learning geography.

Downes and Bishop (2009) conducted an instrumental case study to examine the effects of a technology-rich school environment on 28 disengaged middle school students over a two-year period. The students engaged in project-based technology activities in an environment where each student was equipped with a laptop and had access to digital video cameras, voice recorders, and other media production technologies. Observations and interviews were conducted with students and teachers involved in the project. The qualitative data reported by Downes and Bishop (2009) revealed that both students and teachers saw success and increased engagement created from the technology-rich environment. Teachers in the study also reported increased academic achievement from students who were previously disengaged from the academic experience. Downes and Bishop (2009) deduced from their findings that technology-rich environments, which include project-based learning, community connections, and authentic experiences, can positively influence motivation and, consequently, student achievement, in middle school students.

Kingsley and Boone (2008) investigated social studies achievement as a result of technology integration into seventh-grade middle school history classrooms. The sample size of

the study consisted of 184 students from an ethnically diverse urban school district. The study used a pretest-posttest model in which the experimental group used a multimedia-based American history software program in addition to regular classroom instruction to study the content, and the control group only received regular classroom instruction such as textbook readings and lecture. The results reported by Kingsley and Boone (2008) indicate an increase in achievement from both groups. However, the experimental group increased mean test scores by an average of 12.2% while the control group increased mean test scores by an average of 6.1%. This difference was reported to be statistically significant. Kingsley and Boone (2008) concluded that there is a strong link between technology-enhanced lessons and increased student achievement in middle school students. These results further describe the positive effect of technology integration on student achievement.

As these studies have shown, technology has shown to be an effective strategy to engage students in content and to increase student achievement. However, Mishra and Koehler (2006) suggested that teaching with technology is a complex and challenging task for teachers. According to Harris, Mishra, and Koehler (2009), the effective integration of technology requires proficiency in pedagogy, content-knowledge, technology, and the ability to interweave each of them into effective instruction. Students believe that technology enriches the learning process, and they consistently adopt new and different technologies to make their lives more interesting (Project Tomorrow, 2006). For technology integration to be effective, educators need to learn how to use and integrate it successfully. Professional development is integral in preparing teachers to use effective technology integration strategies, which can motivate and engage today's 21st century student (Digital Learning Environments, 2008). Raulston (2009)

summarized this concept by stating, "If educators begin to integrate technology in the classroom and model skills for students, it can help prepare students for the 21st century" (p. 65)

<center>Geocaching as an Instructional Strategy</center>

Studies have displayed that technology integration can have a positive impact on student performance in many content areas (Huang & Russell, 2006; Page, 2002; Tally & Goldenberg, 2005). However, researchers have called for further study of the influence of technology integration into the achievement of students in the social studies classroom (Diem, 2000; Saye & Brush, 2002; Whitworth & Berson, 2003). Tally (2007) reported that digital technologies have not influenced change in social studies teaching and learning practices. Journell (2009) argued that technology makes history come to life and provides a different perspective on the past for students.

A study of 159 middle and high school students from four different schools by Tally and Goldenberg (2005) revealed that students perceived that technology-enriched history classes were more interesting and increased their academic performance in these classes. The students in the study participated in online historical interpretation tasks and then completed a questionnaire about the experiences in the activity. The results indicated that 87% of students believed that they learned more history content in the technology-enriched class than their previous classes. Tally and Goldenberg (2005) also found that over half of the students associated the use of computers with a more active and interesting learning experience. Tally and Goldenberg (2005) also concluded from their results that hands-on learning activities can be associated with increased learning and motivation as they are in science and math classes.

Geocaching presents an opportunity to implement an innovative teaching and learning technology integration strategy that promotes 21st century skills and reinforces student

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perceptions of the active and hands-on learning experience. However, limited research has been conducted on the effects of geocaching on student achievement and its instructional value in the classroom. While the growth in instructional uses has been slow, the activity of geocaching has tremendous potential as a tool for integrating technology into the classrooms of today (Christie, 2007). Students are increasingly exposed to GPS technology via cell phones, in automobiles, and on television. When educators use this technology as a tool for teaching their subject, students are exposed to both a life-long learning skill as well as the curricular content. The sport or hobby of geocaching provides a framework for educators to follow as they develop lessons for using GPS technology in the classroom.

Geocaching is a technology integration strategy that has emerged from a relatively new recreational activity, and therefore, the amount of scholarly research is significantly lacking. Christie (2007) echoed this discovery with the statement that "Since GPS receivers are emerging technologies, and geocaching is an emerging educational strategy, there is little, if any, formal research on these topics" (p. 3). O'Hara (2008) described much of the writing about geocaching as journalistic with brief overviews and reports on the novelty of the hobby. Most of the scholarly articles relating to geocaching are found in practitioner journals and focus on introducing the concept of geocaching to teachers, providing a rationale for classroom use, or describing instructional geocaching methods (Dixon, 2007; Lary, 2004; Matherson, et al., 2008; Shaunessy & Page, 2006). This section of the review will synthesize that information as well as investigate the idea that geocaching is an effective technology integration tool for educators.

An Emerging Technology Tool

It is evident that GPS and geocaching are emerging technology integration tools because of the numerous articles defining the terms. Often cited as the first scholarly authors to define

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geocaching, Chavez, Courtright, and Schneider (2004) defined geocaching as a scavenger-hunt adventure game for Global Positioning System users. They further described it as a combination of geography and hide-and-seek. This resembles the definition that Groundspeak (2010) provided on the official site of geocaching, "Geocaching is a high-tech treasure hunting game played throughout the world by adventure seekers equipped with GPS devices" (¶ 1). Other articles included the high-tech, hide-and-seek, and treasure hunt elements in their definitions (Christie, 2007; Gentry, 2006; Ihamaki, 2007; Lary, 2004; Shaunessy & Page, 2006). Sarpong (2008) added the recently adopted slogan used by the official site of geocaching to his definition in that participants in the game are "human search engines" (p. 26).

Another element found in the majority of articles is the history of the Global Positioning System (GPS). Most discussed how 24 satellites are used in the Global Positioning System and that in May 2000, the jamming signal was turned off by the United States Department of Defense enabling civilians to gain similar accuracy to that of the military (Baker, 2001; Brown, Freeman, & Wiseman, 2003; Cameron, 2004; Christie, 2007; Gentry, 2006; Hinkley, 2005; Sarpong, 2008; Schlatter & Hurd, 2005; Sinicki, 2006). By including the satellite and military information in GPS articles, the studies attempted to legitimize geocaching as a high-tech and scientific endeavor, but this information also creates an element of mystery or gadgetry usually found only in the entertainment industry. Most educational geocaching articles included a history of geocaching as well. The account of engineer and internet news group user, David Ulmer, hiding a container and publishing the coordinates on the Internet for others to find, has been treated as legendary by some authors (Matherson, et al, 2008; Sarpong, 2008; Schlatter & Hurd, 2005; Sinicki, 2006). However, this first cache did initiate the game of geocaching and over one million other caches around the world (O'Hara, 2008).

Recreational Geocaching

With the high-tech and scavenger hunt characteristics clearly defined and origins described, many authors attempted to specify the basic activities that comprise a geocaching adventure. In general, geocaching involves an individual or group hiding a cache and recording the location using the coordinates from the GPS. Sarpong (2008) added that caches are usually hidden in public locations that would interest people because of natural beauty, unique landscape, or historical value. The caches are usually described as waterproof containers of varying sizes containing items for trading purposes and a log book. After the location is set and the container is hidden, the coordinates are posted online to the official geocaching web site, www.geocaching.com. The individual gives the cache a descriptive name and provides a description of the location along with clues or hints to help with finding the cache. Others who participate in this recreational activity will then be able to see the cache on the web site, and if interested, input the coordinates into a GPS and use the clues to attempt to locate the cache (Ihamaki, 2007; Lary, 2004; Matherson et al., 2008; O'Hara, 2008; Sarpong, 2008; Shaunessy & Page, 2006). Once a geocacher has found a cache, there are three simple rules: "take something from the cache, leave something in the cache, and write about it in the logbook at the cache" (Chavez et al., 2004, p. 69). Shaunessy and Page (2006) and O'Hara (2008) further explained that those who succeed in finding the cache should record their geocaching name along with the date and time that they found the cache. Participants are also asked to return the cache to the location and condition in which they found it (Chavez et al., 2004). Schlatter and Hurd (2005) included that after one finds the cache, signs and dates the log book, and returns to a computer, he or she should go to the web page related to the cache to write about the hunting experience. It is noteworthy to mention that all of the scholarly articles researched for this literature review

failed to mention a major reason for posting logs about found geocaches to the official site. This reason, according to Groundspeak (2010), is to document the number of official geocaches that one has found. It is also important to note that the information posted about a cache can help other geocachers as they plan their adventures (Sarpong, 2008).

Instructional Geocaching

As previously stated, geocaching is a recreational activity for GPS users. However, as many of the articles indicated, this activity is also an innovative technology integration strategy when adapted for classroom use. However, there is currently only one empirical research study relating geocaching to student achievement. Buck (2009) found that GPS integration into the mathematics curriculum produced small, but not statistically significant gains in student achievement using a pretest and posttest model of research. Her study of three ninth-grade algebra classes consisted of 75 students. The classes were divided with 44 students in the treatment group and 31 students in the control group. The students in the treatment group participated in four math-related GPS activities, and the students in the control group participated in traditional math classroom activities. Buck (2009) used a pretest and posttest given through the New Century Education (NCE) mathematics software program to assess student achievement levels before and after the treatment. The pretest mean of students in the treatment group was 3.796, and the posttest mean was 4.193, which revealed a gain of .397. The pretest mean of students in the control group was 3.769, and the posttest mean was 4.185, which revealed a gain of .416. Buck (2009) reported that these results reveal that students are making progress in mathematics achievement, but because the students in the control group outperformed the students in the treatment group, the GPS activity was not effective in increasing student achievement.

Buck (2009) also used two surveys to measure student attitude and perceptions of the GPS activity. The first was an Attitude Toward Mathematics Inventory (ATMI), which addressed students' attitude toward mathematics before and after the GPS activity. The treatment group revealed a slight gain in group mean from 3.231 to 3.243 on a scale of five. The control group indicated a loss in mean from 3.223 to 3.050. Buck (2009) reported that this is a significant difference in attitude toward mathematics according to the results of the *F* tests of repeated measures. Buck concluded that the outcome of the treatment indicated improvement in student attitude toward mathematics could be achieved with GPS activities. She also identified four discrete factors associated with attitude toward mathematics during her study. These factors were value, self-confidence, enjoyment, and motivation. Buck found that the treatment group demonstrated greater means than the control group for three of these factors (value, enjoyment, and motivation). However, gains in group means were reported only for the factors of enjoyment and motivation in both groups. Buck also found that the means for value and self-confidence were higher than those of enjoyment and motivation. From these results, she concluded that students value mathematics, but they do not enjoy learning it. Buck also concluded that with the most significant gains in enjoyment and motivation from pre-activity survey to post activity survey that GPS activities may be a useful strategy for improving attitude toward mathematics.

The second survey used by Buck (2009) addressed the attitudes of male and female students toward a mathematics-based GPS activity. This survey was designed by Buck and was administered after the GPS activity treatment to 29 students in the treatment group. The survey used a Likert-type rating scale with one representing strongly disagree and five representing strongly agree. Factor analysis revealed four important attributes: using a GPS, activities, motivation, and mathematics academics. Group means for males were higher for the factor of

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using a GPS (3.88 to 3.63) and slightly higher for the factor of activities (4.14 to 4.08) than female group means. Males (3.69) and females (3.68) were reported to have similar means for mathematics academics. However, the group mean of females (4.31) for the factor of motivation was substantially higher than the mean for the males (3.85). Buck did not report on the statistical significance of these results. However, she concluded that because all means were 3.6 or above on the Likert-type scale, the results indicate positive attitudes among both male and female students toward the use of GPS activities as a teaching and learning strategy. Further conclusions provided by Buck (2009) indicated that because the factors of activities and motivation demonstrated the highest group means, students enjoyed doing the GPS activity and being outside. Furthermore, she reported that students expressed a desire to do more GPS learning activities.

Christie (2007) related geocaching activities to constructivist learning environments that have been proven "to engage students and enhance learning" (p.3). Dixon (2007) reported that teachers have observed increased problem-solving skills and collaboration from students engaged in geocaching activities. Matherson et al. (2008) added that geocaching activities allow students to use prior knowledge, which stimulates critical thinking and authentic learning experiences.

Although not directly stated by any of the articles, there is a definite pattern revealed in the literature about geocaching. This pattern defines geocaching on two different levels, recreational and instructional. Recreational geocaching is what has been described in the previous sections of this review. It is geocaching as a treasure hunt activity played by GPS users in the general public and involves caches hidden anywhere in the world. However, a need to differentiate between recreational geocaching and instructional geocaching is evident. Rather

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than using caches related to the official geocaching game, instructional geocaching involves teacher-created caches that are used to instruct students in various subject areas. Christie (2007) explained that instructional caches should be hidden "in the vicinity of your classrooms or other outdoor area to which the school has access" (p. 22). Dixon (2007) added that instructional geocaching activities are also effective on school field trips to zoos or historical sites. Shaunessy and Page (2006) suggested parks near schools as locations for geocaching activities. They added that any area for instructional caches should have "plenty of space for hidden caches" (p. 51). Christie (2007) suggested that instructional caches be hidden at least 100 yards apart if possible.

Shaunessy and Page (2006) provided the only specified distinction between instructional and recreational geocaching: "It is also advisable that the teacher simulates an authentic geocaching experience rather than search for caches already posted online, which will allow the teacher to control the safety of the students and caches" (p. 51). Shaunessy and Page (2006) also described the main reason for instructional caching instead of recreational caching as safety for students, but the article also included time and feasibility as important factors for instructional geocaching instead of recreational geocaching as a teaching strategy. Lary (2004) in the first article to reference geocaching in the classroom stated that instructional geocaching provides coordinates, clues, GPS usage, and the hunting experience similar to that of real geocaching. However, the instructional geocaching experience is created only for the students and not the general public to experience. As these articles show, although derived from the same concept, there is a definitely a distinction between the activity of geocaching on school grounds and the activity of geocaching as a recreational hobby.

Instructional Geocaching Strategies

With the emergence of geocaching as a potential technology integration tool and as a growing recreational activity, numerous articles include lesson ideas and strategies for educators who wish to incorporate instructional geocaching into the curriculum. Lary (2004) suggested introducing the GPS to the students prior to geocaching activities. She also suggested programming the coordinates into the GPS before allowing the students to hunt for the caches. In her method, the clues are related to the subject area, and students may have to answer questions related to the content as well. Dixon (2007) discussed a virtual geocaching approach in which students are given coordinates and questions to answer about the location. She also suggested activities with real world implications in which the students locate a cache that has them participate in a ball tossing activity in order for the students to experience probability. Dixon (2007) also provided ideas for creative writing and science experiments that incorporate geocaching strategies. Anderson (2008) illustrated further scientific instructional uses in that teachers can have students identify plant and animal characteristics in life science or have the students identify soil, rocks, or landforms in earth science. Schlatter and Hurd (2005) discussed how map skills, math skills, and historical information can be integrated with physical education activities which involve students running to different caches on the school grounds.

Christie (2007) provided an overview of the constructivist perspective on the use of instructional geocaching as a method for teaching and learning. She suggested that teachers should place items in the caches that "will foster learning, raise curiosity, and encourage discussion about the curricular area chosen" (p. 22). She stated that students should be able to discuss the items that they find in the cache in relation to their understanding of the content. The specific curricular example that she provided has middle school geography students find

information about destinations in each cache and then create a brochure about the destination. Matherson et al. (2008) also described a constructivist learning environment for geocaching. However, these authors required students to research a topic and use information from the research to create a cache and clues for finding the cache. They were then allowed to hide the cache and give the coordinates to the teacher. The teacher then distributed the coordinates in order for other students to search for the cache. Shaunessy and Page (2006) also suggested that allowing students to create their own caches for other students to find is an effective instructional strategy. Shaunessy and Page (2006) further stated that this allows the students to be engaged with the content as they construct the cache and the clues. Dixon (2007) suggested that students use digital photography or video as they are participating in instructional geocaching activities in order to gather data and record experiences. She stated that students can then create presentations to further illustrate understanding of a concept.

Sinicki (2006) and Dixon (2007) stated that the recreational geocaching concept of the travel bug can be used as an instructional tool as well. Travel bugs, according to Sinicki (2006), are similar to military dog tags and are attached to items such as toy cars or action figures. Travel bugs allow the owner to track where the item to which the bug is attached has travelled and the logs that have been written about its adventures. Both authors related this to the *Flat Stanley Project* that encourages discussion about other cultures, places, and people. Lary (2004) also discussed this method as an effective way to teach geography to elementary students because they can use maps to trace the movement of the class travel bug.

As geocaching grows as a recreational and instructional activity, the number of classroom ideas will continue to grow. There are numerous web sites dedicated to instructional geocaching with lesson ideas and classroom strategies like the Illinois Educational Geocaching Association

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Portal (www.ilega.org), The University of Alabama Technology in Motion GPS/Geocaching in

the Classroom Wiki (http://uatim.wikispaces.com/gps), and the Groundspeak GPS in Education

Forum (http://forums.groundspeak.com).

<center>*Rationale for Instructional Geocaching*</center>

The ideas and concepts discussed in this review of literature are only a sampling of the

resources available for teachers who desire to integrate geocaching into the curriculum.

However, as with any emerging technology, there must be rationale for use in the classroom. The

argument for geocaching as an instructional tool was well described in the literature. As

previously mentioned, the main reason for instructional geocaching in the curriculum is that it

encourages students to exercise critical thinking and problem solving skills, which are elements

of 21st century learning (Christie, 2007; Dixon, 2007; Ihamaki, 2007; Shaunessy & Page 2006).

Anderson (2008), Christie (2007), and Dixon (2007) also illustrated that instructional geocaching

can be used for activities in all content areas. Christie (2007) and Matherson et al. (2008)

discussed how specific social studies content standards can be addressed through geocaching

activities, and Brown et al. (2003) illustrated how science standards were addressed with a GPS

scavenger hunt. Anderson (2008) stated that geocaching also closely aligns with two National

Educational Technology Standards for Students. These standards are

> Communication and Collaboration: Students use digital media and environments to
> communicate and work collaboratively, including at a distance, to support individual
> learning and contribute to the learning of others.

> Critical Thinking, Problem Solving, and Decision Making: Students use critical thinking
> skills to plan and conduct research, manage projects, solve problems, and make informed
> decisions using appropriate digital tools and resources. (ISTE, 2007, p.1)

The critical thinking and problem solving element has already been established, but the

21st century skill of collaboration is also prevalent in the literature on geocaching. Sinicki (2006)

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stated that geocaching encourages teamwork, and Dixon (2007) reported that teachers observed high levels of collaboration and teamwork from students during geocaching activities. Broda (2007) described geocaching in relation to both of the technology standards in that geocaching activities "involve elements of teamwork and group problem-solving" (p. 133). He also stated that students must use group processing skills in order to understand directions, input coordinates, and look for visual clues and the cache. Shaunessy and Page (2006) associated geocaching to making global connections and the ability to make effective decisions when students face problems in the real world.

The standards-based argument does not stand alone in providing rationale for geocaching as an educational tool. Broda and Baxter (2003) encouraged GPS use because it offers students a "change of pace" (p. 159), and an opportunity to use the environment in the learning process. Lieberman and Hoody (1998) stated that student achievement in reading, writing, mathematics, science, and social studies can be increased by going beyond the walls of the classroom. The report from Lieberman and Hoody (1998), based on data collected from 40 schools using the Environment as an Integrating Context for Learning (EIC) framework, focused on students using the environment and community around the schools to construct their own learning. Lieberman and Hoody (1998) reported that 39 comparative analyses of data related to student achievement were performed in 14 of the EIC schools. In 36 of these analyses involving data such as comprehensive exams, standardized tests, and grade point averages, the students in the EIC programs outperformed students in traditional programs. Lieberman and Hoody (1998) also reported that data were analyzed from five schools in the areas of student behavior, attendance, and attitudes. From these five schools, nine comparative analyses of behavioral data revealed that students in the EIC programs perform better than those in traditional programs.

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Schlatter and Hurd (2005) argued that geocaching offers skills to students that they can use throughout their lives, which is another important element of the 21st century teaching and learning process. They also introduced the concept that geocaching is an example of how technology and physical activity can be combined. Harmon (2008) also addressed this issue because "kids are spending about 50 percent less time outdoors than they did 10 years ago" (p. 51). She stated that geocaching is an effective way to combat the growing levels of obesity in youth because it involves an interesting technology along with exercise outdoors. She also indicated that there is a large body of research supporting the benefits of outdoor exercise. Ihamaki (2007) also stated that geocaching is good for the health and fitness of students because they are actively hunting for treasures. Lary (2004) provided more rationale in that students get excited about the hunt and about the learning experience. Sinicki (2006) summed up the reasons for incorporating geocaching into the curriculum by stating, "Geocaching is a fun and exciting way to get students outside and exploring the world that surrounds them while using the technology they love" (p. 2).

Impact on Learning Styles

Geocaching as an instructional strategy addresses various student learning styles (Christie, 2007). Attewell (2005) described mobile technology devices as useful in supporting different learning styles of students. Learning styles are defined as the preferred way an individual processes and retains new information (Dunn, Dunn, & Price, 1984). Canfield (1988) added that activities that address an individual's preferred method of learning provide motivation for continued pursuit of knowledge.

Many research studies have indicated that middle school students score significantly higher on achievement tests when instruction is individualized for specific learning styles (Dunn

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& DeBello, 1999; Minotti, 2005). In a study of English as a Foreign Language (EFL) students, Peacock (2001) reported that teaching strategies that did not match student learning styles negatively influenced learning, student motivation, and attitude. A case study of 12 schools conducted by Dunn and Griggs (1988) revealed that students achieved significantly less when instruction was not differentiated for the various learning styles. Chen, Toh, and Ismail (2005) found that technology designed to address different learning styles engaged students and supported learning and achievement.

In a study examining the effects of traditional instruction versus learning styles instruction, Farkas (2003) found that seventh grade social studies students scored significantly higher on achievement tests when instruction addressed various learning styles. Using a pretest-posttest design, the mean achievement test score gain for the students in the learning styles instructed classroom was 10.9 (SD = 3.9). The students in the classroom with the traditional approach to instruction had a mean achievement test score gain of 6.4 (SD = 5.0). In the study of 105 students in an urban middle school, Farkas (2003) also found that students in the learning styles instructed classroom had a significantly more positive attitude than the students in the classroom with the traditional approach to instruction. Farkas (2003) used the Semantic Differential Scale to measure student attitudes toward instructional approach. The mean score of the learning styles group was 54.5 (SD = 4.4), and the mean score of the traditional group was 46.1 (SD = 7.2). Farkas (2003) concluded that classrooms that incorporate instruction through learning style methods provide a better learning environment for increased student achievement and motivation than classrooms that practice traditional methods.

Slemmer (2002) investigated the effects of specific learning styles on student achievement within technology-integrated environments. In the meta-analysis of 48 studies,

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Slemmer (2002) found that learning styles appeared to influence student achievement, but not at a level of practical significance. The meta-analysis found the total mean weighted effect size to be $z_r = .1341$, but the significance level established for the study was $z_r = .16$. Slemmer (2002) added that the value was greater than the level generally considered to have a small effect ($z_r = .10$). Another result reported by Slemmer (2002) revealed that there was a significant difference in student achievement between students with different learning styles when all of the students received the same technology integrated lesson ($z_r = .2952$). Slemmer (2002) concluded that some technology-integrated environments produce statistically significant differences in achievement for students with different learning styles.

Roberts (2001) also examined the relationship of learning styles instruction with student achievement and attitude in the science classroom. The study found that students in a learning styles instructional environment achieved statistically higher test scores and attitude toward science scores than those in a traditional instructional environment. Roberts (2001) also found that students retain the information significantly longer if they were instructed in the learning styles environment. Minotti (2005) also found statistically significant gains in reading, math, science, and social studies achievement in a study of 167 middle school students where homework was designed to address individual learning styles of the experimental group versus traditional homework and study strategies for the control group. The study by Minotti (2005) used a pretest-posttest design to test students on units in reading, math, science, and social studies. The study also found that student attitudes toward homework were significantly more positive for those students in the experimental group than the students in the control group. Using the Semantic Differential Scale (SDS), Minotti (2005) found that the mean attitudes of the experimental group rose from 46.02 to 56.82, which was significant at the $p < .05$ level, and the

control group means rose only from 45.87 to 48.44, which was not statistically significant. Minotti (2005) concluded that middle school teachers can positively influence student achievement and motivation by using instructional strategies that address various learning styles.

There are several different theories concerning learning styles. However, geocaching as an instructional strategy directly relates to the Visual, Auditory, and Kinesthetic (VAK) model of learning styles. Kanar (1995) described these learning styles as physiological factors that reflect the best method for students to learn. Visual learners are more sight oriented and learn by seeing. They prefer to read, watch, observe, and record to gain understanding (Zapalska & Dabb, 2002). Students who are visual learners are exposed to information that they can see and read inside of each geocache. These students are also able to observe and record the information, which is also a characteristic of visual learners as described by Dunn (1993). Auditory learners are more hearing oriented and learn by listening and talking. They prefer to listen and discuss to gain understanding (Kanar, 1995; Vincent & Ross, 2001). Instructional geocaching activities are typically designed as cooperative learning experiences, and students who are auditory learners may benefit from the discussion of the information inside each container as well as the dialogue with other students throughout the activity (Dunn, 1993). Kinesthetic learners are more touch oriented and learn by tactile sense. They prefer engaging in hands-on activities or to be physically involved with the content to gain understanding (Kanar, 1995; Vincent & Ross, 2001). The natural connection to learning styles with instructional geocaching is with the kinesthetic learner. The activity of geocaching requires students to physically search for containers which contain the information. The hands-on learning environment, where the learner can touch the information and move around the geocaching course, may benefit the kinesthetic leaner (McCarthy, 2005).

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Conclusion

As this section has indicated, geocaching is an emerging recreational activity with great potential as an instructional strategy. An activity that enables teachers to integrate content, technology, exercise, nature, critical thinking skills, and standards into the classroom is important to reaching and motivating the 21st century learner. Geocaching is even more useful because it engages and excites students involved in the learning process as well as addresses various learning styles. However, as effective as geocaching has shown to be in theory and experience, there is still need for empirical data to support instructional geocaching as an effective tool for student achievement. In the event that these data are provided and with the availability of GPS receivers increasing, instructional geocaching could become as respected as other technology integration strategies such as the PowerPoint presentation, the webquest, educational blogging, podcasting, and digital storytelling.

CHAPTER III

RESEARCH METHODOLOGY

Introduction

The purpose of this study was to investigate how the instructional use of GPS through geocaching activities engages students and promotes achievement in a middle school social studies classroom. The impact of instructional geocaching on addressing the needs of students with various learning styles was also examined. In addition, the researcher identified student perceptions of geocaching activities and differences between recreational geocaching and instructional uses of geocaching. To date, recreational geocaching has grown exponentially among GPS users worldwide. However, the potential of instructional uses of geocaching has yet to be fully explored. Therefore, this researcher also hopes to provide an overview of instructional uses of geocaching.

Research Design

This chapter provides a description of the quantitative research design and procedures that were used for the study. Student achievement data were collected through two phases of pretests and posttests. A survey was also given to collect students' perceptions of their experiences and attitudes related to the instructional geocaching activities. Qualitative data were also collected from the survey for analysis.

The overall concept of this study investigated the impact of instructional geocaching on student achievement. There were two phases of the study involving four middle school classes. The first phase involved all four classes taking a pretest on the culture traits of Southwest Asia to

assess prior knowledge. Two classes (experimental group) then participated in a GPS activity to learn the content of the lesson, and two classes (control group) participated in a regular classroom activity to learn the content of the lesson. All four classes then completed a posttest to investigate if there was a significant difference in the achievement levels of students in the experimental group versus students in the control group.

The second phase was completed in the same order, but the content of the lesson was the essential elements of geography in Southwest Asia. The classes were also switched so that the two experimental classes in phase one were the control group in Phase II. The control group classes from Phase I became the experimental group in Phase II. The pretest and posttest model was also used to examine the differences in student achievement between the control and experimental groups. After both phases were completed, students in all four classes completed a survey that examined their perceptions and attitudes toward learning with instructional geocaching activities.

<div align="center">Setting of the Study</div>

This study was conducted in a middle school (grades 6-8) located in a small town in a southeastern state. According to the U.S. Census Bureau (2008), the town had an estimated population in 2008 of approximately 7,350 people with a lower than average median salary and educational level compared to other United States towns. Census data from 2000, as reported by the U.S. Census Bureau (2008), revealed that the median household income for the town in which the study occurred was $26,481. The median household income for the United States was reported as $41,994. In the area of education, the percentage of those having college degrees in the town was 19.1% versus 24.4% nationally (U.S. Census Bureau, 2008).

During the 2009-2010 school year, the average daily attendance of the middle school was 524 students out of a total enrollment of 547 students (Alabama State Department of Education, 2009). Table 1 reports the percentage relationship of the participating classes to the total school and community population. The middle school in which the study occurred as well as the high school to which the students progress were in a small percentage of Alabama schools where the ethnicity consisted of almost 50% white and 50% black (Alabama State Department of Education, 2009). The high school to which the students progress was selected as a No Child Left Behind Blue Ribbon School in 2008 for high student achievement in a school system that is considered to be in a high poverty area (U.S. Department of Education, 2009). The middle school consisted of 61% of students who receive free or reduced lunches. More than 40% is considered to be high poverty by the U.S. Department of Education (2009).

Table 1

Population and Participant Demographics

	Ethnicity				
Group	White	Black	Hispanic	Other	Total
Community Population	47.7%	50.9%	1.0%	1.4%	7540
Male	-	-	-	-	3385
Female	-	-	-	-	4155
Student Population	49.5%	48.4%	1.6%	0.4%	547
Male	27.2%	25.2%	0.5%	0.4%	292
Female	22.3%	23.2%	1.1%		255
Student Sample	52.9%	45.2%	0.9%	0.9%	104
Male	28.8%	26.0%	0.9%	0.9%	47
Female	24.0%	19.2%	-	-	47

Note. Dashes indicate that the data were not reported.

The middle school was also a participant in the Alabama Math, Science, and Technology Initiative (AMSTI). According to Jolly (2008), AMSTI is a state initiative to promote a hands-on approach to teaching mathematics, science, and technology. Furthermore, AMSTI (2009) described the program as providing actively engaging curriculum and real-world learning experiences. AMSTI (2009) also described that the goal of the program was to improve math and science teaching statewide in Alabama by providing three key services to schools: professional development, equipment and materials, and on-site support from specialists. The middle school in this study became an AMSTI school in 2007, and the program reported that all of the math and science teachers (grades six through eight) at the school were certified to use the AMSTI curriculum (AMSTI, 2009).

<div align="center">Participants</div>

The participants in this study consisted of a convenience sample of seventh-grade students from four social studies classes at the aforementioned middle school. This sample comprised 60% of the entire seventh-grade population. In the summer prior to the school year, school administrators, who attempted to distribute the students as heterogeneously as possible in terms of ability, assigned students to classes. With approximately 61% of the students in the school considered to have disadvantaged backgrounds, this study also helped to further the understanding of GPS by students who may not have the opportunity to use this type of technology away from a school setting.

The geography component of the seventh-grade social studies curriculum in the State of Alabama directly addresses student knowledge of GPS. The first objective states that students should be able to "describe the world in spatial terms using maps, major physical and human

features, and urban and rural land-use patterns" including "Global Positioning System (GPS)" (Alabama State Department of Education, 2004, p. 54).

Furthermore, these specific seventh-grade social studies classes were selected because they were all taught by the same teacher, who was an experienced geocacher and frequently used GPS receivers with her students. Another reason for the selection of the sample was because the school had a classroom set of 25 GPS receivers that were purchased by the classroom teacher with funds from an after school program. These GPS receivers were handheld devices, which were specifically designed for recreational purposes as opposed to automobile use. The classroom teacher had also attended four instructional geocaching workshops as well as co-taught seven instructional geocaching professional development sessions over the past three years. Although the strategies implemented by this classroom teacher were used regularly to provide hands-on experience with latitude and longitude and as a tool for review games, the strategy of this study using the GPS receivers for an instructional geocaching activity to expose the students to the content was new to the students. However, with the students in her classes having prior experience with GPS receivers, there was no novelty effect to limit the effectiveness of the technology integration strategy that was being studied (Swan, et al., 2005). Appendix A provides the lesson plans from the classroom teacher for this study in which both treatments were implemented.

The students were made aware of their individual learning style through the *Learning Style Survey for Young Learners* (Cohen & Oxford, 2001) administered by the classroom teacher at the beginning of the school year. The instructional geocaching activities were designed to address the various learning styles of the participants in the study. Visual learners were able to read and take notes on the contents of each geocache. Auditory learners were able to discuss the

content of the cache with teammates as well as listen to the information from the cache as it was read by another teammate. Kinesthetic learners were able to physically interact with the learning environment as they searched for the geocaches, which contained the content to be learned.

In the first phase, the students in two seventh-grade social studies classrooms served as the control group, and the students in two different seventh-grade social studies classrooms served as the experimental group. In the second phase, the groups were switched in that the control group from Phase I became the experimental group, and the experimental group from Phase I became the control group. All classes were taught by the same teacher. Table 2 provides a visual representation of the experimental and control groups for each treatment.

Table 2

Class Period Groupings

Class Period	Phase 1	Phase 2
First Period	Control	Experimental
Second Period	Experimental	Control
Third Period	Control	Experimental
Fourth Period	Experimental	Control

The classes were selected in this manner in order to provide similar numbers of students for each group in each phase. Table 3 provides the specific number of students as well as number of students by gender in each class period. The total number of participants in the control and experimental groups for each phase are also reported. The decision to switch the groups and repeat the activity was made for the purpose of increasing the sample size of the experiment.

This helped to ensure homogeneity and also helped the researcher avoid having to control for any differences in the different class periods.

Table 3

Number and Gender of Potential Participants per Phase

Treatment/Period	First Period	Second Period	Third Period	Fourth Period	Total
Control 1	29		28		57
Male	14		18		32
Female	15		10		25
Control 2		30		17	47
Male		21		6	27
Female		9		11	20
Experimental 1		30		17	47
Male		21		6	27
Female		9		11	20
Experimental 2	29		28		57
Male	14		18		32
Female	15		10		25

Prior to data collection, Institutional Review Board approval was obtained (see Appendix B). Parental consent and student assent were solicited prior to data collection. The permission and assent forms were distributed and collected by the classroom teacher. The students who were not given permission to participate in the study, or who did not assent to participation, completed the GPS activity with their class. However, the scores of these students were not reported to the researcher or included in the data analysis. Each assenting participant was assigned a number by the classroom teacher in order to ensure anonymity as well as to ensure that each assenting participant completed both the pretest and posttest. Participants were instructed by the teacher to write the identification number on each test and the survey. The scores of assenting participants who were absent on any day of the study were also not included in the results.

Instrumentation

Five different instruments were used to obtain data in this study: 1) a pretest for Phase I (see Appendix C), 2) a posttest for Phase I (see Appendix C), 3) a pretest for Phase II (see Appendix D), 4) a posttest for Phase II (see Appendix D), and 5) a GPS perceptions and engagement survey (see Appendix E). The standards-based pretests and posttests were created using the Examview© test creation software that accompanied the textbook used by the social studies teacher. In the first phase, the pretests and posttests were identical and consisted of short answer questions on the topic of the culture traits of Southwest Asia. Questions on the tests in the first phase addressed the following *Alabama Course of Study: Social Studies* (2004) objective for seventh grade geography, "Identify physical, economic, political, and cultural characteristics of selected regions in the Eastern Hemisphere, including Europe, Asia, and Africa" (p. 54).

In the second phase, the pretests and posttests were also identical and consisted of short answer questions on the topic of the essential elements of geography in Southwest Asia. Questions on the tests in the second phase also addressed the following *Alabama Course of Study: Social Studies* (2004) objective for seventh grade geography, "Identify physical, economic, political, and cultural characteristics of selected regions in the Eastern Hemisphere, including Europe, Asia, and Africa" (p. 55).

The perceptions and engagement survey instrument (see Appendix E) was developed by the researcher after a review of relevant literature on instructional geocaching, learning styles, student motivation, and achievement. The researcher also used information from the only other existing instructional geocaching study (Buck, 2009) in the development of the survey. Observations of existing GPS and geocaching classroom methods were also taken into consideration in the survey design. After the pretest and posttest administration in the second

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phase, all participants in the study completed this survey which was designed to assess participants' perceptions of and attitudes toward geocaching as an instructional activity. This survey instrument consisted of 12 four-point Likert scale items as well as four open-ended questions to allow students to elaborate on their experience with the instructional geocaching activity. The open-ended questions helped to clarify student responses and provide more detail on student engagement and motivation during the instructional geocaching activity.

There were also six instruments designed by the classroom teacher and researcher, which were used with the procedural aspects of this study. Four of these instruments were used in the instructional geocaching activity (two per phase). These instruments were the geocaching field guides (see Appendix F) and geocache task sheets (see Appendix G). The geocaching field guides consisted of the team number, the coordinates to each of the team's three geocaches, geography terms to be learned, spaces for note-taking and drawing conclusions, and instructions for the activity. The geocaching field guides contained different terms for each phase with Phase I using culture traits and Phase II consisting of essential elements of geography. These field guides were distributed to the student teams before the activity. The geocache task sheets consisted of information that the students needed to know about the content of the lesson. These sheets were divided into three different geocaches for the students to find.

The other two of the six procedural instruments designed by the classroom teacher and researcher were used with the control aspect of the study. These were the presentation notes used by the classroom teacher to present the content to the students in the control groups (see Appendix H). For the first phase of the study, the notes consisted of information on culture traits, and for Phase II, the notes consisted of information on essential elements of geography. For both phases of the study, the information contained in the presentation notes was the same as the

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information in the geocache task sheets. This strategy was used to make the method of learning the content the only variable in the study (a traditional instructional activity versus an instructional geocaching activity). Each instrument was used for the purpose of applying prior knowledge to the content of the lesson.

Data Collection

Prior to data collection, permission was obtained from the school principal and school athletic director to use the athletic fields adjacent to the middle school for the instructional geocaching course. This area provided the necessary space for placement of the geocaches as well as an open area to supervise all students during each activity. The researcher and classroom teacher then used GPS receivers to mark 30 waypoints for the instructional geocaching course. This number of waypoints was selected because the maximum number of teams in each class was ten, and each team would be locating three geocaches. After these waypoints were marked, geocaches which contained the geocache task sheets were created for each waypoint. The geocache task sheets were divided into three sections in order to be distributed in three geocaches. Each geocache was also clearly labeled with the number of the team that was supposed to find it. Team numbers were assigned randomly on the day of the activity through the distribution of the geocaching field guides, which had the team number listed at the top of the page. The geocaches were hidden in the marked locations by the researcher and the classroom teacher on the day prior to the activity.

Also prior to data collection, the classroom teacher divided the students in all four classes into groups of three. According to Brewster and Fager (2005), students of any ability level benefit by heterogeneous grouping. In order to ensure heterogeneity, the teacher divided each class into three sections based on student achievement in the last grading period. For each class,

the names of the top one-third of students were placed in one container. The names of the middle one-third of students were placed in a second container, and the names of the lowest achieving one-third of students were placed in a third container. The classroom teacher then pulled a name from each of the containers to form a group. This process was continued until all names were randomly drawn from each container, and all students were divided into groups of three.

There were three phases of data collection in this study. The first two phases divided the students into control and treatment groups for the pretest, instructional activities, and posttest. Phase III surveyed all students on perceptions of the instructional geocaching activity. The entire study consisted of class periods for six school days in which three consecutive days were used for Phase I and three different consecutive days were used for Phase II. The phases were conducted over two consecutive weeks. Informal interviews with the classroom teacher were also conducted throughout the study to gain insight into the curriculum and instruction of seventh grade social studies.

Phase I

During day one of Phase I, all students completed a pretest on the culture traits of Southwest Asia (see Appendix C), a topic which had not previously been taught by the classroom teacher to these students. The students had been taught a unit on culture traits in general, and the unit on Southwest Asia required the students to apply prior knowledge of culture traits to the specific region that was being covered. Each student was asked to write his or her identification number assigned by the classroom teacher on the test instead of his or her name to ensure anonymity. The pretest lasted approximately 20 minutes and was administered, graded, and recorded in the grade book by the classroom teacher. The tests were then stored in a locked filing cabinet until retrieved by the researcher for data analysis.

On the second day of Phase I, the control group (students in class periods one and three) participated in a traditional classroom activity (see Appendix H). This activity consisted of content presented to the students on the white board by the teacher. Students were expected to copy the information into their own notebooks and apply prior knowledge to match the correct culture traits to the content as it was presented. Students were also required to provide examples of the culture traits from previously covered regions. The classroom teacher reviewed the content after all students completed the activity. This activity took approximately 30 minutes for the students to complete.

Also on the second day of Phase I, the experimental group (students in class periods two and four) participated in the instructional geocaching activity covering the same content as the traditional classroom activity. The students were escorted to the school's athletic fields by the classroom teacher, and after a brief review of GPS use, the students were instructed to separate into their predetermined cooperative learning groups of three for the activity. After instructions for the activity were presented, each group was then presented with a geocaching field guide which contained the team number and coordinates to the group's three geocaches as well as the list of culture traits with which they must match the content in the geocaches. The students then used the GPS receivers to go to three specified locations, find their group's geocache at each location, and match the content of the geocache to the culture traits on the field guide using prior knowledge of the subject. The students were also required to discuss the topics on each geocache task sheet and provide examples of the culture traits from previously covered regions. The students were also required to return the geocache container to its location before moving on to the other locations. After all groups finished the activity, the classroom teacher reviewed the

content to ensure understanding. The instructional geocaching activity took approximately 45 minutes to complete.

On the third day of Phase I, both the experimental and control groups completed a posttest (See Appendix C) on the culture traits of Southwest Asia. This test was the same as the pretest in content and design and was identical for both the experimental and control groups. The classroom teacher administered the posttest reminding the students to write their assigned identification number on the test instead of their name. The pretest took approximately 20 minutes to complete and was graded and recorded in the grade book by the classroom teacher. The tests were then stored in a locked filing cabinet until retrieved by the researcher for data analysis.

Phase II

Phase II of the study was exactly the same procedurally as Phase I. However, in the second phase, the control and experimental groups were switched. The control group consisted of students in class periods two and four, and the experimental group consisted of students in class periods one and three (see Table 2). The topic of study for the students had also progressed to the essential elements of geography for Southwest Asia, a topic which had not previously been taught by the classroom teacher to these students. However, earlier in the semester, the students had been taught a unit on the essential elements of geography in general, and the unit on Southwest Asia required the students to apply prior knowledge of the essential elements of geography to the specific region being studied.

On day one of Phase II, all students (experimental and control) completed a pretest on the essential elements of geography for Southwest Asia (see Appendix D). Each student was asked to write his or her identification number assigned by the classroom teacher on the test instead of

his or her name to ensure anonymity. The pretest lasted approximately 20 minutes and was

administered, graded, and recorded in the grade book by the classroom teacher. The tests were

then stored in a locked filing cabinet until retrieved by the researcher for data analysis.

On day two of Phase II, the control group (students in class periods two and four)

participated in a traditional classroom activity (see Appendix H). This activity consisted of

content presented to the students on the white board by the teacher. Students were expected to

copy the information into their own notebooks and apply prior knowledge to match the correct

essential element of geography to the content as it was presented. Students were also required to

provide examples of essential elements of geography from previously covered regions. The

classroom teacher reviewed the content after all students completed the activity. This activity

took approximately 30 minutes for the students to complete.

Also on day two of Phase II, the experimental group (students in class periods one and

three) participated in the instructional geocaching activity covering the same content as the

traditional classroom activity. The students were escorted to the school's athletic fields by the

classroom teacher, and after a brief review of GPS use, the students were instructed to separate

into their predetermined cooperative learning groups of three for the activity. After instructions

for the activity were presented, each group was then presented with a geocaching field guide

which contained the team number and coordinates to the group's three geocaches as well as the

list of essential elements with which they must match the content in the geocaches. The students

then used the GPS receivers to go to three specified locations, find their group's geocache at

each location, and match the content of the geocache to the essential elements of geography on

the field guide using prior knowledge of the subject. The students were also required to discuss

the topics on each geocache task sheet and provide examples of the essential elements of

geography from previously covered regions. The students were also required to return the geocache container to its location before moving on to the other locations. After all groups finished the activity, the classroom teacher reviewed the content to ensure understanding. The instructional geocaching activity took approximately 45 minutes to complete.

On day three of Phase II, both the experimental and control groups completed a posttest (see Appendix D) on the essential elements of Southwest Asia. This test was the same as the pretest in content and design and was identical for both the experimental and control groups. The classroom teacher administered the posttest reminding the students to write their assigned identification number on the test instead of their name. The pretest took approximately 20 minutes to complete and was graded and recorded in the grade book by the classroom teacher. The tests were then stored in a locked filing cabinet until retrieved by the researcher for data analysis.

Phase III

After both phases, all assenting participants in the experiment completed the survey of student perceptions and engagement (see Appendix E). The survey was administered by the classroom teacher on the day after Phase II was completed. Each student was asked to write his or her identifying number on the survey. The perceptions and engagement survey consisted of a four-point Likert scale format to address items such as "The GPS activity helped me to learn about geography" and "I felt motivated to learn about geography more while using the GPS than while taking notes in class." There were also four open-ended questions to help clarify responses and to provide more information to the researcher on student perceptions of the GPS activity. The survey took approximately 15 minutes to complete. The classroom teacher collected the surveys after they were completed and returned them to the researcher for data analysis.

Research Questions

The research questions explored in this study were as follows:

1. Is there a significant difference in pretest and posttest scores between students who received the instructional geocaching treatment and students who did not receive the instructional geocaching treatment?

2. Is there a significant difference between the pretest and posttest scores of students with different learning styles who received the geocaching treatment?

3. Is there a significant difference between the pretest and posttest scores of students with different learning styles who did not receive the geocaching treatment?

4. Is there a significant difference in student engagement during the geocaching activity based on learning style?

5. Is there a significant relationship between student engagement and student achievement during the instructional geocaching treatment?

6. What are students' perceptions toward geocaching activities for learning?

Data Analysis

After the researcher completed the three phases of the experiment, data were screened for data entry errors, missing data, and outliers using standard procedures. Data were analyzed using *Statistical Package for the Social Sciences* (SPSS) 17.0 ®. Descriptive statistics were used to report gender, learning style, and GPS receiver use of each student. Qualitative data from the open-ended questions on the GPS perceptions and engagement survey were used to clarify responses and to further inform the research regarding student perceptions of geocaching.

Research questions and the data analysis techniques that were used are as follows:

Research Question 1: *Is there a significant difference in pretest and posttest scores between students who received the instructional geocaching treatment and students who did not receive the instructional geocaching treatment?*

Data were collected via the pretest and posttest scores. Prior to data analysis, the scores were tested for normal distribution by observing the skewness, kurtosis, and histograms. When the results revealed that the assumption of compound symmetry was not met, a Shapiro-Wilk test confirmed that the distribution was not normal. Therefore, a non-parametric Mann-Whitney *U* test was conducted to compare the test scores of students who participated in the instructional geocaching activity (experimental group) and of students who participated in the traditional classroom activity (control group) from each phase of the study. A Wilcoxon test was also conducted to determine if there were differences in the scores of the pretests and posttests of all students in each phase of the study.

Research Question 2: *Is there a significant difference between the pretest and posttest scores of students with different learning styles who received the geocaching treatment?*

Data were collected via the pretest and posttest scores. Learning style data were collected from the GPS perceptions and engagement survey. A non-parametric Kruskal-Wallis test was conducted to evaluate differences among the three learning styles (visual, auditory, kinesthetic) on median scores for the pretest and posttest of the experimental group in each phase of the study.

Research Question 3: *Is there a significant difference between the pretest and posttest scores of students with different learning styles who did not receive the geocaching treatment?*

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Data were collected via the pretest and posttest scores. Learning style data were collected from the GPS perceptions and engagement survey. A non-parametric Kruskal-Wallis test was conducted to evaluate differences among the three learning styles (visual, auditory, kinesthetic) on median scores for the pretest and posttest of the control group in each phase of the study.

Research Question 4: *Is there a significant difference in student engagement during the geocaching activity based on learning style?*

Data were collected via the GPS perceptions and engagement survey. The reliability of the survey was tested using Cronbach's alpha. Item 10, "My learning time would have been better spent in the classroom than outside using a GPS," was recoded to match the scale. Items from the survey that had item-to-total correlation below .30 were dropped. The mean results of the remaining items were totaled to determine overall student engagement.

The survey responses were then subjected to an exploratory factor analysis using a principal component analysis with a varimax, orthogonal rotation to provide validity evidence for this instrument. Factor analysis also provided some of the tools needed to define the underlying dimensions of variables in construct validity. Factors with an eigenvalue of 1.00 were extracted, and variance was determined for the factors. An examination of the principal components solution helped to identify the factors of student engagement.

After the factors were determined, the engagement survey results were tested for normal distribution by observing the skewness, kurtosis, and histograms. When the results revealed that the assumption of compound symmetry was not met, a Shapiro-Wilk test confirmed that the distribution was not normal. Therefore, a non-parametric Kruskal-Wallis test was performed to investigate if there was a significant difference in student engagement during the geocaching activity based on learning style. Student engagement was computed by the total score of the 11

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items that remained after the item-to-total correlation, and learning style was indicated on the GPS perceptions and engagement survey. A Mann-Whitney *U* test was used to determine where the differences were found. A Bonferroni correction was used to produce a stricter significance level and prevent a Type I error. Further analysis was conducted using chi-square to determine if there were any differences between learning styles and the individual survey items.

Research Question 5: *Is there a significant relationship between student engagement during the instructional geocaching treatment and student achievement on the posttest? What are students' perceptions toward geocaching activities for learning?*

Data were collected via the posttest scores and GPS perceptions and engagement survey. Pearson product-moment correlation coefficients were computed between overall student engagement and the posttest scores in each phase. Student engagement was computed by the total score of the 11 items that remained after the item-to-total correlation.

Research Question 6: *What are students' perceptions toward geocaching activities for learning?*

Data were collected from the GPS perceptions and engagement survey. Quantitative data from the Likert-scale responses were subjected to an exploratory factor analysis as detailed in Research Question 4 to determine the underlying factors of the survey. The factors were analyzed for relationships using a Pearson product-moment correlation. A Bonferroni correction was used to produce a stricter significance level. Qualitative data from the open-ended questions on the survey were analyzed using constant comparative analysis by reading and re-reading the responses, searching for common patterns and trends (Miles & Huberman, 1994).

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Summary

The purpose of this study was to investigate how the instructional use of GPS through geocaching activities engages students and promotes achievement in the middle school classroom. A comparison of test scores from students who participated in an instructional geocaching activity were compared with the test scores of students who participated in a traditional non-technology integrated classroom activity. Student achievement data were collected through two series of pretests and posttests. A GPS perceptions and engagement survey was also given to collect student attitude and engagement data related to the instructional geocaching activities that were conducted as the experimental treatments. Data were analyzed using quantitative and qualitative methods.

CHAPTER IV

RESULTS

Introduction

The purpose of this study was to investigate how the instructional use of GPS through geocaching activities engages students and promotes achievement in a middle school social studies classroom. The relationship of instructional geocaching with addressing the needs of students with various learning styles was also examined. The study was conducted with four seventh grade social studies classes and in two phases. All students participated in the geocaching treatment to learn content in one phase or the other. Student achievement was measured by a pretest and posttest in each phase of the study. Student engagement and perceptions of the geocaching activity were measured by a perceptions and engagement survey given after both phases of the study were completed. Quantitative data were analyzed for research questions one through six. Qualitative data from the open-ended questions on the perceptions and engagement survey were used to clarify responses and to further inform the researcher regarding student perceptions of geocaching for question six.

Demographic Results

The potential sample size for this study was 104 students from four seventh grade social studies classes. However, data from students who did not assent to the study and from students who were absent during any part of the study were not considered in the analysis. The resulting number of student participants in the study was 81, or 78% of the potential sample size. Of the sample size, 42 males (52%) and 39 females (48%) completed each phase of the study. The students were also asked to report their learning style as indicated on the learning styles

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inventory conducted by the teacher earlier in the school year. Forty students (49%) indicated that

their learning style was kinesthetic. Twenty-six students (32%) indicated visual as their learning

style, and 15 students (19%) indicated auditory as their learning style. Table 4 summarizes the

learning style demographic by class period. Students were also asked to report if they had used a

GPS receiver prior to participating in the activities in this class. Forty-six students (57%)

answered that they had not used a GPS receiver before, and 35 (43%) had previous experience

with a GPS receiver.

Table 4

Number and Percentage of Learning Styles by Class Period

Period/Learning Style	Visual	Auditory	Kinesthetic	Total
First	7	2	14	23
% of Class	30%	9%	61%	100%
% of Sample	9%	2%	17%	28%
Second	7	6	10	23
% of Class	30%	26%	43%	100%
% of Sample	9%	7%	12%	28%
Third	9	4	9	22
% of Class	41%	18%	41%	100%
% of Sample	11%	5%	11%	27%
Fourth	3	3	7	13
% of Class	23%	23%	54%	100%
% of Sample	4%	4%	9%	16%
Total	26	15	40	81
% of Sample	32%	19%	49%	100%

Research Questions

Research Question 1: *Is there a significant difference in pretest and posttest scores between students who received the instructional geocaching treatment and students who did not receive the instructional geocaching treatment?*

Research question one sought to examine the influence of the instructional geocaching activity on student achievement. Prior to data analysis, the pretest and posttest scores from both phases of data collection were tested for normal distribution. Skewness, kurtosis, and histograms of the pretest and posttest scores revealed that the scores did not meet the assumption of compound symmetry (Munro, 2001). A Shapiro-Wilk test confirmed that the test scores differed from a normal distribution where p < .05 (see Table 5). For this reason, the non-parametric Mann-Whitney *U* test was conducted to compare the scores on the pretests and posttests from each phase of the study.

Table 5

Shapiro-Wilk Test of Normality

	Statistic	df	Sig.
Pretest 1	.967	81	.035
Posttest 1	.660	81	.000
Pretest 2	.872	81	.000
Posttest 2	.916	81	.000

The pretest and posttest scores were analyzed using the Mann-Whitney *U* test to address Research Question 1. The experimental group consisted of students who participated in the instructional geocaching activity, and the control group consisted of students who participated in the traditional classroom activity. To protect against a Type I error, a Bonferroni correction was

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used to produce a stricter significance level of p < .025, which involved dividing the desired

level of significance by the number of comparisons that were made (.05/2 = .025) (Munro,

2001). Table 6 presents the average ranks of the pretest and posttest scores for each group in

each phase of the study.

Table 6

Average Ranks of Pretest and Posttest Scores

Group	Pretest	Posttest
Phase I		
Control	43.23	37.74
Experimental	38.21	45.07
Phase II		
Control	44.39	34.29
Experimental	36.76	46.37

The results of the Mann-Whitney *U* test for the Phase I pretest revealed no significant

difference in achievement, z = -.961. As shown in Appendix I, Figure I1 shows the distributions

of the scores on the Phase I pretest. The results of the Mann-Whitney *U* test for the Phase I

posttest also revealed no significant difference in achievement, z = -1.57. Figure I2 shows the

distributions of the scores on the Phase I posttest.

The results of the Mann-Whitney *U* test for the Phase II pretest revealed no significant

difference in achievement, z = -1.54. Figure I3 shows the distributions of the scores on the Phase

II pretest. The results of the Mann-Whitney *U* test for the Phase II posttest revealed a significant

difference in achievement, z = -2.32, p < .05. Figure I4 shows the distributions of the scores on

the Phase II posttest, which reveal that the results were in the expected direction of higher

achievement gains for those students in the experimental group.

A Wilcoxon test was conducted to determine if there were differences in the scores of the

pretests and posttests of each phase of the study. The means and ranks of the pretest and posttest

scores for each phase of the data are reported in Table 7. The pretest comparison results

indicated a significant difference in scores, $z = -6.46$, $p < .001$. The scores for the Phase I pretest

were significantly higher than the scores for the Phase II pretest for both the experimental and

control groups. The posttest comparison results also indicated a significant difference in scores, z

$= -5.98$, $p < .001$. The scores for the Phase I posttest were significantly higher than the scores for

the Phase II posttest for both the experimental and control groups.

Table 7

Overall Pretest and Posttest Means and Ranks

	Pretest			Posttest		
Phase	Mean	SD	Rank	Mean	SD	Rank
Phase I	7.23	2.96	42.30	10.86	1.90	38.64
Phase II	4.33	1.16	18.21	8.21	2.53	26.65

Research Question 2: *Is there a significant difference between the pretest and posttest*

scores of students with different learning styles who received the geocaching treatment?

For both phases of the study, a Kruskal-Wallis test was conducted to evaluate differences

among the three learning styles (visual, auditory, kinesthetic) on median scores for the pretest

and posttest of the experimental group. Table 8 presents the results of the Kruskal-Wallis tests

for each phase of the study. A significance level of $p < .05$ was used for each test. For the

pretests in both phases of the study, the Kruskal-Wallis test, which was corrected for tied ranks,

revealed that there was no significant difference in pretest scores between learning styles. The Kruskal-Wallis test also revealed that there was no significant difference in posttest scores between learning styles in each phase of the study. Follow-up tests for each learning style in each phase were not necessary because the overall differences were not significant (Green & Salkind, 2005).

Table 8

Kruskal-Wallis Results for Experimental Groups

Test	df	χ^2	p
Phase I (n = 36)			
Pretest	2	7.23	ns
Posttest	2	4.33	ns
Phase II (n = 45)			
Pretest	2	7.61	ns
Posttest	2	3.92	ns

Research Question 3: *Is there a significant difference between the pretest and posttest scores of students with different learning styles who did not receive the geocaching treatment?*

For both phases of the study, a Kruskal-Wallis test was conducted to evaluate differences among the three learning styles (visual, auditory, kinesthetic) on median scores for the pretest and posttest of the control group. Table 9 presents the results of the Kruskal-Wallis tests for each phase of the study. A significance level of $p < .05$ was used for each test. For the pretests in both phases of the study, the Kruskal-Wallis test, which was corrected for tied ranks, revealed that there was no significant difference in pretest scores between learning styles. The Kruskal-Wallis test also revealed that there was no significant difference in posttest scores between learning

styles in each phase of the study. Follow-up tests for each learning style in each phase were not

necessary because the overall differences were not significant (Green & Salkind, 2005).

Table 9

Kruskal-Wallis Results for Control Groups

Test	df	χ^2	p
		Phase I (n = 45)	
Pretest	2	1.54	ns
Posttest	2	0.37	ns
		Phase II (n = 36)	
Pretest	2	0.48	ns
Posttest	2	4.14	ns

Research Question 4: *Is there a significant difference in student engagement during the*

geocaching activity based on learning style?

The GPS perceptions and engagement survey (see Appendix E) was used to address

Research Question 4. The original survey consisted of 12 items to be used for this study. This

survey instrument had a reliability coefficient using Cronbach's alpha of .71 and item-to-total

correlations from .24 to .68. After dropping item 4, "I thought the GPS activity was challenging,"

which had item-to-total correlation below .30, a revised instrument was determined consisting of

11 items with a Cronbach's alpha coefficient of .75. According to George and Mallery (2003), a

reliability coefficient of .7 or higher is acceptable. Of the 11 items remaining, the lowest item-to-

total correlation was .33 with the highest being .66. This suggested that most of the items gave a

significant contribution to the total instrument. High item-to-total correlations not only support

the reliability of the instrument, but also document validity in that the items are measuring the

same theoretical construct (Munro, 2001). The standard error of measurement was 1.74. The means and standard deviations are presented in Table 10. The total variable in Table 10 represents the overall level of engagement. This variable was computed by the total score of the 11 items that remained after the item-to-total correlation.

Table 10

Descriptive Statistics of Survey Items (n=81)

Item	Description	m	sd
Total		41.56	3.46
Q1	Learning with technology	3.46	0.57
Q2	Ease of use	3.49	0.50
Q3	Enjoyment of activity	3.85	0.39
Q5	Learning with GPS	3.85	0.48
Q6	GPS helps learning	3.43	0.55
Q7	Motivated to learn	3.44	0.63
Q8	More enjoyable than notes	3.86	0.38
Q9	Understanding the lesson	3.25	0.80
Q10	Outside versus inside	3.43	0.76
Q11	Motivated in other topics	3.41	0.67
Q12	Other subjects	3.53	0.61

The survey responses were subjected to an exploratory factor analysis using a principal component analysis with a varimax, orthogonal rotation. Factor analysis was useful in providing validity evidence for this instrument. Factor analysis provided some of the tools needed to define the underlying dimensions of variables in construct validity. Of the 11 factors, three factors were extracted with an eigenvalue of 1.00 or greater. The first factor explained 31% of the variance with three factors explaining 54% of the variance.

After examining the principal components solution, a three factor solution was retained, which provided the best simple structure. The item loadings were all above .465, which presents evidence to the construct validity of the instrument (Carmines & Zeller, 1979). The underlying

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dimensions identified by each factor were as follows: (I) Fun, (II) Perception of Learning, and (III) Motivation.

The fun factor was represented by items 2, 3, 5, and 8 from the GPS perceptions and engagement survey (see Appendix E). These items addressed information such as, "How easy was it to use the GPS," "How much did you enjoy the GPS activity," "Learning about geography using a GPS was more fun than taking notes.", and "The GPS activity was more enjoyable than taking notes in class," respectively. The perception of learning factor was represented by items 6, 7, 9, and 10. These items addressed information such as, "The GPS activity helped me to learn about geography," "I felt motivated to learn about geography more while using the GPS than while taking notes in class," and "I understood the geography lesson better by using the GPS than by taking notes in class." Item 10 stated, "My learning time would have been better spent in the classroom than outside using a GPS.", and was recoded to match the scale. The motivation factor was represented by items 1, 11, and 12. These items address information such as, "I like learning with technology," "I would be more motivated to learn other topics in social studies if we could use a GPS," and "I would like to participate in GPS activities in other subjects," respectively.

To specifically address Research Question 4, which investigated if there was a significant difference in student engagement during the geocaching activity based on learning style, a Kruskal-Wallis test was performed using a significance level of .05. This nonparametric test was selected after skewness, kurtosis, and histograms of the engagement survey results revealed that student engagement did not meet the assumption of compound symmetry (Munro, 2001). A Shapiro-Wilk test confirmed that the student engagement results differed from a normal distribution where $p < .05$. Student engagement was measured by the total score of the 11 items

that remained after the item-to-total correlation. From the results of the engagement survey, a significant difference was found between student engagement and learning styles, χ^2 (2, n = 81) = 6.87, $p < .05$. Pairwise comparisons among the three learning styles were conducted using a Mann-Whitney U test with a Bonferroni correction to produce a stricter significance level of p < .025, which involved dividing the desired level of significance by the number of comparisons that were made (.05/2 = .025) (Munro, 2001). The Mann-Whitney U test found a significant difference between the students with a visual learning style and students with a kinesthetic learning style, z = -2.27, $p < .025$. In the pairwise comparison, kinesthetic learners had an average rank of 37.79, while visual learners had an average rank of 26.90. Auditory learners did not significantly differ from the other two learning styles. Further analysis was conducted using chi-square to determine if there were any relationships between learning styles and the individual items. There was a significant relationship between learning style and item 7 (χ^2 (4, n = 81) = 11.95, $p < .05$), which stated "I felt motivated to learn about geography more while using the GPS than while taking notes in class."

Research Question 5: *Is there a significant relationship between student engagement during the instructional geocaching treatment and student achievement on the posttest?*

To address Research Question 5, Pearson product-moment correlation coefficients were computed between overall student engagement and the posttest scores in each phase. Student engagement was computed by the total score of the 11 items that remained after the item-to-total correlation. A significance level of p < .05 was used for each correlation, and no statistically significant relationship was found between student engagement and the posttest scores in Phase I (r = .93, n = 36) or Phase II (r = -.06, n = 45).

Research Question 6: *What are students' perceptions toward geocaching activities for learning?*

An examination of Research Question 6 was conducted with data from Research Question 4. This information was obtained from the Likert-scale responses on the GPS perceptions and engagement survey. As detailed in Research Question 4, the survey responses were subjected to an exploratory factor analysis, which identified three underlying dimensions: (I) Fun, (II) Perception of Learning, and (III) Motivation.

A Pearson product-moment correlation coefficient was computed to assess the relationships between the three underlying factors for all students. To protect against a Type I error, a Bonferroni correction was used to produce a stricter significance level of $p < .008$, which involved dividing the desired level of significance by the number of comparisons that were made $(.05/6 = .008)$ (Munro, 2001). The results indicated that there is a significant relationship between all factors. Moderate, positive correlations were found between fun and motivation ($r = .48, p < .001$) and fun and perception of learning ($r = .41, p < .001$). Increases in fun correlated with increases in motivation and perception of learning. There was also a weak, positive correlation between motivation and perception of learning ($r = .33, p < .005$). Increases in motivation have a slight correlation with increases in perception of learning.

Four open-ended questions on the GPS perceptions and engagement survey (see Appendix E) were used to obtain qualitative data. After reading and re-reading the responses to the open-ended questions, the following themes emerged: (1) Being Outside and Moving Around, (2) Hands-On Experience, (3) Finding Directions, (4) Searching for and Finding Things, and (5) Math and Science.

The element of not being confined to the classroom was reported as an engaging factor for many students. The theme of being outside and moving around was indicated by 41 (51%) of the 81 students in the study. It is important to note that of the 41 students who indicated that being outside and moving around was important, 21 were kinesthetic learners, 11 were visual learners, and nine were auditory learners. The element of being outside and moving around was described by students as "being outside having fun instead of sitting inside and taking notes" and "moving around while we learned geography was fun."

Another prevalent theme that emerged from the responses was the engaging factor of the hands-on experience. This theme, which is somewhat related to the moving around aspect of the previous theme, was mentioned by 22 students, or 27%. The students perceived that the GPS activity provided them with an experience that was better than taking notes. One student wrote, "I liked that the GPS activity was hands-on work. It was better than just writing notes." Furthermore, the students indicated that they learned more by stating "I think the lesson was more understandable because we did it hands-on with the GPS."

Students revealed an understanding of GPS receivers as devices to provide directions and determine their current location. The theme of finding directions was the most prevalent in the responses and was reported by 62 (77%) of the students. This included over 32 indications of the GPS receiver preventing students from getting lost. For example, one student said, "If I were to get lost while I was hunting, I could mark the place where the truck was and follow the coordinates," and another echoed this by stating, "A GPS can help me to not get lost in the wilderness." Students frequently mentioned that the GPS activity helped them to learn "which way is north, south, east and west." References to travel and using GPS receivers to locate places

were also frequently found in this theme. One student noted, "I now know how to use a GPS to locate places when I travel with my family."

The element of the scavenger hunt was also prevalent in student responses. Of the 81 students, 34, or 42%, indicated that searching for and finding things was an engaging aspect of the instructional geocaching activity. This theme was evidenced by comments such as "I liked how we learned how to find the latitude and longitude and actually found something when we found our point," and "I liked finding the hidden containers. It was very challenging." One student wrote that they liked "going to that exact location and having to look high and low and all around for the geocache." Another student enjoyed "finding the area that your coordinates tell you that you're supposed to be." Some students offered statements directly relating to scavenger hunts such as "It was like going on a scavenger hunt with a map (GPS)." Some students thought that this would be a fun way to study. For example, one student wrote, "The teacher could hide the answers to study guides in different places and then give us the location to find them." Finally, one student would like to see teachers "put test questions in a box somewhere for us to find and answer using a GPS."

The second most prevalent theme that emerged from the responses was the application of GPS activities to math and science classes. Of the 81 students surveyed, 42 of them (52%) addressed ideas of using the GPS in these two subjects, which were different from the class in which the activities were conducted (social studies). More specifically, 24 students mentioned using GPS for math activities, and 18 students referenced science activities. Examples of the math applications included, "You could use GPS in math because the coordinates can be added and subtracted," and "Distances between countries and states could be calculated using the latitude and longitude." Another student indicated that "in math, you could find some numbers

in the geocaches and use them to solve equations to find a prize." A similar idea was proposed by another student, "We could find a location and then another location and then maybe subtract the numbers to find another location." Science ideas provided by the students varied from "finding the specific location where a plant or animal is located" to "helping scientists find fossils or skeletons." Several students indicated that science notes could be distributed in the same way as the social studies GPS activity. One student stated, "In science, it would be more fun to go outside and do the same thing as we did in this class."

Summary

The findings of this study offer information about the influence of instructional geocaching activities on student achievement, engagement, and learning styles. There were mixed results in the area of achievement. Data from the first treatment (Phase I) did not indicate a significant difference in posttest scores between the control and experimental groups. In the second treatment (Phase II), data revealed a significant difference between the control and experimental groups, which indicated that the instructional geocaching activity had a positive influence on student achievement. No significant differences in achievement were found between students with different learning styles whether they participated in the instructional geocaching activity (experimental group) or the traditional classroom activity (control) in either phase of the study. Survey data revealed a significant difference in engagement between students with a visual learning style and a kinesthetic learning style while participating in an instructional geocaching activity. According to the survey data, the factors of fun, learning, and motivation were important to student engagement. However, no significant correlations between student engagement and student achievement were found. Survey results also indicated that the students perceived that they were more engaged in the learning process because of significant correlations

between each of the factors of engagement. Students revealed that an opportunity to be outside of

the classroom for a hands-on activity involving searching for and finding information was

engaging to them. Students also provided applications of instructional geocaching to real-world

and other in school settings.

CHAPTER V

DISCUSSION AND RECOMMENDATIONS

Introduction

The research conducted for this study investigated how the instructional use of GPS through geocaching activities engages students and promotes achievement in a middle school social studies classroom. In addition, the relationship of instructional geocaching with various learning styles was examined. Student perceptions of instructional geocaching activities were also investigated in relation to motivation and engagement in this study.

Demographic Findings

This study was conducted with a convenience sample of seventh-grade students from four social studies classes with the same classroom teacher. Eighty-one of a potential 104 students (78%) completed all phases of the project, which included two pretests, two posttests, and a GPS perceptions and engagement survey. The scores of students who did not assent or who were absent during any part of the study were not included in the results. The sample consisted of 42 males (52%) and 39 females (48%), which is consistent with the school population of 53% male and 47% female. The responses for learning styles indicated that there were 40 kinesthetic learners, 26 visual learners, and 15 auditory learners participating in the study. The students were made aware of their learning style from an inventory given to them by their teacher at the beginning of the school year.

An interesting finding from the demographics of this study was the number of students who had not used a GPS before the activities in this social studies class. Forty-six out of the 81 did not have previous experience using a GPS receiver. This was unexpected due to the

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popularity that GPS technology has gained in recent years. The lack of experience with a GPS receiver could be attributed to the popularity of cell phones that include a GPS feature, but would not be specifically considered a GPS receiver. Another possible reason could be that the school is classified as having a high poverty population by the U.S. Department of Education (2009), which would suggest that the families of many students might not have the financial ability to purchase GPS receivers. By integrating the GPS activity into social studies lessons, the classroom teacher is providing an opportunity for students to learn a technology skill that many of them would have missed, but that is integral to the 21st century.

Discussion

Research Question 1: *Is there a significant difference in pretest and posttest scores between students who received the instructional geocaching treatment and students who did not receive the instructional geocaching treatment?*

The first research question focused on the achievement of students on pretests and posttests in two separate phases of the study. In Phase I, students in class periods two and four participated in an instructional geocaching activity to learn about culture traits as the experimental group. Students in class periods one and three participated in a traditional classroom activity as the control group. In Phase II, the groupings were reversed and content was changed to essential elements of geography. Pretests were given to all students before the treatments in each phase, and posttests were given after the treatments in each phase. The pretests and posttests in each phase consisted of 12 short answer questions. This two phase model enabled all 81 students in the sample to receive the instructional geocaching treatment in one phase or the other.

The difference in pretest and posttest scores between students who received the instructional geocaching treatment and students who did not receive the instructional geocaching treatment was computed with a Mann-Whitney U test. In Phase I of the study, no significant difference was found between the experimental and control group scores on either the pretest or the posttest. In the Phase I pretest, the mean rank of the experimental group was 38.21, and the mean rank for the control group was 43.23, which may indicate that the control group had more prior knowledge of the first topic. In the Phase I posttest, the mean rank for the experimental group was 45.07, and the mean rank for the control group was 37.74. This indicated that the experimental group made a gain in achievement from pretest to posttest, but the scores were not significantly different from the scores of the control group.

In Phase II of the study, no significant difference was found between the experimental group and control group pretest scores. The mean rank of the control group was 36.76, and the mean rank of the experimental group was 44.39. In the Phase II posttest, a significant difference was found. The mean rank for the control group was 34.29, and the mean rank of the experimental group was 46.37. This indicated a higher level of posttest scores for students in the experimental group, and there was sufficient evidence to conclude the instructional geocaching activity had a positive impact on student achievement.

The findings of Phase I of this study are consistent with the results obtained by Buck (2009). In a study of the influence of GPS activities on mathematics achievement, Buck found that students made achievement gains when participating in GPS activities, but these gains did not represent a significant difference from the control group. However, the findings of Phase II in this study provide evidence to the contrary of Buck's results. Furthermore, the findings of Phase II, in which the GPS activity produced significant gains in student achievement, support

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the research of Hsieh et al. (2008), Kingsley and Boone (2008), McNew (2008), Swan et al. (2005), and Tuzun et al. (2009). Each of these studies found that various technology integration interventions produced statistically significant gains in student achievement scores. However, the findings in this research study are the first to report statistically significant gains in achievement based on an instructional geocaching experimental procedure.

Another important aspect of the data represented by the first research question was the difference in the overall test scores in Phase I and Phase II. As indicated by a Wilcoxon test, the scores on both the pretest ($z = -6.46$, $p < .001$) and posttest ($z = -5.98$, $p < .001$) in Phase II ranked significantly lower than the scores for each test in Phase I for both the control and experimental groups. The mean pretest score was 7.23 in Phase I with a ranking of 42.30 compared to a mean pretest score of 4.33 with a ranking of 18.21 in Phase II. The mean posttest score was 10.86 with a ranking of 38.64 in Phase I compared to a mean pretest score of 8.21 with a ranking of 26.65 in Phase II. This suggests that students were not as familiar with the content in Phase II before the lesson. An informal interview with the classroom teacher indicated that the terminology in Phase II was not as common as the terminology of the content in Phase I. She theorized that students are more familiar with culture trait terms such as economy, government, and religion, which were covered in Phase I. For Phase II, she explained that essential elements of geography such as "the world in spatial terms, physical systems, and human systems" are not part of a middle school student's everyday language even though it is part of the curriculum. The findings that prior knowledge of the Phase II content was lower than Phase I and the occurrence of significant achievement gains in Phase II suggest that instructional geocaching activities may help students learn more about topics that they do not know very well.

Research Question 2: *Is there a significant difference between the pretest and posttest scores of students with different learning styles who received the geocaching treatment?*

The second research question related the differences between the pretest and posttest scores of students with different learning styles while they were participants in the experimental group. A Kruskal-Wallis test was conducted to evaluate these scores for each phase of the study. For both phases of the study, no significant differences in pretest scores or posttest scores of students with different learning styles were found. These results indicated that learning style is not a significant predictor for achievement gains when students learn content using GPS activities.

The findings of no significant difference in achievement scores between learning styles when participating in a technology integrated lesson addressing the various learning styles supported the findings of the meta-analysis of Slemmer (2002). However, since instructional geocaching strategies address various learning styles, and the findings of research question one indicated positive gains in achievement when a technology integration strategy addressing various learning styles is implemented, the research of Chen et al. (2005) was supported. The findings of research question one also support studies that indicated learning styles instructional environments produce statistically higher achievement scores than traditional instructional environments (Dunn & DeBello, 1999; Dunn & Griggs, 1988; Farkas, 2003; Minotti, 2005; Peacock, 2001; Roberts, 2001).

Research Question 3: *Is there a significant difference between the pretest and posttest scores of students with different learning styles who did not receive the geocaching treatment?*

The third research question related the differences between the pretest and posttest scores of students with different learning styles while they were participants in the control group. The

control group participated in a traditional classroom environment. A Kruskal-Wallis test was conducted to evaluate these scores for each phase of the study. For both phases of the study, no significant differences in pretest scores or posttest scores of students with different learning styles were found. In Phase I, visual learners dropped in mean rank from pretest to posttest, and kinesthetic and auditory learners improved slightly, but not significantly, from pretest to posttest. In Phase II, visual learners rose in mean rank from pretest to posttest, while kinesthetic and auditory learners both saw decreases in mean rank. These findings suggest that learning style is not a significant predictor of achievement gains in a traditional classroom environment. As suggested by Dunn (1993), the traditional classroom environment tends to address the learning styles of visual and auditory learners because of the notes being displayed on the board and read to the students. However, the findings of this study do not support that theory with significant statistical evidence. As noted in research question two, these results may have been limited by the small sample sizes of each learning style in each phase with the three styles being distributed between 45 students in Phase I and 36 students in Phase II.

Research Question 4: *Is there a significant difference in student engagement during the geocaching activity based on learning style?*

Research question four was addressed using data from the 12 Likert-scale items on the GPS perceptions and engagement survey. Based on statistical analysis, the survey was found to be valid and reliable. The survey had a reliability coefficient Cronbach's alpha of .75. A coefficient above .7 is considered to be acceptable (George & Mallery, 2003). Overall student engagement was computed by the total score of the 11 items that remained after the item-to-total correlation.

A principal component factor analysis with a varimax, orthogonal rotation revealed that the first principal component accounted for 31% of the variance with the three extracted factors explaining 54% of the variance. The construct validity was supported in that the three factors extracted from the survey loaded above .465. The factors were (I) Fun, (II) Perception of Learning, and (III) Motivation.

To address research question four, which investigated if there was significant difference in student engagement during the geocaching activity based on learning style, a Kruskal-Wallis test found a significant difference between student engagement and learning styles, χ^2 (2, n = 81) = 6.87, $p < .05$. The pairwise comparison conducted with a Mann-Whitney U test found that the significant differences were between visual learners and kinesthetic learners. This suggested that visual learners were engaged differently than kinesthetic learners during the instructional geocaching activity. The average rank of student engagement for kinesthetic learners (37.79) was higher than the average rank of student engagement for visual learners (26.90), which indicated a higher level of engagement for the kinesthetic learner. This supports the theories of Kanar (1995), McCarthy (2005), and Vincent and Ross (2001), which described the kinesthetic learner as performing well in hands-on environments that require physical interaction with the content.

Further analysis of research question four was performed using chi-square to determine if there were any relationships between learning styles and individual survey questions. A significant relationship was found between learning style and item 7 (χ^2 (4, N = 81) = 11.953, $p < .05$). Item seven states "I felt motivated to learn about geography more while using the GPS than while taking notes in class." Sixty-percent of kinesthetic learners strongly agreed with this item compared to 46% of visual learners and 40% of auditory learners. This suggested that the instructional geocaching activity was an important motivational factor for kinesthetic learners.

This result may also support the research that kinesthetic learners are more engaged by activities that require interaction with the content rather than by sitting still in a traditional classroom activity. However, this result may also be attributed to the validity of the engagement instrument.

Research Question 5: *Is there a significant relationship between student engagement during the instructional geocaching treatment and student achievement on the posttest?*

The overall student engagement and the posttest scores were used to evaluate the relationship between engagement and achievement. A Pearson product-moment correlation coefficient was computed for each phase of the study. No significant relationship between engagement and achievement was found for Phase I ($r = .93$, n = 36) or Phase II ($r = -.06$, n = 45). The results of research question five were contrary to the research findings of Rigby et al. (1992), Swan et al. (2005), and Wang and Reeves (2007). Each of those studies reported that increased student engagement was reflected by increases in student achievement. The small sample size may have contributed to the lack of a significant relationship between engagement and achievement in each phase of this study.

Research Question 6: *What are students' perceptions toward geocaching activities for learning?*

Quantitative data and qualitative data were used to determine student perceptions of instructional geocaching activities for learning. The GPS perceptions and engagement survey (see Appendix E) provided quantitative data from the 12 Likert-scale questions. The four open-ended questions on the survey provided the qualitative data.

An exploratory factor analysis identified three underlying dimensions from the survey: (I) Fun, (II) Perception of Learning, and (III) Motivation. The fun factor was comprised of questions and items such as "How much did you enjoy the GPS activity," "Learning about geography

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using a GPS was more fun than taking notes," and "How easy was it to use the GPS." The means

of the responses to the items related to fun ranged from 3.49 to 3.86 on a scale of four. This

indicated that most students perceived the instructional geocaching activity as a fun and

enjoyable learning experience.

The perception of learning factor consisted of items such as "The GPS activity helped me

to learn about geography," "I felt motivated to learn about geography more while using the GPS

than while taking notes in class," and "I understood the geography lesson better by using the

GPS than by taking notes in class." The item that stated, "My learning time would have been

better spent in the classroom than outside using a GPS." was also included in the perception of

learning factor, but it was recoded to fit the scale. The means of the items related to perception of

learning ranged from 3.25 to 3.44 on the four-point scale. This factor suggested that students

perceived that they were learning during the instructional geocaching activity.

The motivation factor consisted of items such as "I would be more motivated to learn

other topics in social studies if we could use a GPS," "I would like to participate in GPS

activities in other subjects," and "I like learning with technology." The means of the responses

related to motivation ranged from 3.41 to 3.53 on the four-point scale. This factor suggested that

students were motivated by the instructional geocaching activity.

A Pearson product-moment correlation coefficient was also computed to assess the

relationships between the three factors for all students. In research question four, the factors were

examined in relationship to posttest scores for only the experimental groups in each phase of the

study. For the purpose of addressing, research question six, the responses of all students were

examined for correlations. Significant relationships were found between all factors. A moderate,

positive correlation between fun and motivation ($r = .48$, $p < .005$) revealed that as perception of

fun increased, student motivation increased. A moderate, positive correlation between fun and perception of learning ($r = .41$, $p < .005$) also revealed that as fun increased, perception of learning increased. Finally, a weak positive correlation between motivation and perception of learning ($r = .33$, $p < .005$) indicated that as motivation increased, perception of learning increased slightly. The results indicate that students were having fun and were motivated to learn while participating in the GPS activity, which supports the findings of other researchers (Buck, 2009; Christie, 2007; Matherson et al., 2008).

From the analysis of the qualitative data provided by the open-ended questions on the survey, the student perceptions of the GPS activity were similar to the perceptions identified by other researchers (Broda & Baxter, 2003; Buck, 2009; Christie, 2007; Matherson et al., 2008). Students indicated an enjoyment of the activity because they were outside and moving around while learning during the GPS activity. The theme of being outside and moving around was referenced by over half of the students and by several students from each learning style. This supports the idea that instructional geocaching activities address all learning styles. The students also revealed that the hands-on aspect of the GPS activity was a motivating factor for learning.

As Christie (2007) proposed, instructional geocaching can engage students in any subject area, and the data from this study revealed that students readily made associations to math and science concepts even though they were participating in a social studies class. Students frequently referenced using the coordinates for solving equations in math classes as well as discovering the location of plants and animals for science classes in their responses to the open-ended questions. This factor along with the hands-on aspect may have been influenced by the presence of the AMSTI curriculum in the math and science classes at the school. The AMSTI curriculum incorporates hands-on and real-world learning activities into the learning experience

(AMSTI, 2009). The students may have become accustomed to the hands-on activities in these subjects as well as the social studies class in which the instructional geocaching activity occurred. The informal interview with the classroom teacher indicated that assignments such as art and digital media projects were part of her normal curriculum in social studies. The AMSTI curriculum as well as the art and technology influenced social studies curriculum could have also influenced the higher percentage of kinesthetic learners in the sample because of the emphasis on projects.

The perceptions of real-world application of the GPS activity revealed that students understood that a GPS receiver could help them find directions and places to visit. This perception was the most prevalently mentioned item from all of the open-ended student responses. The connection is most likely created by the increasing popularity of GPS receivers in cars and cell phone technology. However, of the 62 students who referred to the GPS as a directional tool, 32 mentioned that the GPS could prevent them from getting lost. Frequently, the students wrote that it would prevent them from becoming "lost in the woods." This finding can most likely be attributed to the location of the town in which the school is located. The hunting and outdoor culture is pervasive in this small southeastern town. The researcher is unaware of any previous research of the fear of being lost in the wilderness or its prevalence in the thoughts of middle school students as this is not the focus of this study. However, future research on the use of GPS receivers as a tool to relieve the anxiety of being lost could be beneficial to students with this fear.

The perception that students enjoyed and were engaged by the scavenger hunt element of the GPS activity can be related to each of the other themes that were found in the study. The students were outside of the classroom using technology to find content, which directly relates to

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the theme of being outside and moving around. Many referenced the GPS receiver as a map to take them to the hidden information. The element of searching for and then finding the geocaches was revealed to provide the students an instant feeling of success, which supports the findings of Huffaker (2003) on the learning process of the 21st century middle school student. The hands-on aspect can also be related to the use of the GPS receiver to search and the finding of the content to learn. The students expressed that finding the location and then the geocache containing the information was an enjoyable challenge that was more interesting than just taking notes. Many students also indicated that they would like to participate in GPS scavenger hunts in other subjects especially math and science.

Implications for Educators

Instructional geocaching has significant potential as a technology integration strategy for teachers. As this study and other studies (Broda & Baxter, 2003; Buck, 2009; Christie, 2007; Matherson et al., 2008) have indicated, students are motivated and engaged by GPS activities for learning. Furthermore, this study found that significant achievement gains can be also be attained by students who participate in instructional geocaching activities. The significant achievement gains were found when the students were exposed to content that was less familiar to them as evidenced by the significantly lower pretest scores in Phase II. This supports the research that the 21st century student wants to be challenged and actively engaged by both the content and delivery of the lesson (Lee & Spires, 2009). Students also experienced achievement gains in Phase I, where the content was more familiar to them as evidenced by the pretest scores, but these gains were not significantly different from the gains achieved through traditional classroom instruction. However, in observing the scores as a whole, it is evident that instructional geocaching activities facilitate learning in middle school students of various learning styles.

As Prensky (2006) noted, today's student is not motivated by traditional teaching and learning processes. As indicated by the survey responses, the instructional geocaching activity in this study provided students with a hands-on and fun learning experience. This experience also engaged and challenged the students while allowing them to be active participants in the learning process. As Lee and Spires (2009) suggested, teachers must be creative and flexible with technology integration pedagogical strategies in order to reach 21st century students. Instructional geocaching provides a tool for teachers to meet standards and objectives in all subject areas while actively involving students in the learning experience.

With the impact of instructional geocaching on achievement and engagement as a consideration, teachers are encouraged to implement GPS activities into their teaching practice. For social studies teachers, implementing instructional geocaching activities and other engaging technology strategies could help change student opinion of the subject from boring and irrelevant (Ciborowski, 2005; Stetson & Williams, 2005) to active, challenging, and fun. Real-world implications are embedded into GPS use, and GPS use is found in most social studies courses of study. Therefore, as Doolittle and Hicks (2003) explained, the students will be engaged by the authentic and active learning experiences that teachers can offer with a technology-enriched curriculum.

Of course, practice and experience with the use of GPS receivers are also encouraged before attempting to develop an activity or GPS-infused curriculum. As Mishra and Koehler (2006) suggested, this learning should take place in the context of TPACK, where the technology use is driven by the pedagogy and content. Professional development in the area of instructional geocaching practices is suggested to help teachers repurpose the activity of geocaching for their teaching needs. However, as has been the experience of the researcher, practical experience in

using a GPS in recreational settings can often produce ideas that translate to educational practice as well as an overall understanding of GPS functionality. Even still, there are several instructional geocaching webinars and classroom activity guides endorsed by ISTE as well as numerous web sites such as the Illinois Educational Geocaching Association Portal (www.ilega.org), The University of Alabama Technology in Motion GPS/Geocaching in the Classroom Wiki (http://uatim.wikispaces.com/gps), and the Groundspeak GPS in Education Forum (http://forums.groundspeak.com) that can help teachers in the design of instructional geocaching activities for their students.

Professional development and teacher education programs should consider including innovative practices such as instructional geocaching into their course offerings. As emphasis on using the technology within the framework of content and pedagogy grows, it is important that these programs help teachers learn the technology as it relates to effective instructional design instead of simply teaching them how to use the technology (Mishra & Kohler, 2006). Creativity and innovation should be encouraged in these programs as well as flexibility to address the need for today's students to be plugged-in at school (Dede, Korte, Nelson, Valdez, & Ward, 2005; Levy & Murnane, 2004; Spires, Lee, Turner, & Johnson, 2008).

Another implication for teachers is the potential overwhelming nature of setting up an instructional geocaching course on a school campus. Through his career as an instructional technology specialist, the researcher has designed, set-up, and conducted instructional geocaching activities at approximately 30 schools in Alabama. Through these experiences, the researcher has learned that it is advantageous for any teacher who would like to use instructional geocaching with students to recruit a fellow teacher to help with the course set-up and design. This makes the set-up process of recording coordinates, creating and hiding caches, and

designing the instructional content of the caches much easier. With two teachers involved in the process, this also enables both teachers to be able to use the same waypoints and containers with the same content or different instructional content. Nevertheless, if more teachers are using instructional geocaching activities, then more students are being engaged in the learning process.

Other than the ability for teachers to learn how to use and effectively implement GPS technology into their curriculum, the most import aspect of integration is access to the technology. GPS receivers are not as common in most schools as laptops, projectors, digital cameras, mini-camcorders, or classroom response systems. Teachers can reference the increase in achievement found in this study to aid in finding the funds to purchase GPS receivers. As this study demonstrated and the studies of Buck (2009) and Christie (2007) suggested, the most effective ratio of students per GPS receiver is three to one. Any higher ratio of student to GPS receiver has the potential to decrease the level of engagement and consequently, the level of achievement of the students. The researcher has found through experience with this study and other instructional geocaching activities, that a basic GPS receiver is sufficient for student use. These receivers, which should cost no more than $100, enable students to locate latitude and longitude as well as mark waypoints. Basic GPS receivers are also easier to learn and use because of fewer features, which may appeal to teachers who are not tech-savvy, but desire to engage their students with technology.

Finally, school administrators should encourage teachers to incorporate innovative learning strategies in their curriculum and help them obtain the technology tools necessary for success. They should also make sure that teachers have the opportunity for job-embedded and sustained professional development to help them become more skilled at reaching today's students with technology. All of these implications may require creative spending or fundraising,

but as the results of this study indicate, effective technology integration strategies such as instructional geocaching have the potential to positively affect student achievement and motivation.

Limitations

There were some limitations of this study. The study was limited by the number of students in the sample of convenience. The sample size consisted of 81 students, which comprised approximately 15% of the student population in one small town middle school. The students in the classes were distributed as heterogeneously as possible in terms of ability by the school principal at the beginning of the school year. However, due to the small sample size, the results cannot necessarily be generalized to other classes, schools, or regions.

Another limitation was the short duration of the study. Each phase of this study consisted of a one week unit, and therefore, the entire study only lasted two weeks. Difference results could potentially be found in a longer study. The length of time of the class periods at the school was also a limitation. The class periods at the school were only 55 minutes in length, and with the time that it took for the students to walk to the athletic fields from the school, only 45 minutes of instructional time were spent on each instructional geocaching activity.

As indicated by the mean scores on each of the tests, the complexity of the topics of the units differed. The topic of culture traits in Phase I of the study had significantly higher mean scores than the topic of essential elements of geography in Phase II. Unit topics that were equally complex could potentially produce different results in the area of student achievement.

Another limitation may have been the GPS perceptions and engagement survey. Although the instrument was determined to have content validity, this was the first time that it

was used in a study. Validity of the instrument can be increased by the use of the survey in future research.

A final limitation of the study may have been the weather on the days of the geocaching activities. The temperature variations from one class period to the next may have influenced student perception of the activity. All activities were conducted before noon during both phases, and therefore, the wet grass left by the dew may have also influenced student perception.

Recommendations for Future Research

Instructional geocaching activities have been found in practitioner journals since 2004, but empirical research on the effectiveness of this technology integration strategy are just beginning to be seen. Future research should continue to investigate the impact that instructional geocaching activities have on student achievement in all subject areas. As the results of this study indicated, students connect the aspects of GPS activities to other content areas especially in the area of math. The students in this study frequently referenced math in their open-ended responses. Studies examining motivation and achievement in math, similar to that of Buck (2009), with larger populations are recommended. The relationship of GPS to geography in the social studies curriculum observed in this study also encourages similar studies of longer duration and larger student populations.

Although it was not the purpose of this study to explore this question, recent discussion has discredited learning styles theory. As this study found no significant difference in achievement between students with different learning styles, future research with larger populations to validate these findings are recommended. The VAK theory of learning styles was used for this study. Future research could also examine the relationship of other learning style theories such as multiple intelligences to instructional geocaching activities.

Studies that measure the influence of instructional geocaching on critical thinking skills and project-based learning are necessary. These studies would require longer duration of class period and procedure to be effectively investigated. These studies could also initiate comparison studies between instructional geocaching activities and other technology integration strategies to measure impact on achievement and engagement. As more 21st century skills and strategies are incorporated into classrooms, more studies examining their influence on student achievement are necessary to determine which ones are the most effective and efficient at helping students learn.

Summary

The overall findings of this study are important in providing rationale for teachers to repurpose the technology of GPS receivers and the hobby of geocaching for educational purposes. Middle school students, who are labeled by the education world as difficult to reach and disinterested, were engaged by the instructional geocaching activity. They had fun while they were studying a subject they call boring and irrelevant. Most importantly, they learned and achieved while participating in the instructional geocaching activity.

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APPENDIX A

Classroom Teacher-Created Lesson Plans

Culture Traits of Southwest Asia - Phase One

Grade Level: 7th Grade

Subject(s):

- Social Studies/Geography

Duration: Three 55-minute sessions

Description: This three day lesson focuses on understanding cultures of Southwest Asia.

Goals:

1. To increase students' knowledge of the geography of Southwest Asia.
2. For students to recognize differences between cultures and why they exist.

State Objectives:

1.C.   Analyzing the relationships among people, places, and the environment by mapping information about them including trade patterns, government alliances, and immigration patterns

2.B. Comparing the physical and human characteristics of various places using observational data and geographic resources.

Chapter Objectives: Students will be able to:

1. Define culture.
2. List and distinguish specific culture traits in Southwest Asia.
3. Explain what makes up a people's culture.
4. Explain what elements make each culture unique.
5. Describe how and why cultures change.

Materials:

- Geography textbooks
- Notebooks
- Presentation for notes
- Section Worksheets
- GPS devices, caches, and answer sheets

Procedure:

Day One: Student will be given a pretest consisting of 12 questions to determine previous knowledge of culture traits.

Day Two: Students in classes one and three will be introduced to the information by looking at vocabulary words from the sections.

> Vocabulary:
>
> Culture
> Government
> Religion
> Daily Life
> Economy
> Language
> History
> Culture region

Then the teacher will present a series of notes, in which case, the students will write in their notebooks. At this time, the notes will be explained in full detail.

Students in classes two and four will be introduced to the information using a geocaching activity.

Day Three: Students will be given a posttest to assess how well they learned the content.

Assessment: Students will be assessed using the pretest (Quiz grade) and a posttest (Major test grade).

Essential Elements of Southwest Asia - Phase Two

Grade Level: 7th Grade

Subject(s):

- Social Studies/Geography

Duration: Three 55-minute sessions

Description: This three day lesson focuses on understanding the essential elements for Southwest Asia.

Goals:

1. To increase students' knowledge of the Geography of Southwest Asia.
2. For students to recognize differences between the essential elements and give examples of each.

State Objectives:

1.C. Analyzing the relationships among people, places, and the environment by mapping information about them including trade patterns, government alliances, and immigration patterns

2.B. Comparing the physical and human characteristics of various places using observational data and geographic resources.

Chapter Objectives: Students will be able to:

1. Define essential elements.
2. List and distinguish specific essential elements in Southwest Asia.
3. Give specific examples of essential elements in the Southwest Asian region.

Materials:

- Geography textbooks
- Notebooks
- Presentation for notes
- Section Worksheets
- GPS devices, caches, and answer sheets

Procedure:

Day One: Student will be given a pretest consisting of 12 questions to determine previous knowledge of culture traits.

Day Two: Students in classes two and four will be introduced to the information by looking at vocabulary words from the sections.

> Vocabulary:
>
> Essential elements
> The world in spatial terms
> Physical systems
> Human systems
> Uses of technology
> Environment and society
> Places and regions

Then the teacher will present a series of notes, in which case, the students will write in their notebooks. At this time, the notes will be explained in full detail.

Students in classes one and three will be introduced to the information using a geocaching activity.

Day Three: Students will be given a posttest to assess how well they learned the content.

Assessment: Students will be assessed using the pretest (Quiz grade) and a posttest (Major test grade).

APPENDIX B

Informed Consent for Research Study

May 16, 2008

Robert Mayben
ELPTS
College of Education

Re: IRB # 08-OR-117 "Geocaching in Geography: An Analysis of GPS
Receivers as Tools for Technology Integration into the Middle School
Social Studies Classroom"

Dear Mr. Mayben:

The University of Alabama Institutional Review Board has granted
approval for your proposed research.

Your protocol has been given expedited approval according to 45 CFR
part 46. Approval has been given under expedited review category 7 as
outlined below:

(7) Research on individual or group characteristics or behavior
(including, but not limited to, research on perception, cognition,
motivation, identity, language, communication, cultural beliefs or
practices, and social behavior) or research employing survey, interview,
oral history, focus group, program evaluation, human factors evaluation,
or quality assurance methodologies.

Should you need to submit any further correspondence regarding this
proposal, please include the assigned IRB application number. Please use
reproductions of the IRB approved informed consent form to obtain
consent from your participants.

Good luck with your research.

Sincerely,

Carpantato T. Myles, MSM, CIM
Director of Research Compliance & Research Compliance Officer
Office of Research Compliance
The University of Alabama

THE UNIVERSITY OF ALABAMA

Informed Consent for a Research Study

Your child is being asked to take part <u>in a research study.</u> This study is called *Instructional Geocaching: An Analysis of GPS Receivers as Tools for Technology Integration into a Middle School Social Classroom.* The study is being conducted by *Robert Mayben* who is a doctoral student at The University of Alabama. Mr. Mayben is being supervised by *Dr. Vivian Wright* who is a professor at The University of Alabama.

What is this study about?

This study is being conducted to find out if the use of GPS (Global Positioning System) receivers in the classroom promotes student achievement. The GPS receiver is a handheld technology that many teachers are incorporating into their classroom activities. The study will compare the scores of students who use the GPS activity to learn the content (experimental group) and the scores of students who learn the content using regular classroom activities such as teacher presentation and student note-taking (control group).

The Global Positioning System is a U.S. space-based navigation system that provides reliable positioning, navigation, and timing services to civilian users on a continuous worldwide basis-freely available to all. For anyone with a GPS receiver, the system provides location and time. GPS provides accurate location and time information for an unlimited number of people in all weather, day and night, anywhere in the world. The GPS is made up of three parts: satellites orbiting the Earth; control and monitoring stations on Earth; and the GPS receivers owned by users. GPS satellites broadcast signals from space that are picked up and identified by GPS receivers. Each GPS receiver then provides three-dimensional location (latitude, longitude, and altitude) plus the time.

Geocaching is an entertaining adventure game for GPS users and is often referred to as a GPS scavenger hunt. It is a combination of the words geography and cache (container). The general idea is to have individuals and organizations set up caches all over the world and share the locations of these caches on the internet. GPS users then obtain the coordinates and search for the caches. The basic idea for the use of geocaching in education is for teachers to set up caches around their school grounds and share the locations in the form of coordinates of these caches with their students. Students can then use the GPS receivers and the location coordinates to find the caches. Once found, a cache may provide the student with content in a wide variety of activities such as a critical thinking activity, worksheet, puzzle, scientific examination of the area around the cache, or creative writing activity about the area. This study will require students to apply prior knowledge of culture traits and essential elements of geography to answer the questions in the geocaches.

Why is this study important--What good will the results do?

This knowledge is useful because technology use in the classroom is a growing requirement for teachers and students. This study will reveal if the GPS receiver is an effective technology for teachers to use with their students.

Why has your child been asked to take part in this study?

Your child has been asked to be in this study because he or she is a student in a classroom that will be participating in activities using GPS receivers.

How many people besides my child will be in this study?

About 100 other people will be in this study.

What will my child be asked to do in this study?

If you decide to allow your child to participate in this study, he or she will be asked to do these things:

1) On the first day of week one, your child will take a pretest to assess prior knowledge of culture traits of Southwest Asia. This test will be part of regular classroom instruction and will be administered by the classroom teacher. The test will consist of short answer questions on topics such as landforms, people, places, culture, beliefs, and government in Southwest Asia. For example, your child will identify which culture trait applies to the following statement: "_____ Jordan has a constitutional monarchy. Israel is a democratic republic."

2) On the second day of week one, if your child is in the experimental group (2nd/4th Period), he or she will learn about the culture traits of Southwest Asia by participating in a supervised GPS scavenger hunt activity on the football field next to the school. He or she will be placed in a group with two other students. The GPS activity will involve three hidden containers which your students will locate using coordinates given to them by the teacher. When they locate the containers, your student's team will complete the assignment inside the containers. After your student's team has located each container and completed each assignment, they will report to a predetermined location on the field for a brief review of the information. Students will be allowed to take their assignment sheets home to study for the posttest.

    On the second day, if your child is in the control group (1st/3rd Period), he or she will learn about the culture traits of Southwest Asia by taking notes presented by the teacher in class. Students will be allowed to take their notes home to study for the posttest.

3) On the third day of week one, all students will complete a posttest on the culture traits of Southwest Asia. This test will be part of regular classroom instruction and will be administered by the classroom teacher. The test will consist of short answer questions on topics such as landforms, people, places, culture, beliefs, and government in Southwest Asia. It will consist of the same information as the pretest.

4) On the first day of week two, your child will take a pretest to assess prior knowledge of essential elements of geography for Southwest Asia. This test will be part of regular classroom instruction and will be administered by the classroom teacher. The test will consist of short answer questions on topics such as environment and society, places and regions, and the world in spatial terms for Southwest Asia. For example, your child will identify which essential element applies to the following statement: "_____ Turkey is located west of the Caspian Sea and north of the Mediterranean Sea.

5) On the second day week two, if your child is in the experimental group (1st/3rd Period), he or she will learn about the essential elements of Southwest Asia by participating in a supervised GPS scavenger hunt activity on the football field next to the school. He or she will be placed in a group with two other students. The GPS activity will involve three hidden containers which your students will locate using coordinates given to them by the teacher. When they locate the containers, your student's team will complete the assignment inside the containers. After your student's team has located each container and completed each assignment, they will report to a predetermined location on the field for a brief review of the information. Students will be allowed to take their assignment sheets home to study for the posttest.

   On the second day of week two (2nd/4th Period), if your child is in the control group, he or she will learn about the essential elements of geography for Southwest Asia by taking notes presented by the teacher in class. Students will be allowed to take their notes home to study for the posttest.

6) On the third day of week two, all students will complete a posttest on the essential elements of geography for Southwest Asia. This test will be part of regular classroom instruction and will be administered by the classroom teacher. The test will consist of short answer questions on topics such as landforms, people, places, culture, beliefs, and government in Southwest Asia. It will consist of the same information as the pretest.

7) On the fourth day of week two, if your child has elected to participate in the study, he or she will complete a survey regarding his or her experience using the GPS.

How much time will your child spend being in this study?

Being in this study will take about 5 non-subsequent hours or parts of 3 class periods. Each test should take about 20 minutes to complete. The GPS activity should take about 45 minutes, and the survey should take about 15 minutes. Each of these activities will take place as a part of regular classroom instruction.

Will your child be paid for being in this study?

You and your child will not be paid for being in this study.

Will being in this study cost me or my child anything?

There will be no cost to you or your child except for his/her time in completing the pre-test, posttest, GPS activity, and survey.

Can the researcher take my child out of this study?

The researcher may take your child out of this study if he or she is absent from school during one of the days of the study without penalty.

What are the benefits (good things) that may happen to my child if he or she is in this study?

There are no direct benefits to your child from being in this study. However, your child will be receiving experience using a GPS receiver which may be beneficial to achievement and life-long learning.

What are the benefits to scientists or society?

This study will help educators learn if the GPS receiver is an effective technology tool for teachers. Society will benefit from our learning better ways to teach using technologies that have real world implications.

What are the risks (dangers or harm) to your child if he or she participates in this study?

There are no foreseeable risks for participating in this study.

How will my child's confidentiality (privacy) be protected? What will happen to the information the study keeps on my child?

Your child's privacy will be protected through the use of ID numbers on the pretests and posttests. His or her social studies teacher will assign the numbers. The survey given at the end of the study will also use the ID number. All documents will be secured in a locked cabinet during the study. After the pretest and posttest scores have been entered into a database, your child's social studies teacher will file the test documents according to school procedure. Data from the perception survey will be destroyed after they have been transcribed by the researcher. Only your child's teacher and the researcher will have access to the data at any time during the study.

What are the alternatives to being in this study? Does my child have other choices?

Students who are not part of the study will participate in all of the regular classroom activities related to the study, but their information will not be used for research purposes. The classroom activities related to the study which are required by the classroom teacher are the pretests, teacher notes presentation, GPS activity, and posttests.

What are my child's rights as a participant?

Taking part in this study is voluntary—it is your free choice to allow your child to participate. You and/or your child may choose not to take part at all. If your child starts the study, he or she can stop at any time. Leaving the study will not result in any penalty or loss of any benefits your child would otherwise receive and will not affect your child's grade. However, your child is responsible for participating in the regular classroom activities that are part of this study.

The University of Alabama Institutional Review Board (IRB) is the committee that protects the rights of people in research studies. The IRB may review study records from time to time to be sure that people in research studies are being treated fairly and that the study is being carried out as planned.

Who do I call if I have questions or problems?

If you have questions about the study right now, please ask them. If you have questions about the study later on, please call the investigator, Robert Mayben, at (205) 210-9737 or the supervising professor, Dr. Vivian Wright, at (205) 348-1401. If you have any questions about your rights as a research participant you may contact Ms. Tanta Myles, The University of Alabama Research Compliance Officer, at (205) 348-5152.

I have read this consent form. The study has been explained to me. I understand what my child will be asked to do. I freely agree to allow my child to take part in it. I will receive a copy of this consent form to keep.

_____   _____

Signature of Research Participant   Date

_____   _____

Investigator   Date

Informed Child Assent Statement

Dear Student:

It is being requested for you to play a part in a research study that deals with GPS (Global Positioning System) technology.

It will involve completing 2 pretests and posttests on content that your social studies teacher will present to you. While you are in the experimental group, it will involve participating in a GPS scavenger hunt activity related to the content. After the activity and tests, you will complete a survey about your experience with the GPS receiver. While you are not in the experimental group, you will complete regular classroom activities related to the content.

By helping out in this study, there will be no risks, worries, or direct benefits to you. With your help from the survey, hopefully technology instruction can be improved.

All information from you will be confidential. The pretests and posttests will have an identification number assigned by your social studies in order for you to receive credit. The survey asks for general information and your ID number. Your participation in the research study is completely voluntary, and it is your decision whether or not to participate. You may choose not to answer any questions on the survey that make you feel uncomfortable, and you may stop at any time. There will be no punishment or loss if you decide not to participate in the study, but you will have to take the pretest and posttest as part of regular classroom assessment. However, your results will not be reported to the researcher if you choose not to participate in the study.

If you have any questions about the study, you may contact Robert Mayben at 205-348-4281 or Dr. Vivian Wright at 205-348-1401. If you have any questions about your rights as a research participant, please contact Ms. Tanta Myles, Research Compliance Officer at The University of Alabama at 205-348-5152 or e-mailing cmyles@fa.ua.edu.

By signing this form, you agree that you have read the above and agree to be a research participant.

I understand that I will not miss any instruction time nor will I be penalized for not completing this study.

Assent of Minor (Participant's Name): _____

Date: _____

APPENDIX C

Phase I Pretest and Posttest

Pretest/Posttest Culture Traits

Completion

Each statement represents one of eight culture traits. Write the culture trait in the space provided that best describes the statement.

1._____ Many nations in southwest Asia have large oil reserves. This produces a great deal of income.

2._____ Most countries in Southwest Asia practice Islam. However, Christianity was born in Israel.

3._____ People in Southwest Asia make hand-knotted floor coverings, sometimes called Persian rugs. They become very skilled carpet-weavers.

4._____ Jordan has a constitutional monarchy. Israel is a democratic republic.

5._____ Jews originated in Israel. They were scattered by the Romans many years ago. This was called the Diaspora. In 1950, because of "the Law of Return," Jews began to return to their ancestors homeland.

6._____ Most of the Southwest Asian nations speak, Turkish -Turkey, Arabic, and Farsai.

7._____ Turkey was once a part of the Byzantine empire. Istanbul, the capital, was once named Constantinople after the Roman Emporer Constantine.

8._____ Because of Israel's location on the Mediterranean coast, the region has good farmland. This is a good source of income for Israel.

9._____ The Lebanese people speak Arabic and French.

10._____ Makkah, a holy Islamic city is located in western Saudi Arabia.

11._____ Falafel is a favorite in the Middle East. It consists of chickpeas or fava beans combined with spices.

12._____ Iran is an Islamic republic, run by Muslim religious leaders.

Pretest/Posttest Culture Traits
Answer Section

COMPLETION

1.	ANS:	Economy
2.	ANS:	Religion
3.	ANS:	Daily Life
4.	ANS:	Government
5.	ANS:	History
6.	ANS:	Language
7.	ANS:	History
8.	ANS:	Economy
9.	ANS:	Language
10.	ANS:	Religion
11.	ANS:	Daily Life
12.	ANS:	Government

APPENDIX D

Phase II Pretest and Posttest

Pretest/Posttest Essential Elements

Completion
Complete each sentence or statement.

1._____ Many people live in Istanbul, Turkey because it is a major trading center.

2._____ Southwest Asia is located north of the Indian Ocean and east of Europe.

3._____ Global positioning systems can be used to navigate the Hindu Kush, a mountain range in Afghanistan.

4._____ Some places in Turkey and Israel have a Mediterranean climate, while some places in Iraq and Iran have a desert climate.

5._____ Saudi Arabia uses its oil resources to boost its economy.

6._____ Since rain is scarce in much of Southwest Asia, there are no tornadoes.

7._____ Because of satellite images, scientists can see the desert without having to go there.

8._____ Turkey is located west of the Caspian Sea and north of the Mediterranean Sea.

9._____ Jews and Palestinians feud over land in Israel.

10._____ Iraq, Iran, and Afghanistan are also called the Middle East.

11._____ Many countries in Southwest Asia have witnessed sandstorms that can cover entire cities.

12._____ Because Afghanistan is so mountainous, terrorists use them for cover.

Pretest/Posttest Essential Elements
Answer Section

COMPLETION

1. ANS: Human Systems
2. ANS: The World in Spatial Terms
3. ANS: Uses of Geography
4. ANS: Places and Regions
5. ANS: Environment and Society
6. ANS: Physical Systems
7. ANS: Uses of Geography
8. ANS: The World in Spatial Terms
9. ANS: Human Systems
10. ANS: Places and Regions
11. ANS: Physical Systems
12. ANS: Environment and Society

APPENDIX E

GPS Perceptions and Engagement Survey

GPS STUDENT PERCEPTION SURVEY   ID: _____

Directions: Circle the choice that best describes you or your opinion about the activity.

I am a: Boy   Girl

I learn best by: Seeing (Examples: Reading, Graphic Organizers, Notes, Videos)

                          Hearing (Examples: Lectures, Songs, Discussions)

                          Doing (Examples: Experiments, Projects, Hands-On Activities)

Have you used a GPS before the activities in this class?   Yes   No

---

1) I like learning with technology (computers, response systems, interactive whiteboards, etc.).

   Strongly Agree   Agree   Disagree   Strongly Disagree

2) How easy was it to use the GPS?

   Very Easy   Easy   Difficult   Very Difficult

3) How much did you enjoy the GPS activity?

   A Lot   A Little   Not Much   Not at all

4) I thought the GPS activity was challenging.

   Strongly Agree   Agree   Disagree   Strongly Disagree

5) Learning about geography using a GPS was more fun than taking notes in class.

   Strongly Agree   Agree   Disagree   Strongly Disagree

6) The GPS activity helped me to learn about geography.

   A Lot   A Little   Not Much   Not at all

7) I felt motivated to learn about geography more while using the GPS than while taking notes in class.

Strongly Agree   Agree   Disagree   Strongly Disagree

8) The GPS activity was more enjoyable than taking notes in class.

Strongly Agree   Agree   Disagree   Strongly Disagree

9) I understood the geography lesson better by using the GPS than by taking notes in class.

Strongly Agree   Agree   Disagree   Strongly Disagree

10) My learning time would have been better spent in the classroom than outside using a GPS.

Strongly Agree   Agree   Disagree   Strongly Disagree

11) I would be more motivated to learn other topics in social studies if we could use a GPS.

Strongly Agree   Agree   Disagree   Strongly Disagree

12) I would like to participate in GPS activities in other subjects.

Strongly Agree   Agree   Disagree   Strongly Disagree

Open-Ended Questions: Write your answers in the space provided.
                               Please use the back of the paper if you need more room.

13) What did you like about the GPS activity?

14) What did you not like about the GPS activity?

15) How could you use GPS activities in other subjects?

16) How can the GPS activity help you in real life?

APPENDIX F

Geocaching Field Guides

Field Guide Team X (Culture Traits)

1) **Each cache will have your team number on it.**
2) **Do not bother the other caches.**
3) **After you have matched each culture trait and determined an example, place the task sheet back into the cache, and hide it back exactly where you found it.**

_____

The coordinates for your 1st cache are: 32° 30.471 N   Hint: Clear Box
                                            087° 50.154 W

Daily Life:

_____

_____

     Example: _____

Government:

_____

_____

     Example: _____

The coordinates for your 2nd cache are: 32° 30.514 N   Hint: Camo Box
                                            087° 50.172 W

Religion:

_____

_____

     Example:_____

History:

_____

_____

      Example:_____

The coordinates for your 3rd cache are: 32° 30.544
                        087° 50.126 W

                        Hint: Small Camo Soap Dish

Economy:

_____

_____

      Example: _____

Language:

_____

_____

      Example: _____

When you have finished finding your caches, return to the center of the field.

Field Guide Team X (Essential Elements)

1) **Each cache will have your team number on it.**
2) **Do not bother the other caches.**
3) **After you have matched each essential element and determined an example, place the task sheet back into the cache, and hide it back exactly where you found it.**

_____

The coordinates for your 1st cache are: 32° 30.471 N   Hint: Clear Box

                                               087° 50.154 W

The World in Spatial Terms:_____

_____

     Example: _____

Places & Regions: _____

_____

     Example: _____

═══

The coordinates for your 2nd cache are: 32° 30.514 N   Hint: Camo Box

                                               087° 50.172 W

Physical Systems: _____

_____

     Example: _____

Human Systems: _____

_____

    Example: _____

_____

The coordinates for your 3rd cache are: 32° 30.544 N

    087° 50.126 W

    Hint: Small Camo Soap Dish

Environment & Society: _____

_____

    Example: _____

Uses of Geography: _____

_____

    Example: _____

When you have finished finding your caches, return to the center of the field.

APPENDIX G

Geocache Task Sheets

CACHE #1 – Culture Traits

Your Team's Tasks:

1) Match the culture trait definitions below with the correct culture trait on your field guide.
2) Write an example of this culture trait from a country or region that you have studied this semester.
3) Put the task sheet back in the container and replace the container just as you found it when you are finished with your tasks.

Culture Trait Definition:

- The languages people speak in a country.

- Dialect, or a local form of language, might differ in the same language.

Culture Trait Definition:

- How a nation makes money or produces goods and services

CACHE #2 – Culture Traits

Your Team's Tasks:

1) Match the culture trait definitions below with the correct culture trait on your field guide.
2) Write an example of this culture trait from a country or region that you have studied this semester.
3) Put the task sheet back in the container and replace the container just as you found it when you are finished with your tasks.

Culture Trait Definition:

- What people believe about a deity (God or gods).

Culture Trait Definition:

- What happened within a country in the past.

CACHE #3 – Culture Traits

Your Team's Tasks:

1) Match the culture trait definitions below with the correct culture trait on your field guide.
2) Write an example of this culture trait from a country or region that you have studied this semester.
3) Put the task sheet back in the container and replace the container just as you found it when you are finished with your tasks.

Culture Trait Definition:

- How people interact socially.

- What people do on a day to day basis.

Culture Trait Definition:

- How a nation is ruled.

- Authority and administration of laws

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CACHE #1 – Essential Elements of Geography

Your Team's Tasks:

1) Match the essential element definitions below with the correct element on your field guide.
2) Write an example of this element from a country or region that you have studied this semester.
3) Put the task sheet back in the container and replace the container just as you found it when you are finished with your tasks.

Essential Element Definition:

- Where a place is located – location

- Maps

- Directions

Essential Element Definition:

- Describes characteristics; physical (landforms), climate, plant or animal life.

- Describes human characteristics; language, way of life.

- Specifies regions

CACHE #2 – Essential Elements of Geography

Your Team's Tasks:

1) Match the essential element definitions below with the correct element on your field guide.
2) Write an example of this element from a country or region that you have studied this semester.
3) Put the task sheet back in the container and replace the container just as you found it when you are finished with your tasks.

Essential Element Definition:

- Hurricanes, volcanoes, glaciers, etc.

- Things that shape the earth's surface.

Essential Element Definition:

- How boundaries are made or determined.

- Why people settle where they do.

- Why people move.

CACHE #3 – Essential Elements of Geography

Your Team's Tasks:

1) Match the essential element definitions below with the correct element on your field guide.
2) Write an example of this element from a country or region that you have studied this semester.
3) Put the task sheet back in the container and replace the container just as you found it when you are finished with your tasks.

Essential Element Definition:

- The way people interact with the land.

- The way people use their surroundings.

Essential Element Definition:

- Using geographical tools to understand people, places, and environment.

- Examples: GPS, GIS, etc.

APPENDIX H

Traditional Classroom Activity Presentation Notes

The following content was given to the control group in Phase I using presentation software:

Slide 1 - Culture Trait Definition: Language

- The languages people speak in a country.

- Dialect, or a local form of language, might differ in the same language.

Slide 2 - Culture Trait Definition: Economy

- How a nation makes money or produces goods and services.

Slide 3 - Culture Trait Definition: Religion

- What people believe about a deity (God or gods).

Slide 4 - Culture Trait Definition: History

- What happened within a country in the past.

Slide 5 - Culture Trait Definition: Daily Life

- How people interact socially.

- What people do on a day to day basis.

Slide 6 - Culture Trait Definition: Government

- How a nation is ruled.

- Authority and administration of laws

The following content was given to the control group in Phase II using presentation software:

Slide 1 - Essential Element Definition: The World in Spatial Terms

- Where a place is located – location

- Maps

- Directions

Slide 2 - Essential Element Definition: Places and Regions

- Describes characteristics; physical (landforms), climate, plant or animal life.

- Describes human characteristics; language, way of life.

- Specifies regions

Slide 3 - Essential Element Definition: Physical Systems

- Hurricanes, volcanoes, glaciers, etc.

- Things that shape the earth's surface.

Slide 4 - Essential Element Definition: Human Systems

- How boundaries are made or determined.

- Why people settle where they do.

- Why people move.

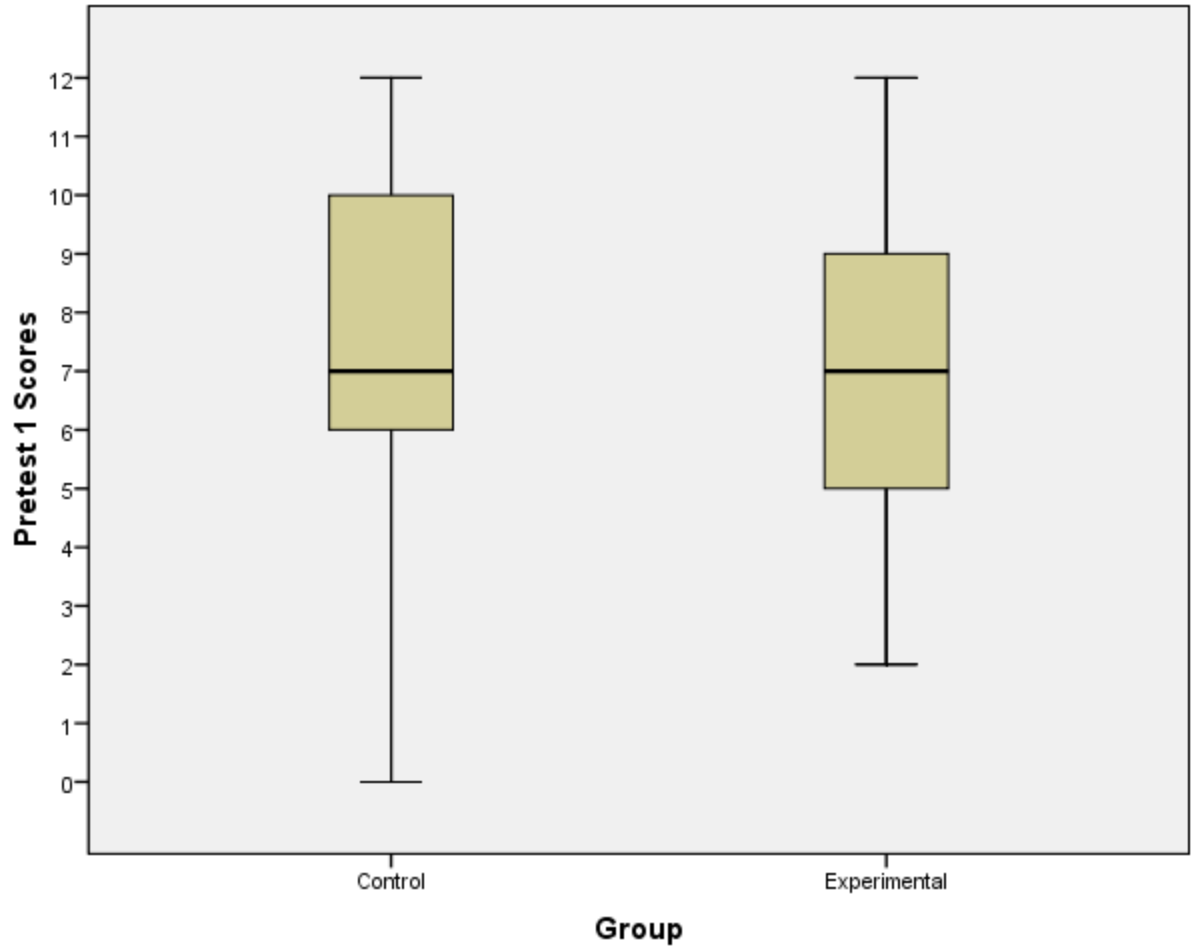Slide 5 - Essential Element Definition: Environment and Society

- The way people interact with the land.

- The way people use their surroundings.

Slide 6 - Essential Element Definition: Uses of Geography

- Using geographical tools to understand people, places, and environment.

- Examples: GPS, GIS, etc.

APPENDIX I

Figures of Pretest and Posttest Average Ranks

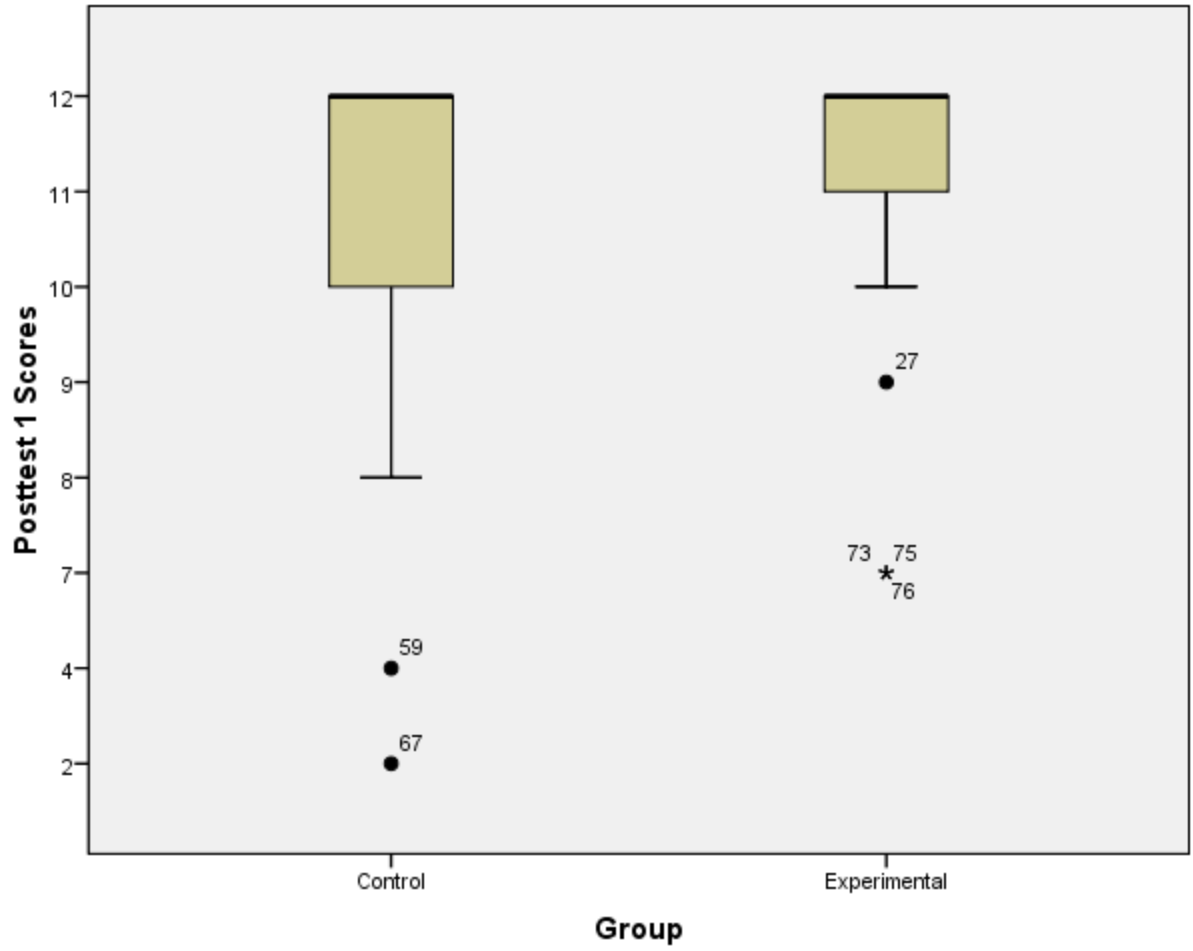*Figure I1*. The distributions of Phase I pretest scores for the control and experimental groups.

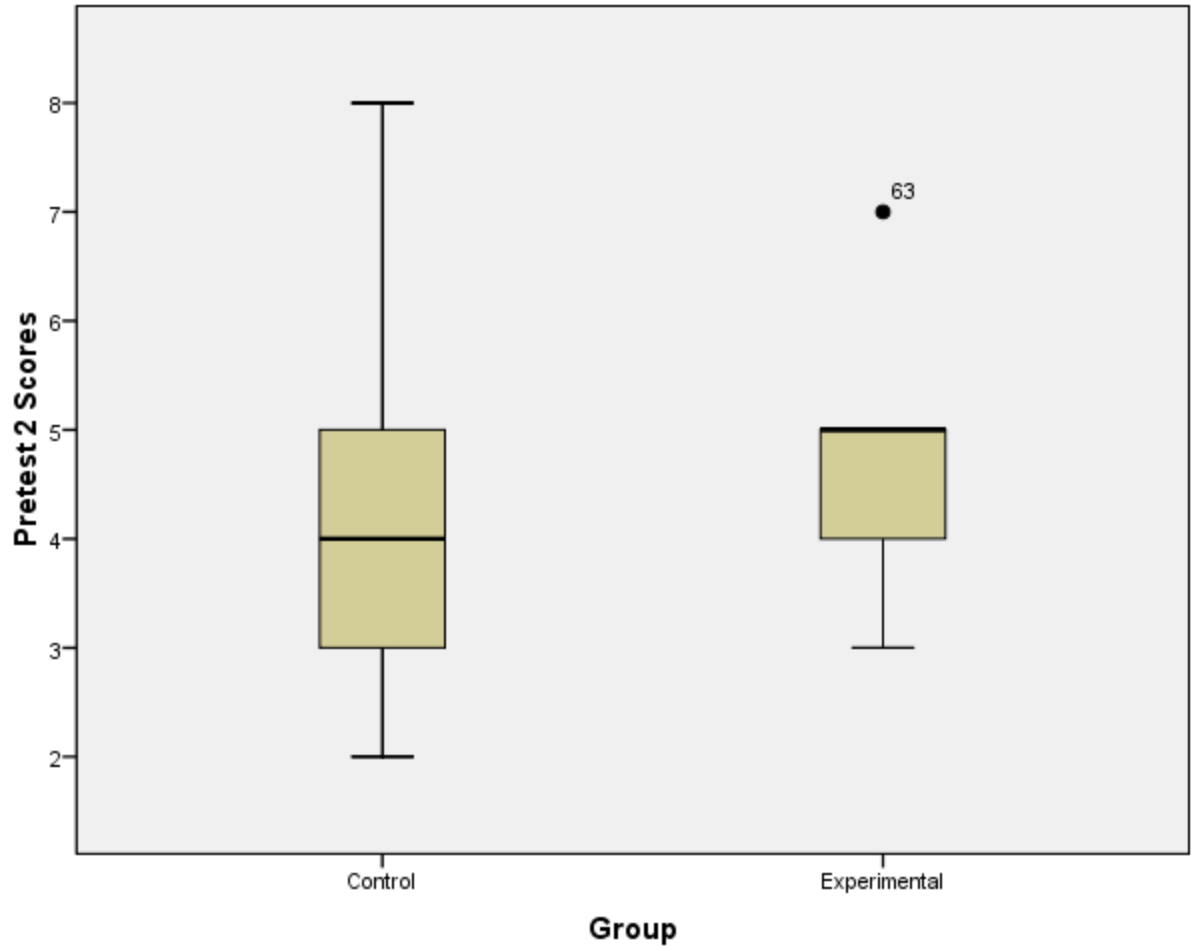*Figure I2.* The distributions of Phase I posttest scores for the control and experimental groups.

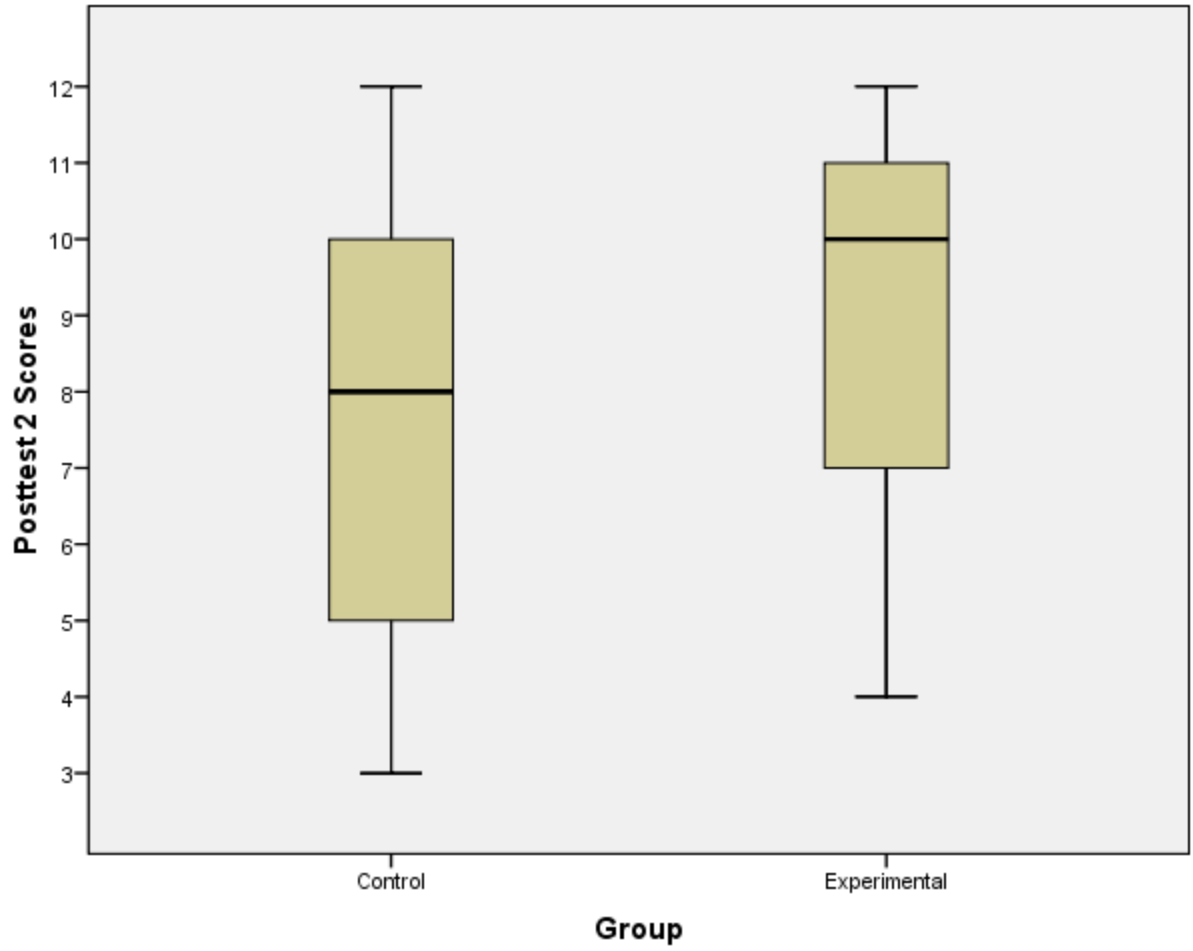*Figure I3.* The distributions of Phase II pretest scores for the control and experimental groups.

Figure I4. The distributions of Phase II posttest scores for the control and experimental groups.