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Supporting vocabulary growth of high school students: An analysis of the potential of a mobile learning device and gaming app

Jennifer Redd

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Supporting vocabulary growth of high school students:
An analysis of the potential of a mobile learning device and gaming app

By

Jennifer Betsy Redd

A dissertation submitted to the graduate faculty in partial fulfillment of the requirements for
the degree of

DOCTOR OF PHILOSOPHY

Major: Education (Curriculum and Instructional Technology)

Program of Study Committee

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Iowa State University
Ames, Iowa
2011

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ABSTRACT

The purpose of this dissertation was to explore the educational benefits of using an app on a mobile device (i.e. iPod Touch) to aid in the process of high school students’ learning. The emphasis of this study explored the possibilities of learning vocabulary using a mobile device in an informal environment. Mobile devices embrace and encourage ubiquitous learning through their ease of portability and access to various activities that can allow for learning to occur. Learning theories and cognitive techniques were explored as a means of providing a mobile educational experience that is individualized, motivational, and beneficial for transfer to later word learning and reading comprehension.

Following a pre-test/post-test design, twenty-five high school students participated in this study by using a mobile device and vocabulary gaming app over the course of three weeks. The use of a game as an instructional tool offered a portable way for students to engage with content. The amount of vocabulary mastered after playing the app on the mobile device was examined in relation to the pre-test and post-test scores. The results via a paired sample t-test indicated there was no significant difference in performance between the tests, although the amount of time in using the app was important. The implications that emerged through a regression involved the direct correlation with the pre-test score as a predictor for the post-test score as well as the score achieved within the app as a predictor for the post-test score. The techniques used to play the app indicated that participants called upon the process of elimination and roots/word parts as tools to aid in the mastery of the vocabulary words. Participants offered suggestions related to the design characteristics of the app and how this affected the overall experience.
These findings pointed to the potential for incorporating a gaming application on a mobile device as an instructional tool for vocabulary development. Mobile devices provided a way of teaching today's high school students by allowing for learning to take place in an informal, individualized environment. This study indicated how the broadening of one's vocabulary might occur through the use of a mobile device and a gaming application.

Keywords: mobile devices, informal learning, vocabulary, high school students
CHAPTER 1. GENERAL INTRODUCTION

The 2010 Horizon Report notes that trends in teaching and learning during the next year will involve mobile learning, where the portability creates a way for anytime, anywhere learning experiences (Schachter, 2009; The New Media Consortium & EDUCAUSE Learning Initiative, 2010). Taking advantage of the possibilities that are created when students carry around their assignments and activities at all times brings about new opportunities for learning. Students can now, in the palm of their hand, embark on the use of tools that can expand their content knowledge. Ching, Shuler, Lewis, and Levine (2009) note, “Mobile technologies can help advance the goal of achieving digital equity because of their ubiquity, low cost, and familiarity. The anytime, anywhere availability of mobile devices also has potential to promote a seamless 360-degree learning experience that breaks down the barriers between formal and informal educational environments” (p. 28). Having the possibility and capability to learn whenever you want is a unique feature of the mobile learning movement.

Today’s students need opportunities for exploration and involvement in the learning process (Ben-Jacob, Levin, & Ben-Jacob, 2006; Kumar & Lightner, 2007). The use of a mobile device provides a means to reach students in a way that they are accustomed to. It gives them active control of their learning in the palm of their hands. The mobile device that is the central focus of this study is the iPod Touch. Admob (2009) found that 69% of iPod Touch users are between 13-24 years of age. Lenhart (2009) found that 74% of teens ages 12-17 own an iPod or Mp3 player. The proposed participants for this research study are 10th and 11th grade students who are typically 15 to 17 years of age. This is also the grade level and age when high school students begin preparing to take the ACT or SAT.
Specifically for use on mobile devices, interactive applications have been designed that are commonly referred to as apps. The particular app at the center of this study is called the Vocab Challenge App. The Vocab Challenge App is a vocabulary game that consists of 250 vocabulary words most commonly found on the SAT test and requires the players to work with a particular vocabulary word until mastery (Modality, 2010). Mastery learning is when a learner is unable to move beyond an area of study until it is demonstrated that the information is fully understood and all prerequisite activities are completed (Bloom, 1968). Within the Vocab Challenge App, this can only occur by responding correctly to activities that involve practice with synonyms, antonyms, connotations, and definitions. Thus, mastery of a particular vocabulary word only occurs after correctly answering specifically designed exercises involving all four criteria areas. One of the major benefits of the game is the amount of practice the user gets from working with each word in all four dimensions.

**Rationale of the Study**

Reading and writing skills are the foundational element to success in school (U.S. Department of Education, 2010). Both of these skills involve having a strong vocabulary. Unfortunately, many more words exist than teachers can provide instruction on in classrooms (Nagy & Anderson, 1984). With large class sizes, the amount of previous word knowledge and experience can vary greatly across the classroom. In order to meet student needs, high school English teachers need to incorporate teaching methods that ascribe to the students’ unique abilities and learning styles (Ericson, 2001). One way to accomplish this might be through using technology. Technologies create a flexible and rich environment in which students can view and interact with what they are learning (Jonassen, Carr, & Yuen, 1998). The technologies, such as a mobile device, put students in active control of their own
learning and mastery of information anytime and anywhere (Gee, 2008). These mobile devices create an environment where the student controls the pace and the amount of information to be studied. Jonassen, Howland, Marra, and Crismond (2007) state, “Technologies support meaningful learning when they fulfill a learning need - when interactions with technologies are learner initiated and learner controlled and when interactions with the technologies are conceptually and intellectually engaging” (p. 7).

Learning activities performed on mobile devices should be meaningful to the students by integrating the content curriculum standards in a way where they are engaged and making meaning with the information encountered. One way this can be accomplished is by using educational video games.

**Statement of the Problem**

Educational video games are gaining popularity as a means to teach students. The Horizon Report (2009) stated, “Multi-touch interfaces, GPS capability, and the ability to run third-party applications make today’s mobile device an increasingly flexible tool that is readily adapted to a wide range of tasks for social networking, learning, and productivity” (p. 5). Incorporating these tools into teaching is right on the horizon. Shaffer, Squire, Halverson, and Gee (2005) describe that incorporating games creates new more powerful ways of learning that tie in the developments taking place in the new Information Age. It is through the use of video games that students can be reached in a way they have grown accustomed to by parents and teachers (Mayo, 2007). A game on a mobile device creates an immersive and interactive environment. Shaffer et al. (2005) conclude video games allow for learning by doing in an environment with some constraints placed to present helpful
guidance. The game provides the student guidance by offering the support and scaffolding necessary to successfully master the content encountered.

Kittl, Edegger, and Petrovic (2009) note that by using a combination of digital games and quality learning content, it will engage the student during the learning process. Having a game that picks up where a teacher left off that day in class or that allows the user to explore a topic or issue more in-depth outside of classroom time, helps to broaden the students’ educational experiences. Kittl et al. (2009) note that education needs to move away from the traditional lecture format toward one that emphasizes teamwork, independence, and responsibility. Games accessed on mobile devices now provide students with opportunities for learning inside and outside the classroom that were previously not available. New possibilities of learning have developed by combining the advances in mobile devices with the tools with which students are familiar.

Another benefit of a student using a mobile device is the ability to individualize the educational experience. Using mobile devices such as the iPod Touch in the high school English classroom provides a way for students to work at their own pace and at their own skill level. By working alone on the mobile device, students are receiving an individualized educational experience. They are learning by doing in a safe, controllable problem space where technology is a partner (Child, 1993; Jonassen & Reeves, 1996). Ching et al. (2009) conclude, “The ability of mobile learning to accommodate many different needs and learning styles can also make it an attractive choice for teachers” (p. 28). These devices can benefit various students such as more mature learners, gifted learners, international learners, remotely based learners, and learners with cognitive/behavioral problems or physical/mental difficulties (Ching et al., 2009). To address individualization through computer-assisted
learning, Child (1993) remarks that each student reviews the results instantaneously and works on the material at a pace that is comfortable. This allows for the student to avoid any potential embarrassment or humiliation since the feedback is provided on each individual’s device. The ability to work at a pace that accommodates the needs of each individual creates a way for the students to work on the same thing but in a way and at a time that best suits them.

**Purpose of the Study**

The purpose of the study is to explore the educational benefits of using an app on a mobile device (i.e. iPod Touch) to aid in the process of learning. Shuler (2009) conducted a content analysis of iTunes Apps and suggested that research needs to investigate what is working in regards to education and apps. Of particular interest are the possibilities for high school students to use an iPod Touch to extend their learning from a formal to an informal environment. Mobile devices embrace and encourage ubiquitous learning through their ease of portability and access to various activities that can allow for learning to occur. Learning has the potential to take place anytime and anywhere without geographical constraints.

This study looked at the impact the educational app, Vocab Challenge, had provided and discovered the implications for teaching and learning this had for high school students. Newton, Padak, and Rasinski (2008) claim:

> Everyone agrees that an extensive vocabulary helps us share our thoughts and feelings more effectively with others. Not surprisingly, an extensive vocabulary is also central to reading comprehension. The more words a reader is familiar with, the easier it is for him or her to understand the meaning of the text. (p. XV)
By increasing a student’s vocabulary, he may have more success in reading and comprehension activities throughout the rest of his academic career. A strong vocabulary can lead a student to success not only on the SAT test itself, but also in reading comprehension. Mobile devices might allow high school students a portable opportunity to work at their own pace and at their own skill level while acquiring and mastering a wider vocabulary.

The Vocab Challenge App focuses on the building of vocabulary through mastery. The app engages students in a variety of vocabulary related gaming activities, such as synonyms, antonyms, connotations, and definitions. This study examined how using a mobile device might impact the growth of a student’s vocabulary by first looking at their present vocabulary word knowledge by means of a pre-test. Then students used the app for a three-week period. Following the three-week period, students took a vocabulary post-test to track potential vocabulary growth. Also, at the end of the study, students completed a brief survey about the design of the Vocab Challenge App. The survey explores the features of the app that may have helped aid in the memory and building of a stronger vocabulary.

Mobile devices are innovative tools that need to be explored as a new methodology of teaching today’s students. As these devices become more commonly used by high school students, the development and quality of educational applications they might use need to be researched.

**Dissertation Format**

The format of this dissertation is written in the alternative format approved by Iowa State University. This format permits the creation of three journal articles that can be published. A standard introduction and conclusion are also included to tie the common
themes of mobile learning, gaming, and vocabulary together. The first article, “Using Mobile Devices and Gaming as a Means of Building Vocabulary” serves as a review of literature on the potential of developing vocabulary knowledge using a mobile device. The main areas discussed include mobile devices, theoretical frameworks, game theory and design, games in education, and vocabulary learning techniques as they relate to vocabulary acquisition by high school students. The discussion of the literature provided offers a thorough review of the current research known in these areas.

The second article, “The Potential of Building High School Students’ Vocabulary Using an iPod Touch and Gaming App” explores the possibilities that an iPod Touch App, Vocab Challenge, offers for high school students to develop vocabulary and word knowledge over time. The Vocab Challenge App is a game enriched with frequently encountered vocabulary words found on the SAT exam, specifically geared for use by high school students. The article also examines the different study strategies used by the students and the influence these study strategies have on their successful mastery of new vocabulary words. The emphasis of this article is on the results of using the iPod Touch and this app via the pre- and post-tests, transfer suggestions that may emerge, and the differences, if any, in performance based on an increase or decrease between the scores on the pre-test and post-test.

The third article, “Mobile Device Learning: An Exploration of the Processes Involved in High School Students’ Vocabulary Development” explores game design characteristics and psychological principles of encoding, retrieval, and attention that are inherent in the iPod Touch App called the Vocab Challenge and the impact this might have on secondary students’ mastery of vocabulary. As more and more applications are designed for such
devices, the design characteristics presented should be explored to discover which
components help to lead to information retention. This article also looks into the potential of
using mobile devices to take learning outside of a classroom and into informal learning
environments. It is equally important to explore how students’ previous technology usage
might impact performance while using this type of device.

The strength of this dissertation lies in the fact that it addresses a timely topic of
incorporating a mobile device into the education of high school students. The study is
grounded in using quantitative methodologies because all data were collected by means of
surveys and forms. All of the articles take into account the design behind the development of
the Vocab Challenge App and the effects this might have on the students playing it. The first
article offers an in-depth exploration of the research currently known about gaming and looks
toward the future of the importance of careful thought behind the development and quality of
the games that will be provided to high school students during their educational endeavors
both inside and outside the classroom. The second article tackles this new technology of
using a mobile device for learning vocabulary by high school students. There is only limited
research currently available on this topic and this study can serve as a reference for teachers
and educational professionals who are interested in exploring other tools that can assist
learners present in their classrooms and schools. The third article explores how portable
media devices can impact the vocabulary development of high school students. It also
explores game design characteristics and educational psychological principles behind ease of
use. Connections to how students use technology and the impact this has on their use of the
app (demographic comparisons) are examined. This article can provide developers and
educators with information regarding what works when developing a vocabulary app as well
as what to look for when selecting a vocabulary app. Overall, this dissertation investigated
the use of mobile devices by high school students in a way that blurs the border of the
classroom. By using a mobile device, students can gain control of their learning wherever
and whenever they see fit.

Tables, figures, and references cited within each article are appended at the end of
each of their respective articles. General documents used during the data collection phase are
attached in the Appendices, which appear at the end of the document.
References


CHAPTER 2. USING MOBILE DEVICES AND GAMING AS A MEANS OF BUILDING VOCABULARY

A paper to be submitted to International Journal of Interactive Mobile Technologies

Jennifer Redd

Abstract

Mobile devices are gaining momentum and popularity in the daily lives of today’s youth. It seems important to explore what these devices offer as a tool for learning. These devices embrace and encourage ubiquitous learning through their ease of portability and access to various activities that can allow for learning to occur. This article serves as a review of literature that explores how the broadening of one’s vocabulary may occur through the use of a mobile device and a gaming application. Learning theories and cognitive techniques are explored as a means of providing a mobile educational experience that is individualized, motivational, and beneficial for transfer to later word learning and reading comprehension.

Keywords: mobile devices, game theory, gaming in education, vocabulary
“The digital world has placed the great library resources of the world at anyone’s fingertips” --(Kolb, 2008, p. v)

This article provides a review of the literary foundation for the basis of studying vocabulary acquisition using mobile devices. The main areas discussed include mobile devices, theoretical frameworks, game theory and design, games in education, and vocabulary learning techniques as they relate to vocabulary acquisition by high school students. Each of these areas plays an instrumental role in providing the background required to study the impact mobile technologies can have on vocabulary development.

**Mobile Devices**

Technology is constantly evolving and this change is moving into the educational realm by creating opportunities for enhanced learning that is characterized as mobile learning, seamless learning, and ubiquitous learning (Rogers, 2009). This learning can be accomplished through the use of mobile devices. Mobile devices are small portable computing devices that can be used in a variety of environments (Microsoft Corporation, 2010). This includes handheld devices, such as, personal digital assistants (PDA), portable media players (iPod Touch), and handheld game consoles (Nintendo DS). They possess the features of an operating system, a processor unit, a microbrowser, input/output devices, memory, and batteries (Hu, Yeh, Chu, & Lee, 2005). These devices are making their way from outside to inside classrooms. They provide a way for students to construct knowledge and meaning from experiences by accomplishing learning tasks by using a portable tool (Rogers, 2009). Many of these mobile devices are characterized as miniature classroom computers that allow students to partake in the “anytime, anywhere” learning movement (Schachter, 2009). Mobile devices may be useful in creating a way for secondary students to
transfer learning from inside to outside the classroom seamlessly.

The use of mobile devices, such as the iPod Touch, is becoming more common among secondary students. For example, Admob (2009) found that 69% of iPod Touch users are between 13-24 years of age with 46% of the users between 13 and 17. Similarly, Lenhart (2009) found that 74% of teens (ages 12-17) own an iPod or Mp3 player. As mobile devices get more advanced, the possible educational applications improve, which can lead to a re-organization of the learning environment (Holzinger, Nischelwitzer, & Meisenberger, 2005). Fox (2010) notes there are many ways to incorporate the use of mobile devices and library activities, such as searching for and reading information (i.e. Kindle App) or interacting with the environment (i.e. Google Goggles). Croy (2007) describes a variety of ways of using mobile devices, for example, composing podcasts and movies. Mobile devices allow secondary students to engage in educational activities using the devices they are accustomed to.

**Theoretical Frameworks Related to Learning with Mobile Devices**

Behind the scenes of these mobile devices are theories at work that describe the way with which learning can occur. Three learning theories, Zone of Proximal Development, Social Learning Theory, and The Law of Effect, offer an explanation as to how learning can occur using this type of portable device. Table 1 provides a comparison of the major components, motivation features, and feedback responses that these three theories provide while learning with mobile devices.
Table 1

*Theories Associated with Learning with Mobile Devices*

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Vygotsky’s Theory of Zone of Proximal Development</th>
<th>Bandura’s Social Learning Theory</th>
<th>Thorndike’s Theory of Law of Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Components</td>
<td>Provides guidance and scaffolding to build up the learner’s knowledge level</td>
<td>Shaped by knowledge of behavior’s consequences</td>
<td>Choosing the path of least resistance toward a goal that results in the greatest satisfaction Learners rewarded and punished based on actions made</td>
</tr>
<tr>
<td>Motivation</td>
<td>Intrinsic drive draws learners to build knowledge</td>
<td>Behaviors performed with the concept of reinforcement in mind</td>
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</tr>
<tr>
<td>Mobile Device Feedback</td>
<td>Activities tailored to the individual’s current skill level</td>
<td>Activities formulated toward the development of imitative behavior by means of attention, repetition, reproduction, and motivation</td>
<td>Activities selected through trial and error to increase level of satisfyingness</td>
</tr>
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**Zone of Proximal Development**

One-way knowledge is constructed via a mobile device is based upon Vygotsky’s Theory of Zone of the Proximal Development. This theory highlights the space between the actual level of problem solving and the level that can be achieved through guidance and support (Vygotsky, 1978) (see Figure 1).
This theory can be broken down into three stages that look at what the learner can do alone, the level he wants to achieve, and the scaffolding and support necessary to achieve that level. The first stage is *independent*. This is the learner’s present knowledge and skill level and where he feels comfortable and will have success achieving and solving problems on his own. The next stage is where the zone of proximal development rests. The learner through guidance and collaboration is able to work on something that is just above the level where he can complete it independently, but not so difficult it causes confusion or boredom (Murray & Arroyo, 2002; Vygotsky, 1978). The ultimate goal of providing these supports is to build up the learner’s knowledgebase so he can later perform the tasks independently. The third stage is *frustration*. This is what happens when a learner attempts to move beyond his current knowledge level without the proper support. Mobile devices have the ability to engage players individually while in the zone of proximal development.

While using mobile devices, players move beyond their current skill level with the mobile device acting as a scaffold (Benson, 1995; Ganske, 2000). This theory suggests learners work within the state of instruction and development (Chaiklin, 2003). By using the
mobile device with a vocabulary game, players are introduced via instruction to words that are currently beyond their knowledge base but within their grasp. Then through interaction with these words, provided by strategically placed scaffolds, knowledge of the vocabulary words is attained. Benson (1995) describes, “Knowledge within a discipline is important, but solving problems that encourage students to go beyond their current skill and knowledge level is critical to effective instruction” (para. 20). This can apply to learning vocabulary words with a mobile device since the game is designed to provide support beginning with meeting the player at his present knowledge level. Then through these scaffolded experiences, knowledge levels advance beyond what they were before. Slowly, the scaffolds are phased out, leaving the learner with the ability to apply the knowledge gained with support into scenarios without any support (Chaiklin, 2003; Murray & Arroyo, 2002). Ultimately, it is the learner’s goal to possess knowledge on the particular subject area independently, thus allowing for the cycle to once again begin.

Typically, games designed for mobile devices push players beyond their current knowledgebase slowly and with support. For example, the Playstation 3 game, Brain Challenge, starts at the level where the player is currently. Then through a self-adjusting difficulty system, the questions on topics, such as logic, math, and concentration adjust depending on the responses and choices made by the player (Play.com, 2010). The Zone of Proximal Development seeks to engage learners at the optimal instructional level in a safe and supported manner. Another theoretical model that explores the way learning occurs with a mobile device is based on social learning theory.
Social Learning Theory

The use of mobile devices also coincides with Bandura’s Social Learning Theory. This theory notes that the actions of a person are strongly influenced by their consequences (Bandura, 2006). After discovering the effects of performing a behavior, the learner mentally begins to anticipate the possible consequences of the behavior (Bandura, 2006). Then matching behaviors are performed with the concept of reinforcement in mind. Learning in this manner takes into consideration four essential components. These include attention, retention, reproduction, and motivation (Child, 1993; Erickson, 1974; Kirsch, 2010; Moore, 1999).

These four essential components may be applied to learning with a mobile device. First, the amount of attention paid to the task and the steps needed to complete it are essential for success while playing games. For example, having knowledge that a certain behavior will reap certain rewards will cause extra attention to be paid to models and important components deemed necessary in order to achieve the reward (Bandura, 2006). Second, the images and text encountered on the device aid in remembering the content experienced. Memory is used to organize and mentally code the items which were paid attention to and experienced (Learning Theories Knowledgebase, 2010). Third, based on the feedback from the game the user’s behavior is modified and reproduces the correct responses for success. This can also be considered imitative learning because by observing and focusing on the feedback provided, decisions are made that will attempt to maximize the rewards earned (Bandura, 2006). Finally, there are motivational incentives when it comes to games. This can be in the form of intrinsic factors, such as satisfactory feelings of learning something new by means of curiosity, exploration, and manipulation, or extrinsic factors, such as incentives,
rewards and punishments, co-operation, and completion (Child, 1993). Another theoretical framework that can explain how learning transpires through trial and error while using a mobile device is based on Thorndike’s theory of law of effect.

**Law of Effect**

The theory of law of effect is based on choosing the path of least resistance toward a goal that results in the greatest satisfaction (Thorndike, 1905). The theory explains that behaviors are modified based upon experiences and their consequences (Thorndike, 1913). This theory is best exemplified by trial and error learning (Simpson & Stansberry, 2008). The luxury of using a mobile gaming device is the repeated opportunities to engage in an activity. Then if the strategy used was not successful or did not, for example, earn the most points, the player has the ability to try it again and modify the original behaviors based upon the feedback received. Increasingly, the level of satisfyingness felt while completing the activity is the goal (Thorndike, 1913). Erickson (1974) describes, “The learner is rewarded or punished depending upon what he does; the ‘effect’ (satisfaction or annoyance) contingent upon how the learner responds to the environment” (p. 15). The interaction allows for the learner to try out different actions and experience rewards and punishments based upon those decisions. These can cause an increase in the motivation and attention the learner may exhibit while playing a game (Erickson, 1974). Once the learner has discovered the behavior principle behind the learning, which can occur through a combination of positive and negative reinforcements, the learner can continue to learn in new contexts (Blachowicz & Fischer, 2008; Erickson, 1974; Skinner, 2006). Playing a game on a mobile device can create new educational possibilities of learning.
The theoretical foundations for learning on a mobile device can be constructed through the combination of these three theories. The Zone of Proximal Development explains how these devices can bridge the gap of learning through well-constructed scaffolds. Social Learning Theory illustrates the impact that attention, motivation, and feedback can have on the player. Finally, theory of law of effect highlights the importance of trial and error learning opportunities and the effects of feedback in the games. Together, these three theories lay the foundation for learning on a mobile device. Also of importance is the programming that goes into the development of gaming applications. The construction of a game is based on the game theory, which includes the foundational elements, such as choices, rules, and goals, that are instrumental to the proper unfolding of a game (Kremers, 2009).

**Game Theory**

Game theory defines the core structure of a game by developing and providing numerous sequences of decisions and choices pre-programmed into the gaming structure that will allow the player to progress based upon their own actions. This theory develops gaming sequences based upon utility, or the probability that a selection will be made by the player (Salen & Zimmerman, 2004). Botturi and Loh (2008) describe the following:

> Within game theory, the structural elements of a game exist as rules, turns, collaboration and competition, where winning, or fun, is modeled as numerical payoff. Game theory explains *how playing (a game) works*, and defines games as an interactive process striving toward payoff. (p. 7)

This theory is based on decisions. As decisions are made, they should be well-informed and based on prior knowledge learned through experiences in the game (Kremers, 2009). Inside
of a game there are decision trees that create various paths based on the choices made by the player (Poundstone, 2006; Salen & Zimmerman, 2004). Each decision causes a chain reaction leading to a different outcome.

As the player progresses, his interactions within the game help to evolve into strategies that maximize the chance of success at reaching predetermined goals (Birdwell 2006; Bjork & Holopainen, 2006; Crawford, 1984). For example, the Leapster Explorer Learning Game, *Mr. Pencil Saves Doodleburg*, introduces the player on how to write numbers and letters and to create art and recognize shapes (Leapfrog Enterprises, 2010). Reproducing the correct symbols allows Mr. Pencil to progress though the game and save the town. There are rules built into the game that funnel the player’s actions to have specific consequences. This means there are multiple paths to success solely dependent on the actions and decisions of the player. For example, if the letters are not correctly traced, the player has to start again, and when correctly traced, the player proceeds to more difficult activities.

Game theory explains how the achievement principle applies to learning with games. Gee (2003) notes learners while gaming are impacted by the intrinsic rewards. The rewards are customized based on the player’s movements. As the levels shift, the effort and skill mastery required by the player also does (Holland, Jenkins, & Squire, 2003). The rewards signify the growing achievements earned by the player. Every player’s experience is different with the same game (Crawford, 1984). A common algorithm implemented into the design of a game is based on the SuperMemo Method. This method offers a custom, adaptive spaced repetition program adapted to suit the learner’s abilities (SuperMemo World,
Information is strategically placed in increments that complement the curve most commonly associated with forgetting (see Figure 2).

*Figure 2.* Game algorithm that replicates the forgetting curve (Wolf, 2008)

The game begins at the player’s knowledge level and then moves through playful, free movements within a well-defined, rigid structure at a level and pace that best suits the player (Botturi & Loh, 2008). Reminders are spaced after the first introduction of material in order to reduce forgetting. This is accomplished through practice and easily refined through active integration, meaningful use, and repetition (Smith, 2008). Gee (2003) concludes that a virtual world provides the player with numerous opportunities for practice that is not boring since it allows for the player to create their own experiences. Through these interactions with the games by means of images, text, and actions, players’ skills and knowledge are then constructed. The design and development involved in the creation of the game creates an environment conducive for learning.
Game Design

The design of a game can take on two formats (Lumsden, 1975). The most common is a linear format. This is where the player, after making a certain response, receives a reinforcement or reward, and then progresses onto the next frame. The second format involves branching. This is when the next page to be encountered varies upon the action performed by the player. A branching game is well designed when no two students follow the exact same pathway through the learning experience (Kolb, 2008). Based on this format, the player has multiple ways to make progress in the game by making choices based on individual strengths and learning styles (Gee, 2003).

There is an overarching, basic design, though, that games must follow. Loftus and Loftus (1983) note that games should possess three essential characteristics. The first, challenge, means that games will shift in complexity based upon the user’s actions. There is a goal to be reached and when play begins, the user is uncertain of the outcome. The second, fantasy, creates mental images. These images allow the learner to relate prior knowledge toward the understanding of new items (Loftus & Loftus, 1983). Fantasy involves evoking the senses through the use of images, plot structure, and sound effects. The third essential characteristic is curiosity. By having a game that possesses the “optimal level of informational complexity,” the users are engaged and not overwhelmed (Loftus & Loftus, 1983, p. 42).

Games also need to adjust to the player’s skill level, offer elements of surprise, and appeal to emotions (Grodal, 2003; Malone, 1984; Squire, 2003). The design of a game begins with a clear goal structure that offers scoring and feedback along the way (Bowman, 1982; Malone, 1984). The feedback mechanism offers valuable information to the player,
which will shape his later decisions and actions within the game (Gee, 2008). The feedback helps a player progress by offering corrective information and emotional support (Sweetser & Wyeth, 2005). Harris (2009) notes games allow learning to change by providing opportunities to fail safely and create memory knowledge that can improve later recall and performance.

The knowledge built into memory is a key component of learning and the design of a game needs to take this into account. Memory involves the activities of acquiring, retaining, and recalling information (Child, 1993). The act of learning involves taking new information presented and intertwining it with previous knowledge in a meaningful way (Donovan, Bransford, & Pellegrino, 1999; Hunter, 1995). Then, the act of analyzing, synthesizing, and developing critical thinking skills evolves as the player moves through the game and takes the information previously encountered and remembered and builds upon it (Dickey, 2005). Erickson (1974) found the following:

Learning is a continuous process of combining the familiar with the new. We learn how to perceive constancy in an ever-changing world of sensory stimulation, to perform old skills in new settings, to extract meaning out of new word combinations, and to solve problems, each of which is novel to some degree. (p. 114)

The amount and extended opportunities of practice are instrumental components of the design of a game to aid in memory and the learning process. The use of gaming in education can allow for these types of opportunities to occur.

**Gaming in Education**

Historically, video games were only seen as a form of entertainment, but as the technologies progress, these tools are becoming increasingly more popular as new mediums
for education (Shreve, 2005). Klopfer (2008) defines a game as “purposeful, goal-oriented, rule-based activity that the players perceive as fun” (p. 14). Mattel released the first handheld game, *Football*, in 1977 (Klopfer, 2008). This first game was primitive in the design and artificial intelligence as the range of actions allowed in the game was quite limited. Over the years, this type of game has advanced in complexity and design so that it is now used on cell phones and other portable devices. For example, some games today have motion sensors and touch screens that react based on the player’s movements (i.e., Wii, iPods). Mobile devices have increased in processor power and screen resolution and allow for gamers to play for a few minutes here and there since they are always connected (Klopfer, 2008).

As the evolution of mobile devices dramatically increases every year, so do the possible applications within the educational realm. Technology in and of itself can create activities that allow students to master and experience things that could not be discovered in another manner. Squire (2003) discusses the possibilities of educators using video games as a model to improve learning environments by providing clear goals, challenging students, allowing for collaboration, using criterion-based assessments, giving students more control over the learning process, and incorporating novelty into the environment. In regard to video games as a means of learning, McFarlane (2007) concludes digital games allow for the unfolding of actions and interactions to happen naturally, slowly revealing the path to success as opposed to traditional games, which state the rules up front. McFarlane goes on to explain that digital gaming environments need to support the varying pace of the learners. This is necessary to build up the player’s gaming confidence by encouraging and motivating them with the drive to continue to play and succeed. Also, using games allows learners to
experience things that would be difficult to replicate in another manner. For example, the
game, *Go, Diego, Go: Safari Rescue* for the Wii, allows the player to go on an African safari
rescue with the game’s characters. Together, they save the animals from the mischief of a
magician while at the same time collecting stamps and photos of the different locations
visited (Nintendo, 2010). Another game, Sid Meir’s *Civilization Revolution* for the Nintendo
DS, allows players to construct an entire empire from the very beginning. This includes
activities such as waging war, conducting diplomacy, and discovering new technologies
(Nintendo, 2010). Games give players the opportunity to experience things that otherwise
would not be possible.

Gaming provides a method of instruction in education that may allow for greater
learning outcomes. Papastergiou (2009) implemented a computer memory concepts activity
with 88 high school students. Approximately, half of the students experienced the activities
by means of a game and the others used non-gaming techniques. Based upon a computer
memory knowledge pre-test and post-test, the gaming students found the approach more
effective and motivational in the memorization of concepts. Tuzan, Yilmaz-Soylu, Inal, and
Kizilkaya (2009) studied the effect that a 3D geography game they developed had on 24
upper elementary students. They reported significant learning gains made by students while
participating in the game (based on pre- and post-achievement tests) and a dramatic increase
in motivation to engage in the game-based learning environment.

Understanding the possibilities that gaming can provide in education is vital to the
success of this method of teaching. Ray and Coulter (2010) conclude when preservice
teachers are instructed on possible uses of digital games in education, the view of how these
games might be effective shifts dramatically in favor of the game’s potential positive impact
on learning. Games that connect educational needs and games elements (visualization and problem solving) can lead to the most engagement by learners (Amory, Naicker, Vincent, & Adams, 1999). They also need to take into account the content, which encourages and promotes the learning of new material.

A video game’s content is of great importance. Antoniette and Mellone (2003) note that learning through video games is dependent upon the situation that it simulates as opposed to the characteristics of the computer itself. This means that it is not the hardware but rather the software. It is through the design and development of the features of the game that can promote learning opportunities (Antoniette & Mellone, 2003). The mobile device may be the technological tool, but it is material that comprises the game that harvests the potential learning possibilities. Kittl, Edegger, and Petrovic (2009) state the combination of digital games and quality learning content engages the learner during the process of learning. Then it is the interactions in this gaming medium that allows for the mastery of material in a personalized manner.

Using a mobile gaming device allows the player to master the skills of the game while learning about the content of the game itself. Suoranta and Lehimaki (2004) state that game playing requires the ability to read and interpret the rapidly changing images encountered. While in the gaming environment, the player needs to comprehend and analyze the various amounts of information he encounters. This helps to refine reading skills. Also, developing an understanding of the rules of the game is an important component of playing the game (Berger, 2002). Pearson, Hiebert, and Kamil (2007) found that by making sure students understand what is expected of them, students often do better. It is not just understanding the game’s rules, but it also requires active participation in comprehending
and internalizing what is required of them. The active engagement with the game creates the opportunity for learning to occur.

**Gaming and Active Learning**

Using games in education provides teachers with ways that allow students to become active participants in their educational experience. Gee (2008) describes games as “action-and-goal-directed preparations for, and simulations of, embodied experience” (p. 201). Games provide the medium for learning, but in order to gain the full experience submersed in a gaming environment, the player needs to become an active participant—a producer—playing toward the completion of goals/win state (Gee, 2008). Games can enhance learning by providing an active method of building knowledge that was not previously possible (Wideman, Owston, Brown, Kushniruk, Ho, & Pitts, 2007). The use of a game on a mobile device creates new and possibly even more powerful methods of educating a generation of students that have grown up accustomed to using the technology accessible to them.

Games give the player a chance to participate in a series of activities from a particular perspective toward the accomplishment of a goal in the manner they see fit (Gee, 2008; Sweetser & Wyeth, 2005). While using games, players are actively working toward the completion of a series of tasks toward a goal. McKinney (2009) defines, “Active learning refers to techniques where students do more than simply listen to a lecture. Students are DOING something including discovering, processing, and applying information” (para. 1). This means students are in charge of their learning; they are involved and engaged (Wellert, 2008). Laws, Sokoloff, and Thornton (1999) found that only 30% of students in college level physics courses of a traditional nature had a grasp on fundamental acceleration concepts whereas with active learning activities using computer software and other tools, this
percentage increased to 75%. The use of games as a form of active learning can also be exemplified by the game, *River City*. This game encourages small group collaboration to determine the cause of illness in the 19th century. Based on realistic historical, sociological, and geographical data, together the group members actively look for solutions to the outbreak by formulating hypotheses, conducting experiments, and recommending possible solutions (The River City Research Team, 2007). Gaming allows users to participate in the construction of their own knowledge by connecting concepts and applications. Kumar and Lightner (2007) remark games encourage active learning, collaboration, and interactivity. Games allow for collaboration, practice, discussion and negotiation within a virtual environment. Through hands-on manipulation of this virtual environment, students are actively shaping their knowledge and learning at the same time.

The idea of active learning through game usage creates an environment where the learner is in charge of his actions: learning by doing (Devine, Habig, Martin, Bott, & Grayson, 2004; Suoranta & Lehtimaki, 2004). The game provides the format for the learning and by its basic design “all aspects of the learning environment are set up to encourage active and critical, not passive learning” (Gee, 2003, p. 49). Chuang and Chen (2009) found that computer-based video game playing improved fact differentiation/recall processes as well as problem-solving skills by allowing for the exploration of multiple problem solutions. Part of the learning that evolves when using a gaming technology is the aspect of problem solving in addition to learning the basic facts.

Active learning using a mobile device allows each individual student to have a different experience with the game. Mayo (2007) notes video games allow the players to navigate different scenarios facing the consequences of varying actions. By making
decisions the learner is in control of what happens next. The mobile device provides the means for an individualized educational experience that allows the learner to take on a more active role where learning does not occur by just listening but rather by doing (Ryu & Parsons, 2009). Through active engagement, students experience the curricular concepts “metal representations of coherent classes of entities”, being taught by completing activities that require doing and then reflecting upon them (Murphy, 1991, p. 11). These experiences have the capabilities to be transferred to new learning situations.

**Gaming and Transfer**

The use of gaming in education can create possibilities of transfer from one situation to another. Kumar and Lightner (2007) conclude, “Creating opportunities for students to practice applying the material, such as in a game or simulation, can bridge the distance between learning concepts presented in a classroom and using the information to solve a problem met outside of the school” (p. 54). It is this transfer of knowledge that can have such a profound impact. When participating in these games, students gain a skill set that will help them work with others and apply the conceptual knowledge to new situations (Kumar & Lightner, 2007). As the player progresses in a game, the concepts behind the game play are mastered as well as the content. By understanding the principles, procedures, and general rules behind the game, students can recognize the meanings of specific and factual events, which can lead to transferring these ideas into new settings (Erickson, 1974; Harmon, Wood, & Hedrick, 2008). A helpful component to transferring ideas and skills is the motivation that the game provides.
Gaming and Motivation

Games are a way to extend motivational factors that typically apply to their recreational use to that which can apply in the classroom. Using games in educational environments allow students to be taught in innovative ways that can increase their motivation while teaching content. Mayo (2007) concluded that games could address the systemic deficiencies that are present in today’s traditional teaching formats. She notes that 86% of students who leave the engineering major cite poor teaching, predominantly lecture format, by faculty of undergraduate science and engineering classes as an influential factor. By transforming the way we teach, learning itself is transformed. Mayo (2007) reported that lectures had the lowest rated learning outcomes in today’s classrooms, and using games increases the motivation of the students. For example, in the collegiate classroom, the games Geography Explorer and Virtual Cell increased students’ learning outcomes by 15%-40% and 30%-63% respectively when compared to the lecture format. She concluded that video games provide one means of motivating students to learn. Kittel et al. (2009) note education needs to move away from the traditional lecture format toward one that emphasizes teamwork, independence, and responsibility. They found the use of mobile devices and a digital economy game as a learning mode led to an increase in positive student emotions and knowledge transfer as opposed to the traditional lecture method and the use of economy case studies. Gaming is a technology the students of this generation are accustomed to and instead of ignoring or avoiding it, needs to become implemented into the curriculum and pedagogy of educators (Weibe, 2007). Using teaching techniques that appeal to and motivate learners in class is key in today’s classrooms.
Creating something that will appeal to and motivate the learners in today’s classrooms is one of the possibilities available by using video games. Schrand (2008) discovered while adding interactive multimedia into his teaching repertoire to help promote active learning, students were more motivated to engage in class activities in an authentic and spontaneous manner. Malone (1984) conducted a survey of computer game preferences and found that not one single game can appeal to everyone, but some factors that contribute to intrinsically motivating instruction include personally meaningful goals, performance feedback, uncertain outcomes, scorekeeping, and randomness. In regards to increasing motivation, Malone (1984) concludes that personalization must be present. This involves a gaming environment that responds to the learners’ actions as well as provide ample opportunity for reflecting upon their actions. A game can become personally motivating by allowing the player to create an account and each time he enters, he receives a personal message. He can also pull up his individual achievements previously attained on the game, for example, scores. Also, every gaming experience is different since the outcomes are based on the individual’s actions. Games have the capabilities to move at the individual’s pace and at their skill level, which can be an instrumental learning tool when mastering certain curricular concepts, such as vocabulary.

**Vocabulary Development Related to Gaming**

Mastery of new vocabulary is a complex process, involving acquiring the words of a language (Pearson et al., 2007). The development of vocabulary is a major curricular concept addressed throughout the K-12 school curriculum. Academic vocabulary consists of content-specific, school-task, and literary words (Heibert & Lubliner, 2008). A strong vocabulary has been linked as a catalyst for improving reading fluency (Harmon et al., 2008;
Segalowitz, Watson, & Segalowitz, 1995; Smith, 2008). In order to strengthen vocabulary, certain techniques might be implemented. This involves immersion in rich environments that provide rich and varied language experiences (Graves, 2008; Pressley, Disney, & Anderson, 2007; Withrow, 2004). Baumann, Ware, and Edwards (2007) found that students immersed in a vocabulary-rich environment, who were provided with word instruction and learning strategies, ended up developing larger, more expansive vocabularies. The use of a computer game can mimic an immersive environment that permits the player to have multiple interactions with vocabulary words. An immersive environment allows for active inquiry and exploration in a defined space (Colella, 2000; Roussos, Johnson, Moher, Leigh, Vasilakis, & Barnes, 1999).

Immersive experiences in the gaming realm might be helpful for building a foundation for learning vocabulary. A word-rich environment is a catalyst for an increase in vocabulary usage and reading fluency (Smith, 2008). Lieven and Tomasello (2008) note, “Children learn language from their language experiences – there is no other way” (p. 168). The players, by taking on an active role by playing the game, master the game’s components as well as the vocabulary based content of the game itself. Through interactions with different word activities, situations are created where learners can move at their own pace to master new vocabulary.

Blachowicz and Fischer (2008) note that games and word play provide a context where students can enjoy the process of learning. By playing games, various types of interactivity and engagement occur, such as player positioning, narrative, and choice (Dickey, 2005). Nguyen and Khuat (2003) reported the use of games contributed to the learning of vocabulary as long as the game allowed the student the opportunity to interact
with the word through practice and review in an atmosphere optimal for learning (pleasant). The choice of the game should reflect the needs of the students, such as, proficiency level, cultural contest, and timing (Nguyen & Khuat, 2003). Engagement is important in learning scenarios in order to permit the learners to extract meaning and make sense of the information (Dede, 2000; Kumar & Lightner, 2007; Prensky, 2005). Yip and Kwan (2006) found that when engineering undergraduate students were given one of two conditions to learn English vocabulary–experimental (web sites with games) or control (face-to-face activity-based lessons)–those in the group using games statistically outperformed the control group. Also, many students found that the gaming format provided a context that made remembering of the vocabulary words easier.

**Word Activities**

Another key element that increases vocabulary learning is teaching individual words by providing concise and student friendly definitions (Graves, 2008; Phythian-Sence & Wagner, 2007; Pressley et al., 2007). Lu (2008) found that when high school students were presented with concise vocabulary information through Short Message Service (SMS) messages as opposed to detailed print materials, more vocabulary was recognized on the post-test. The use of easily understandable definitions also has an impact. In a high school science classroom, Young (2005) concluded that the use of definitions linked to related ideas and concepts ultimately lead to a better understanding of the words, which in turn impacted the overall understanding of the concepts they helped define. It is a combination of concise and understandable definitions that may contribute to the retention and learning of new vocabulary words.
Graves (2008) notes it is important to engage students in a variety of word activities. This involves designing activities that take into account the multiple facets of a word and its meaning and how the word relates to other words. Myers and Shu-fen (2009) found that high school students involved in varied exposure to vocabulary words in meaningful contexts outperformed their peers on a vocabulary post-test. It is important that within vocabulary building activities the word is not learned as a stand-alone item, but rather to learn its connections with other words (St. Clair Otten, 2003; Young 2005). Within the gaming environment, this can be done by implementing various activities, such as, finding a word’s synonyms and antonyms. Higgins and Hess (1999) found a significant difference in post-test scores between a group of elementary students who received vocabulary instruction with only electronic book activities (animations about six different vocabulary words) and those who received the electronic book along with feedback, prompting, and supplemental information. They concluded that it was important to use supplemental tools (e.g., synonyms and asking questions), not just books for engaging students in a variety of word learning formats.

Another important component to building a larger vocabulary involves repeated encounters with words. Graves (2008) explains students should work with a word more than once. Building up a strong vocabulary is not something that can happen in just one day through one encounter. It needs to occur over a long period of time, incrementally, within more than one context (Graves, 2008; Pearson et al., 2007; Pressley et al., 2007). This repeated exposure will help build word precision, which means developing an understanding of when it would be appropriate to use the word (Phythian-Sence & Wagner, 2007). By interacting with a word multiple times via multiple activities, learning of words and the
relationships between them occurs. Zimmerman (1997) concluded that L2 (English as a Second Language) students who received periods of reading and interactive vocabulary instruction showed an increase in vocabulary knowledge. This finding may provide an understanding regarding the way words and vocabulary are mastered. By understanding the skills needed to learn vocabulary, word development has the possibility to transfer into other scenarios. Pearson et al. (2007) define transfer as a movement beyond the texts to which the original learning is tied. This can be done by teaching word learning strategies within a contextual environment, such as a game (Graves, 2008). Nagy and Anderson (1984) explain the instruction of vocabulary should emphasize skill development and strategy building to allow for the growth of independent word learning. It is essential to not just teach words in isolation, but instead to teach the concepts and skills behind learning and mastering new words with the ultimate goal of transitioning the new words into one’s vocabulary. By introducing functional and skill-based strategies for word learning in the English classroom, transfer applications emerge for application in other content areas within secondary classrooms (Harmon et al., 2008).

**Vocabulary Acquisition by Secondary Students**

New words are learned in a variety of ways in the secondary school context, for example, through reading literature (Baumann et al., 2007; Segalowitz et al., 1995; Withrow 2004). A main staple of most high school literacy curriculum involves vocabulary acquisition (Common Core State Standards, 2010; Iowa Department of Education, n.d.). Understanding and maintaining a strong vocabulary is essential for comprehending texts (Harmon et al., 2008). Unfortunately, with estimates at 88,500 word families known by ninth grade, there is no way they could all be covered by one teacher, which is where
supplementary out-of-class activities come in (Nagy & Anderson, 1984). Nagy and Anderson (1984) claim that due to the large number of words encountered in reading, the approach to teaching vocabulary must include methods that increase the capabilities for children in secondary schools to learn vocabulary on their own. Vocabulary instruction should use a variety of approaches, methods, and techniques (Allen, 1999). Webster and Hazari (2009) reported that secondary science students indicated they would like to have a greater number of opportunities to practice, organize, and strategize their vocabulary knowledge. Thus, students appear to need more opportunities for learning vocabulary inside and outside of the classroom. Zimmerman (1997) reported a similar finding where L2 (English as a Second Language) students wanted more opportunities to practice with new words and receive vocabulary knowledge more expansive than a dictionary definition provided. Mobile learning offers opportunities for secondary students to work more in-depth with vocabulary words in a variety of engaging formats in an individualized manner.

**Individualization**

The building of vocabulary is an individualization process. Every person has a different composition of vocabulary that connects with previous experience and knowledge (Pearson et al., 2007). In order to successfully build a vocabulary the individual’s needs and baseline knowledge need to be taken into account (Pressley et al., 2007). Every student starts at a different level, and by using a game this is taken into account. The game provides the scaffolding necessary to reduce errors and tailor the words encountered based on the individual’s knowledge. The individual possibilities provided by a mobile device and game are important to keep in mind since as Whitaker (2008) notes students need to learn more words than teachers have the ability to directly teach. Anderson, Wilson, and Fielding
(1988) found a direct correlation with the amount of time spent independently reading and the number of words known. The more time spent interacting with reading materials the larger the growth in reading skills, which includes a greater knowledge of words and more expansive vocabulary. The game allows the individual to interact on his own time with more words at the pace and level suited best to him.

The individualization provided via the game helps make the integration, clarification, and identification of new words more successful (Harmon et al., 2008). Using the game creates the opportunity for student-centered learning, where the encounters differ based on each student’s ability. Christensen, Horn, and Johnson (2008) note, “Student-centric learning opens the door for students to learn in ways that match their intelligence types in the places and at the paces they prefer by combining content in customized sequences” (p. 38-39). The combination of a game on a mobile device lets students learn vocabulary based on their personal preferences.

**Reading Comprehension**

The building of a strong vocabulary is a skill that is learned by students throughout their K-12 school experience, but as students enter high school and think about applying to higher education institutions, the need becomes even greater. One of the main components of the SAT and ACT standardized tests is a verbal portion that requires the test taker to read passages, answer vocabulary based questions, and write brief essays (Kaplan, n.d.). For example, the SAT asks the test-taker to choose the correct vocabulary word to complete a sentence (The College Board, 2011). A vocabulary that is advanced and developed becomes instrumental in success on these performance-based tests. Maughan, Messer, Collishaw, Pickles, Snowling, Yule, and Rutter (2009) examined students’ intelligence, reading ability,
and spelling, and how they interrelate and found a significant relationship between those classified as poor readers and the capacity of their spelling knowledge. This finding suggests that reading is directly related with spelling and vocabulary. If the meaning of a word is unknown in a reading context, there is a relationship with the ability to spell the word as well as comprehend the passage. Pearson et al. (2007) note the close relationship between vocabulary and comprehension. They (2007) conclude that vocabulary knowledge has a positive correlation of .6 and .8 with comprehension. Thus, the higher the level of vocabulary knowledge the better one will comprehend while reading. This is why the introduction of vocabulary and its related activities should take on multiple forms, such as multiple exposure to words, exposure to words in contexts, varied information about words introduced, connections among words, experiences, and prior knowledge displayed, and active participation throughout the entire learning process (Zimmerman, 1997). Maughan et al. (2009) emphasized that students who are characterized as poor readers and spellers as adolescents (age 14) when restudied thirty years later (age 44) displayed the same impairments and in some cases had even grown worse. Those who were identified as poor readers read less frequently, held a job where literacy was not of high demand, and earned a less advanced degree. Maughan et al. (2009) notes that one way to combat this progressive trend for poor readers of adolescent age is to increase their reading and literacy activities. A strong vocabulary and the skills on how to build one can lead to success in the different core subjects in school, performance on standardized tests, and future endeavors, such as post-graduate work.
Conclusion

Through the implementation of a mobile learning device and a gaming tool, learning meets the needs of today’s students of the learn anywhere and anytime movement. Vygotsky’s Zone of Proximal Development, Bandura’s Social Learning Theory, and Thorndike’s Theory of Law of Effect, provide the theoretical base explaining how learning expands outside the restriction of the classroom building and one teacher’s instructions by means of a mobile device. Students become actively in control of their own learning potential. The goal and intention of using this mobile device and game is to build up a student’s word consciousness, which is “an awareness of and interest in words and their meanings” (Baumann et al., 2007, p. 116). The use of word activities based on the secondary school curriculum and the way memory unfolds creates a supportive environment conducive for learning.

The design of the game holds great importance. It provides the structural element that houses the content material of vocabulary building. The design needs to take into account active learning essentials, game theory, future transfer implications as well as motivational principles. All of these elements together can encourage and contribute to the success of a player in the game.
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CHAPTER 3. THE POTENTIAL OF BUILDING HIGH SCHOOL STUDENTS’ VOCABULARY USING AN IPOD TOUCH AND GAMING APP

A paper to be submitted to *International Journal of Computer Game Research*

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**Abstract**

This research study focused on the potential of building 25 high school students’ vocabulary word knowledge through the use of a mobile learning device and gaming app. The use of a game as an instructional tool offers a portable way for students to engage with content. The amount of vocabulary mastered after playing the app on the mobile device was examined in relation to a pre-test and post-test that were completed three weeks apart. The aspects that were investigated involved the transfer potential of learning on a mobile device and the variation of performance levels. The implications that emerged involved the direct correlation with the pre-test score as a predictor for the post-test score. Also, the techniques used to play the app indicated that participants called upon the process of elimination and roots/word parts as tools to aid in the mastery of the vocabulary words. These findings point to the potential for incorporating a game as an instructional tool for vocabulary development.

*Keywords:* vocabulary, mobile devices, gaming

**Introduction**

As the world of technological innovations continues to evolve, so must the way these tools are implemented into the educational realm (Facer, Joiner, Reid, Hull, & Kirk, 2004; Rosen, 2010). These innovations have led to the development of mobile devices that create scenarios for informal learning to take place where students can learn anywhere and at any pace. In this study, the iPod Touch serves as a mobile learning device that allows high
school students to build their vocabulary knowledge. It begins by looking at their present vocabulary word knowledge as a starting point and tracking their growth of vocabulary knowledge over a three-week period. During the three weeks, students are gradually introduced to new words through a gaming application called the Vocab Challenge. This app involves mastering specific vocabulary words on a variety of formats, such as definitions, synonyms, antonyms, and connotations. Warschauer (2006) notes, “To move all students to high levels of learning and technology literacy, all students will need access to technology when and where it can be most effectively incorporated into learning” (p. 29). With ample opportunities for practice, this study examined how a mobile learning device along with a vocabulary application might establish a rich gaming environment conducive to the acquisition of frequently encountered vocabulary words found on the SAT exam for high school students.

**Literature Review**

The present study was designed to investigate how a portable media device (i.e., iPod Touch) and a gaming application (i.e., Vocab Challenge App) impact high school students’ vocabulary development and word knowledge over time. The word study strategies used by students that influenced vocabulary mastery were also explored. In this review of literature, the theoretical foundation behind the app’s design is investigated as it relates to gaming and good game design characteristics. Of equal importance is the understanding of the information processing model and how it applies to learning and mastering new vocabulary by means of a mobile device. Finally, through the use of a mobile device, the possibilities of
learning in an informal environment are further investigated as a tool to extend the vocabulary development that can assist high school students for later educational scenarios.

**Theory of Gaming**

The use of gaming as a pedagogical method is nothing new. What is new is using educational games on mobile devices so individuals can learn at their own pace on their own time. Lenhart (2009) notes that 74% of teens ages 12-17 own an iPod or Mp3. Nearly 97% of teens engage in game playing whether on a console, mobile device, web, or computer (Lenhart, Kahne, Middaugh, Macgill, Evans, & Vitak, 2008). Of particular interest is the incorporation of games into the school curriculum. Gaming is an activity that has been around for many years (Rose & Pentagram Design, 2010). Behind the activities and actions of a game rests a theory of gaming. Botturi and Loh (2008) describe, “Within game theory, the structural elements of a game exist as rules, turns, collaboration and competition, where winning, or fun, is modeled as numerical payoff. Game theory tries to explain *how playing (a game) works*, and defines games as an interactive process striving toward payoff” (p. 7).

Thus, a game provides the overall structure toward reaching a goal (Provenzo, 1991). The goal is the intended outcome of interacting with the game, which leads the player to acquire knowledge, perfect a skill, solve a problem, or modify an attitude (Steinberg, 1991). For example, the goal might be to master the skills needed for negotiating a union contract, and the game provides the scaffolds of an environment where the steps toward this skill are learned and practiced before applying them to a real life scenario (Steinberg, 1991). Also, in Schrier’s (2007) game on reliving history through the use of augmented reality, the players know from the beginning the goal of the game is discovering who fired the first shot at the Battle of Lexington. Through investigation and interaction with historical artifacts,
documents, and figures, the player is able to reach this goal. Knowledge of the goal from the beginning impacted the information the players sought out as they navigated themselves through the game world. There should be an alignment between the goal and the meaningful activities to be performed in order to keep the player motivated to continue playing (Shelton, 2007).

Game theory examines the human reactions within a gaming environment based on the information known (Levine, 2001). The design takes into account the typical patterns and actions performed by players. Games limit the amount of time, space, and resources a player encounters in order to allow him to come up with solutions through problem solving strategies (Holland, Jenkins, & Squire, 2003). Games need to provide a unique balance of challenge and inquiry without being too difficult to cause frustration. Game theory links together game design and learning as a process of testing frameworks for understanding (Holland et al., 2003). It is based on a series of decisions that are made impacting decision trees and rule strategies (Poundstone, 2006; Salen & Zimmerman, 2004). Each decision is made based off of an understanding of the rules and the subsequent development of a strategy that will lead to success. Every action made requires thinking about the course of action, choosing what to do, experiencing the action, and then reflecting upon that action before making future decisions (Paras & Bizzocchi, 2005). The decisions result in the formulation of branches creating a new path to progress through the game. A component necessary for good game design is getting the player actively involved in the co-creation of his experience in the game through his actions and decisions (Gee, 2005).
**Components and Features Necessary for Good Game Design**

Crawford (1984) explains that there are four components essential to designing a game. The first, representation, explains that a game is a closed formal system where there are rules. It is important the players grasp an understanding of the rules and what is expected (Berger, 2002; Hsu & Wang, 2010). Read (2000) notes when tasks are designed that can be easily understood by all students, they tend to do better. Clear, understandable rules help to lure in players and keep them playing. The second essential component of good video game design is interaction. This incorporates the players’ actions while in the game, such as generating causes and observing effects. This gaming component is always evolving depending on the player’s decisions. Each event encountered in a game has the ability to transform the player’s meaning of the information in some way (McAllister, 2004). A game needs to acknowledge each move and action that the player makes (Birdwell, 2006). The third component essential to designing a game involves conflict. This can be active or passive and builds upon the struggles endured while facing obstacles toward a goal (Berger, 2002). The final component essential to the design of games requires that games provide a safe way for real-life activities to be experienced. For example, the Nintendo Wii game, *Trauma Team*, allows the player to take on the role of a doctor and complete a variety of real-life tasks, such as surgery and diagnosis (Nintendo, 2010). Games allow for mistakes or missteps to happen in a controlled environment.

As players enter a game, they bring with them varying levels of prior knowledge and skills related to gameplay. In addition to these four essential components of game design, games also need to possess certain features that will stimulate students’ engagement and
motivation. Common features required in most games include active participation, offering constructive feedback, and encouraging repeated interactions.

Successful games usually encourage active, discovery learning while possessing a unique balance of competitiveness and enjoyment (Blachowicz & Fischer, 2008; Child, 1993; Gee, 2008). The most successful gaming programs are learner initiated, learner controlled, and intellectually engaging (Jonassen & Reeves, 1996; Nitsche, 2008). Games that require active participation by the player treat learning as an active and constructive process (Kittl, Edegger, & Petrovic, 2009). The player’s decisions and actions within the gaming environment directly affect future encounters in the game thus the player’s active participation is essential (Nitsche, 2008). Ryu and Parsons (2009) note that active participation in learning permits the learner to test ideas and approaches based on prior knowledge and experiences, and then the learner can apply this knowledge to new situations. A successful game builds on the user’s previous knowledge and takes it to a new level of intellectual stimulation and engagement. One important feature of a game is its ability for allowing a player to interact with the game design by having the player’s actions affect the progression of the game (Berger, 2002; Birdwell, 2006). Besides promoting active participation, the design of a game also needs to offer feedback to the player.

A second important feature in game design involves the development of a program that offers feedback. Feedback includes providing overall results, correct answers, and a rationale for why a response is wrong (Child, 1993; Steinberg, 1991). This game feature is the message or display presented once a response is made (LeBlanc, 2006; Steinberg, 1991). In terms of feedback design, games can be broken down into four items. This includes the game state, which is the present status or location a player is located in. It also includes the
scoring function, which is the rule that tracks and measures the player’s actions. Another item is game mechanical bias, which is the rules that are built into the game and triggered by the player’s actions. The fourth item is the controller, which is the device used to put the rules into action (LeBlanc, 2006) (see Figure 1).

Figure 1. Feedback loop within a video game

These four items collectively create a feedback loop when coupled with a player’s responses. Then information provided via feedback allow the player to re-experience activities in the game and make alternative choices. Games have the ability to provide a feedback loop by having game play immediately followed by feedback (Haslerud, 1972). The feedback provided through games allows for the development of skills that can be transferred to either later scenarios in the game or to operational environments (Dempsey & Sales, 1993). Games thus allow for remediation to take place depending on the responses generated (Steinberg, 1991). If a player is challenged or makes an incorrect choice, he rehearses alternative approaches based on the feedback provided in order to learn from the mistakes (Holland et al., 2003). Besides feedback, another feature of successful game design is the number of opportunities allowed for repeat interactions.
Repeat interactions, best defined as practice, allow for multiple opportunities of engagement with material. Hunter (1995) explains, “Successful planned practice involves decisions of ‘how much,’ ‘how many times,’ and ‘how often’” (p. 35). The number of interactions with information in a game is critical for bringing about memorable connections. This can in turn change the learning pattern and structure of later interactions in a game. Child (1993) explains how habits, response patterns elicited by certain stimuli, can be acquired through repetitive practice activities. Through intensive practice scaffolded by a game, the learner is able to acquire content knowledge as well as the overarching skills required to reach mastery. In a study conducted at the Center for Teaching - Learning Mathematics (2004), researchers found that when 6th grade students were given the game *MugginMath* to learn and practice algebraic reasoning and spatial sense, they significantly outperformed their peers who did not play the game. The game allowed them to gain greater mathematical confidence, strategize, and solve multi-step problems through repeat interactions with the mathematical material. By selecting games relevant to authentic learning tasks, the practice of the skills used to solve the problems become learned while simultaneously learning the content of the game itself, which is why the games selected should relate to topics relevant to authentic learning tasks (Hsu & Wang, 2010). Games provide a way to transfer the learning typically only occurring during school hours to occur in other environments.

**Gaming as an Informal Learning Environment**

Harnessing the power of gaming brings about new learning opportunities for students. Shaffer, Squire, Halverson, and Gee (2005) explain that games will not replace learning in schools, but rather offer ways in which more powerful modes of learning can be incorporated
anywhere and at anytime. Computer and video games offer new approaches to learning material in an individualized, interactive, and guided environment (Child, 1993). Gaming environments give players chances to fail safely (Squire, 2005). This means players can work in a “free zone” where only the game exists without the pressures of the external factors of grades and mandatory work (Botturi & Loh, 2008, p. 9).

Learning within a gaming environment might be considered informal learning. Informal learning happens through engagement with intentional, but not too structured, activities that are completely controlled by the learner (Marsick & Watkins, 1990). This type of learning occurs through daily experiences and educational influences that happen in the players’ own environment (Conner, 2009). Peters (2008) notes an essential characteristic of informal learning is that it provides a place where the majority of learners have success, build confidence, and gain valuable knowledge vital for skill and interest development for future endeavors.

Games on mobile devices support learning to happen anywhere by allowing learning to transpire in a combination of physical, digital, and communicative space (Facer et al., 2004; Rogers, 2009). Taking learning out of the structured environment of a typical classroom with limited time periods and expanding it onto mobile devices that tap into the unrestricted realm of after school time and weekends at any location has the potential to engage learners even more (Bongey, Caizadlo, & Kalnback, 2006; Putman & Kingsley, 2009). Caronia and Caron (2009) studied the use of iPods by students. They reported the majority (44%) of use of this device for academic purposes occurs at home. Engaging in educational activities on a mobile device helps to relate to the interests and needs of young
people growing up in a technologically mediated environment as well as offer opportunities for multitasking (Rosen, 2010).

No physical environment limitations exist in the world of gaming due to the mobile device’s small size and easy portability. Mobile device usage is self-selected and flexible without bounds of time and space (Goodyear, 2008). Ching, Shuler, Lewis, and Levine (2009) note mobile technologies are familiar, ubiquitous, and relatively low cost tools that can help transition formal and informal learning from inside to outside the classroom in a seamless manner. Playing a game on a mobile device allows for learning to occur whenever and wherever the player wants. Ryu and Parsons (2009) describe mobile game-based learning as an individual activity occurring on an engaging pedagogical medium. The engagement in the learning process is essential when the goal is to master knowledge and skills to be later applied in other scenarios. Kittl, Edegger, and Petrovic (2009) conclude that mobile games can be used for transferring knowledge learned from the virtual world to the real world.

The one-on-one capability of playing a game on a mobile device allows for the individualization of the learning experience to occur. The interactions with the game are tailored to the individual playing it. Ching et al. (2009) note that mobile devices possess the ability to accommodate a variety of needs and learning styles that learners possess. They encourage the actions of personal engagement, satisfaction, and a highly motivated learning process without the restrictions of a certain geographical location (Kittl et al., 2009; Ryu & Parsons, 2009). Gaming on a mobile device permits the active construction and creation of new learning situations that begin within the game and transfer to other situations.
Gaming and Transfer

Knowledge of mastering certain skills in one scenario and then implementing them in another brings about the idea of transfer. Haslerud (1972) defines transfer as the change in ability in one activity based directly on the experiences endured while performing a related activity. Through gaming, skills are learned and experienced, which can then prepare the player for future learning and problem solving in other related domains (Gee, 2003). Loftus and Loftus (1983) explain, “The reliance of motor skills on higher-level goals is obviously beneficial when video games are being played because it means that once a particular skill has been learned, it will transfer to slightly different physical configurations of the same game” (p. 69). Skill knowledge is one component that is learned in gaming that can be later transferred to other scenarios. For example, it is documented that individuals who have taken a virtual driver education course will transfer the skills learned within the online training program to real driving experiences (Virtual Driver Interactive, 2007). Hyltander, Liljegren, and Rhodin (2002) found that the skills learned from a laparoscopic simulator can be transferred into the operating room. Through ample opportunities for practice, skills used to solve early problems and misconceptions can be used, adapted, and transformed in order to solve later problems (Gee, 2003).

Transfer involves taking things learned from past experiences and applying them to the present (Hunter, 1995). It is a combination of linking ideas and skills previously acquired with new information. Hunter (1995) explains when a concept already learned coincides in some way with a new one, it will help with acquisition and memorization. The impact of learning particular skills in the gaming environment and then having the ability to take these skills mastered to broader contexts revolves around the process of transfer.
Gaming and the Information Processing Model

Gaming involves decision-making. Kremers (2009) defines games as “a series of interesting choices” (p. 4). The decisions made are based on current knowledge and previous experiences endured in a game. This combination of knowledge and experience can also be referred to as memory. Moving information from just one experience into memory involves the active actions of acquiring, retaining, and recalling (Child, 1993). These actions are explained by the information-processing model (See Figure 2).

Figure 2. Information-processing model (Vockell, 2001)

This model involves three stages. The first, encoding, is when information is first put into memory; the second, storage, involves the methods used to retain the information; and the third, retrieval, requires recovery of the information from the memory (Child, 1993). The active retention of information into memory is enhanced by using a game that provides a rich and flexible media to represent what is known and what is being learned (Kirkley & Kirkley, 2004).
The activities in the game can serve a dual role. In one role the game provides new information, but on the other hand, its other role can serve to test that the information is being retained. Haslerud (1972) noted, “Efficient methods of establishing a retrieval set during learning so that, with an adequate cue, the item or relation can be reconstructed include the following: good discrimination and identification; optimal motivation; attention to the relatedness or meaningfulness of the material; spaced study and review; and especially the intent-to-retrieve” (p. 128). Gaming as an education tool can allow for overlearning, which is learning that goes beyond just the recognition of the word (Haslerud, 1972). The act of overlearning allows for connections and patterns to be recognized to the point of understanding.

The use of a mobile device to complete the game plays a role in the memorization of the information presented. Willingham (2006) states the material that remains in a learner’s memory is not only what was presented, but includes what the learner thought about at the time when the information was presented. This is where the mobility of gaming comes into play. The game player has the opportunity to change his geographical location in order to maximize the amount of attention to be paid to the game’s content. Through this, the player can learn to avoid distractions and hold and control attention (Haslerud, 2009). Doolittle, Lusk, Byrd, and Mariano (2009) describe attention as an essential component to computer-based learning. In a study with undergraduates using an iPod video tutorial (how a car brake works), these researchers observed some students remaining stationary while using the iPod while others were mobile. They (2009) concluded that those who were stationary were able to retain more and possess more recall of the topic when tested on the information. The
impact of attention being placed upon completing one task without having to divide it into another task simultaneously can impact the learning potential.

Games need to gather and maintain the player’s attention through visual experiences and audio designs (Kremers, 2009). For example, Hyde and Jenkins (1969) required all study subjects to listen to words every two seconds, where some participants rated the pleasantness of the words and others just counted the number of times the letter E appeared. Those performing the pleasantness ratings had stronger memories, which implied thinking about the meaning of the terms and not just the physical structure of them aids in the memory process. The process of making meaning can be derived out of a well designed game where the context to be encountered is built with signs with significance that can be interpreted by the player to build his own meaning (Salen & Zimmerman, 2004).

**Vocabulary Development, Word Knowledge, and Gaming**

Terminology and words used in games have the capability to tap into various content areas. Blachowicz and Fischer (2008) note, "Games and word play can provide a context in which students can enjoy word learning and develop word consciousness" (p. 50). Games provide a way for words to be presented in an organized manner that can extend the school day and amount of time spent working in a content area. Nagy and Anderson (1984) note that direct vocabulary instruction can only cover a small percentage of the words that children should actually know. An average high school student knows 45,000 words (Pinker, 1994). This number is small in proportion to the number of distinct words present in language, which Nagy and Anderson (1984) estimate to be around 88,500. Since more words must be learned than one teacher can teach, vocabulary enriched games might fill this instructional gap.
Interactions in the gaming medium allows for the mastery of content in a personalized manner. Cobb (in press) explored the personalization principle within the gaming environment of the Nintendo DS game My Word Coach. In this study, 50 students explored the impact a game can have on vocabulary development. Cobb (in press) states, “The large amount of material to be covered, the likelihood of strong individual differences in both goals and learning rates, and the need for recycling and record-keeping were identified early on as reasons to look to computerized instruction” (p. 3). In this case, the gaming environment provides a personalized experience that would probably not be possible in a traditional classroom. The game begins by testing the learner in order to place them in the correct word difficulty level. Then the player interacts in multiple mini-games with the requirement of working with the same words at least 5 times on a daily basis. Cobb (in press) concludes after two months of game play, there was a 10 to 20 percent increase in vocabulary recognition and an 18 to 36 percent increase in speed of lexical access. These results indicate that this method of practice and repetition with gaming has promising potential to assist learners in memory retention and vocabulary building.

All content areas are constructed and built up with words and word knowledge. Words can be defined as a “rote-memorized chunk: a string of linguistic stuff that is arbitrarily associated with a particular meaning” (Pinker, 1994, p. 142). Words can be studied in a variety of formats. Zimmerman (1997) notes successful approaches to learning vocabulary must be multifaceted in the demands placed on the learner and also must include deep explanations about the target words. One approach words can be learned is by reviewing definitions. McKeown (1991) describes a definition as a way to capture the essence of a word by encompassing all possible applications of a word. A definition serves
to identify and summarize the conceptual meaning of a word (Yule, 1996). Another approach to learning a word is through association. This can involve associating a meaning—a connotation—to a word. One example of association would be the thought of pain when the word needle is introduced (Yule, 1996). Association can also link words with previous experiences. Murphy (1991) explains people make better connections with new things if they draw connections to things they already know. When readers make connections to prior knowledge, the comprehension level increases (Teachervision, 2010). Words are not independent ideas, but rather are tied together between student experiences and prior knowledge (Zimmerman, 1997). Through these logical chains of reasoning the linkages are formulated (Haslerud, 1972).

Vocabulary acquisition should include methods and activities that will allow learners to learn words on their own (Nagy & Anderson, 1984). The strategies used may differ based on an individual level. For example, Barron (1980) found that good and poor readers differ in the strategies used in spelling. It may prove helpful to note the differences and offer alternative modes of learning. A variety of vocabulary building activities must be introduced in an educational environment so all types of learners can achieve success and build their vocabulary word bank. Once a successful strategy is discovered, it can be applied in new scenarios with new words (Gee, 2003).

Typically, gaming on a mobile device provides players with a chance to play at their own pace, at their own level, and during their own time. Using gaming to acquire vocabulary may create a way to extend the classroom day to an unlimited number of hours with limitless geographical boundaries. This study explored the effects of using a game on a mobile device
with the purpose of improving vocabulary knowledge as well as the skills behind the mastery of vocabulary development.

**Methodology**

Before any part of this study began, approval was obtained from the University’s Institutional Review Board (see Appendix A). Once approval was granted, the various components of instrument development, recruitment, and data collection began. Each research component developed was connected with the study’s three research questions.

**Research Questions**

This study investigated the impact on using an iPod Touch App. called the Vocab Challenge with high school students. Using a research design, this study explored the growth and transfer of high school students’ vocabulary from pre-test to post-test. The major research questions explored were the following:

(1) How does a portable media device (i.e. iPod Touch) and a gaming application (i.e. Vocab Challenge App) impact high school students’ vocabulary development and word knowledge over time?

(2) How do certain word study strategies influence students’ success in vocabulary mastery?

(3) Based on high school students’ self-perceptions, what impact does a mobile device have on learning vocabulary?

**The App: Vocab Challenge**

This study examined possible implications of using a portable media device, such as the iPod Touch, as a means to facilitate the mastery of vocabulary words. An iPod Touch is
a portable media device made by Apple Inc. This device operates by means of the user touching the screen. The activities performed on the device include things such as listening to music, downloading applications, storing files, surfing the Internet, and taking pictures (Apple, 2010). Using this as the hardware component, the software used for this study was the Vocab Challenge App. Apps are applications made by third-party developers specifically for use on portable media devices (Black, 2010). This application is a vocabulary game that consists of 250 vocabulary words most commonly found on the SAT test, a standardized test for college admissions in the United States. This game involves the user working with a particular vocabulary word until mastery. This can only occur through correct answers on the synonym, antonym, connotation, and definition activities. Thus, mastery of a word only occurs after correctly answering a word on all four criteria. Proficiency of the word must be displayed before the player can move on to new words.

The Vocab Challenge App was developed by Modality. This company specializes in making digital learning, assessment, training, and reference software for Apple mobile devices. The company, founded in 2006, is comprised of educators, technologists, and designers (Modality, 2010). The app was designed in conjunction with The Princeton Review. The 250 words in the app were selected from the Hit Parade’s list of words most frequently tested. The goal was to incorporate fun and learning into a mobile app for students preparing to take the SAT exam.

The app itself was designed based upon the concept of mastery. This meant that in order to display knowledge and understanding of a word, it must be correctly answered in more than one instance. Through this idea of repetition and practice, the player had to interact with each word a minimum of four times, once with each game. The four games that
appear in the app include the following vocabulary components: synonym, antonym, definition, and connotation. Synonym required removing any words that were not similar, antonym required removing any words that were not the opposite, definition required the removal of the words that the definition did not belong with, and connotations required determining whether or not the word had a positive or negative meaning. Each game included a total of twenty items and for each item gave a series of three choices with only one being correct. The games were designed to reinforce the training aspects for the process of elimination. This was done by requiring the removal of the incorrect answers off the screen and leaving the one that was correct. While designing the app, Modality (2010) spent extra attention to create viable distractors, so that the correct answers would not be too obvious without a really good grasp on the meaning of the word itself (see Figure 3).

![Typical game screen layout](image)

*Figure 3. Typical game screen layout*

Each of the four games were similar in font, color scheme, and layout. This helped with consistency of locating features and presenting only the necessary information without being bombarded with other distracting items.
The design of the Vocab Challenge App also included multiple features to engage the players. In order to play, the player needed to use his finger on the touch screen to make selections. The player also could shake the iPod Touch to answer or pass an item. Throughout the game, points were earned based on the consistency of correct answers and the time that it took to do so. The number of points earned varied depending on the quickness of the response. As soon as an item would appear, the clock would start ticking down from ten seconds. The closer to ten seconds that it was correctly answered, the more points earned. This meant that if the item was correctly answered in 1-3 seconds, 100 points would be earned, but if it was incorrect, 25 points would be deducted. If the item was correctly answered within 4-6 seconds, 80 points would be earned, but if incorrectly answered, 20 points would be deducted. If a word was passed or not answered at all, no points would be earned or lost. As many words as necessary can be passed. The words show up on the summary screen without a check mark for being correct or an x for being wrong, but rather without a mark at all. The item will need to be repeated in that game again and correctly answered before the player can move on.

Data Collection Tools

Three instruments were used in this study to collect data from participants. Demographic surveys were used to gather baseline information about each participant at the beginning of the study and then again at the end of the study to gather information regarding their personal experience with the iPod Touch and app. A vocabulary test was used at the beginning of the study and at the end to discover each participant’s knowledge and understanding of words. The third instrument was a daily log form that participants used to keep track of their usage and progress from using the Vocab Challenge App.
Demographic Surveys

Two demographic surveys were administered to participants. Both surveys were created using an online software program that allowed for a combination of question types, such as short answer and multiple-choice. The first survey, *Vocabulary Acquisition via iPod Touch 1*, was administered at the beginning of the study. The questions for this portion were designed to gather some basic demographic data about each participant. This included items like year in school, age, ethnicity, primary language, previous ACT/SAT materials used, familiarity with an iPod Touch, and frequency of use related to different technologies (see Appendix B). The design of the demographic questions was based on questions that appear on the *National Survey of Student Engagement* since these questions have been specifically designed to gather the demographic information of student populations (Indiana University Center for Postsecondary Research, 2009). The frequency scale was based upon the work on Fowler (1995) who provided helpful techniques of designing survey questions as well as items used in the *Survey of Technology Use at Penn State by Faculty, Staff, and Students* (Sonak & Williams, 2008) and the *Illinois Instructional Technology Data Portal* (Oyer, 2009).

The second survey, *Vocabulary Acquisition via iPod Touch 2*, was administered at the end of the study (see Appendix C). This survey collected data about the participants’ overall experience with the iPod Touch and the Vocab Challenge App. It included items about level of difficulty using the iPod Touch, overall experience using the Vocab Challenge App, helpfulness of the feedback the app provided, emotions felt while playing the app (Bakera, D’Mello, Rodrigoc, & Graesser, 2010; Gow, Cairns, Colton, Miller, & Baumgarten, 2010), and techniques used to figure out the different vocabulary words (Allen, 1999). These
questions were all multiple-choice format. There were two final short answer questions where participants could write a brief descriptive explanation of their overall experience with the app, and also they could discuss any suggestions for redesigning the app. Collectively, these two surveys gathered data from the participants that documented their experiences using the iPod Touch and the Vocab Challenge App.

Vocabulary Tests

The Vocab Challenge App contains 250 words. The first time the app was opened it would draw from only the first 50 to 100 words in the list. In order to simulate what this would be like, the researcher went into the app as a player. She played each of the four games once and created a document noting the twenty word items encountered in each game (see Figure 4). This meant a list of eighty word items were created. The items noted included the question and the three possible answer choices for each. From this list, she then took out the duplicates and copied down the first forty words encountered (first 10 of each type minus the duplicates) breaking it into the four different game types. This left 10 questions based on synonyms, 10 questions on antonyms, 10 definitions, and 10 connotations. Then based upon the answer sheet provided by Modality, the researcher recreated these items as the test that was administered to university students.

Figure 4. Vocabulary test creation process
University students who were enrolled in one of three courses for teacher education majors at a large Midwestern University were asked to complete the vocabulary test. The undergraduate courses selected focused on incorporating technology into teaching. These students were targeted because many had recently taken or were about to take the PPST: Pre-Professional Skills Test for Teachers. This test possesses similar components to the SAT and ACT in terms of vocabulary development and reading comprehension. For example, the SAT asks the test-taker to determine the correct vocabulary word in the context of a reading passage (The College Board, 2011). Some students received the invitation to voluntarily participate by email while others were asked to participate by a professor announcing it at the end of a class period. Students were asked to complete the 40-item multiple choice vocabulary test, which would took them approximately twenty minutes to complete.

Sixty-two university students voluntarily participated and completed the forty-item vocabulary test (see Appendix D). One participant did not complete the entire vocabulary test and was removed from the results calculated. All responses remained anonymous and in no way could be linked to the participants. It required reading through questions about antonyms, synonyms, connotations, and definitions and then selecting a choice. For example, the first section asked the participant to match the definition to the correct word (i.e., definition: vacant, lacking ideas or intelligence, answer choices: nonsensical, abstracted, vacuous). The results of the test were used to determine the difficulty level of the words. Based on the participants’ answers, information about each individual word was acquired to allow for the creation of the two vocabulary tests that were used later in this study. Overall, these results helped validate the instruments, pre-test and post-test, that were used by the high school participants during the study.
Ultimately, this 40-item vocabulary test was split into two twenty-item tests of equal difficulty, one of which became the pre-test and the other the post-test. The mean score on the 40-item test that was taken by the sixty-one university students was 65.33%. Specific steps were then followed to design a pre-test and post-test of equal difficulty. The test consisted of 40 questions, which was divided up into 10 questions based on synonyms, 10 questions on antonyms, 10 definitions, and 10 connotations. First, each individual test item was analyzed by determining the percentage of participants who answered it correctly. These values ranged from 100% (every participant answered it correctly) to 16% (only about 10 participants answering it correctly). Based upon these numbers (percentage correct), the pre-test and post-test were created. Five questions of each type (synonym, antonym, definition, and connotation) were placed on each test depending on the difficulty level. The questions selected to be on the pre-test and post-test needed to include similar correct percentages. For example, for the definition section, the pre-test included the correct percentages of 93, 32, 72, 72, and 41 (total equals 310), and the post-test included the correct percentages of 100, 29, 90, 55, and 40 (total equals 314). This same process was completed for the remaining questions to develop a pre-test and post-test that contained questions of similar difficulty level resulting in similar overall percentages (see Table 1).

To test for reliability, Cronbach’s alpha was computed resulting in a reliability coefficient of 0.65 on the pre-test items and .62 on the post-test items, meeting the minimally acceptable level (> .60) of consistency among items (Klassen, 2004). Finally, questions were then inserted into the pre-test and post-test by means of an online software program. The resulting 20-item vocabulary pre-test and post-test were used by the high school students during the study.
Table 1

Correct percentage values pre-test and post-test

<table>
<thead>
<tr>
<th>Question Type</th>
<th>Question 1</th>
<th>Question 2</th>
<th>Question 3</th>
<th>Question 4</th>
<th>Question 5</th>
<th>Average Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>93.4%</td>
<td>32.8%</td>
<td>72.1%</td>
<td>72.1%</td>
<td>41.0%</td>
<td>62.3%</td>
</tr>
<tr>
<td>Post-test</td>
<td>100.0%</td>
<td>29.5%</td>
<td>90.2%</td>
<td>55.7%</td>
<td>41.0%</td>
<td>63.3%</td>
</tr>
<tr>
<td>Antonym</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>42.6%</td>
<td>65.6%</td>
<td>50.8%</td>
<td>34.4%</td>
<td>59.0%</td>
<td>50.5%</td>
</tr>
<tr>
<td>Post-test</td>
<td>42.6%</td>
<td>65.6%</td>
<td>49.2%</td>
<td>57.4%</td>
<td>39.3%</td>
<td>50.8%</td>
</tr>
<tr>
<td>Synonym</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>95.1%</td>
<td>68.9%</td>
<td>98.4%</td>
<td>37.7%</td>
<td>45.9%</td>
<td>69.2%</td>
</tr>
<tr>
<td>Post-test</td>
<td>96.7%</td>
<td>67.2%</td>
<td>16.4%</td>
<td>78.7%</td>
<td>75.4%</td>
<td>66.9%</td>
</tr>
<tr>
<td>Connotation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>98.4%</td>
<td>59.0%</td>
<td>96.7%</td>
<td>70.5%</td>
<td>86.9%</td>
<td>82.3%</td>
</tr>
<tr>
<td>Post-test</td>
<td>93.3%</td>
<td>59.0%</td>
<td>91.8%</td>
<td>100.0%</td>
<td>54.1%</td>
<td>79.6%</td>
</tr>
</tbody>
</table>

*Daily Log*

A daily log form was created using Google Forms so participants could keep track of their daily game usage (see Appendix E). Google Forms provided an online access point where participants could track their daily usage with the Vocab Challenge App. Each day the app was used, the participant would go online and enter certain data such as, their ID number, amount of time played, where played, number of new words mastered, and would copy down the information off the game stats section of the app.

*Research Context and Participants*

The context of the study and the participants involved centered around two locations: local high schools and university campuses. Participants were actively recruited at their high
school and then the participation in the study took place on the university campus or another location agreed upon by the researcher and each participant.

Recruitment

Multiple steps were taken to recruit the high school students for the study. This primarily involved getting permission from the local school districts. For students in one high school, High School 1, permission was sought and granted from the research committee of the school district. Next, an email was sent out to three local high school English teachers. The email provided the teachers with background information about the study and requested permission for the researcher to come into their classes to introduce the project to high school students. Based upon teachers’ feedback, a schedule was created that included visiting a total of six 10th and 11th grade English classes. The researcher chose to speak with the potential participants in person in order to make it more personal in hopes of having a higher participation rate. In each class the researcher gave a brief presentation that explained the study, answered students’ questions, and passed out flyers to students who expressed interest. The flyers highlighted basic study information (tool to assist in the preparation for the ACT and SAT exams), noted the researcher’s contact information (email and phone number), and discussed possible compensation (i.e., entered into a drawing, free app) (see Appendix F). Students did not need to own an iPod Touch to participate because there were a limited number available that they could borrow from the researcher. Students were encouraged to take the flyers home and share them with their parents. The parent or student then contacted the researcher though email or by phone in order to answer any remaining questions and to set up a time to meet and begin participation in the study.
For the other high school, *High School 2*, similar procedures were followed. First, the researcher met with the school counselor where the details of the project were discussed. The counselor then contacted the high school principal who gave permission for the researcher to recruit students for the study in the district. Next, an announcement was made at the school that any students interested in participating should contact the counselor. The counselor then met with the students and gave them a copy of the consent form. The researcher scheduled a time to come to the school and meet with these students. They met in the computer lab during the homeroom period. The participants first turned in the signed consent forms. Next, their contact information was exchanged, in case any questions arose during the course of the study. Then, they logged onto the computers and took the vocabulary pre-test and completed the *Vocabulary Acquisition via iPod Touch 1* demographic survey. The researcher then showed the students the app, noting how to play the games and also the statistics section. Next, the daily form was reviewed as a way to track their usage during the next three weeks. Next, those participants with their own iPod Touch received the $5.00 to purchase the app. The other participants borrowed an iPod Touch on a rotating basis over the next two months. At the conclusion of the three-weeks, a reminder email and phone call went out to all participants asking them to enter one final log and remind them to go to the computer lab the following day. The participants then on the designated date and time returned to the computer lab to take the vocabulary post-test and *Vocabulary Acquisition via iPod Touch 2* survey. Those who borrowed iPod Touches also returned them at this meeting.

*Participants*
The participants were enrolled at one of two high schools. One was a large suburban high school with approximately 1,451 students in grades 9-12. The high school has a graduation rate of 93% and last year 13 students were named as National Merit Finalists in the National Merit Program. Students from this school who take the SAT and ACT tend to exceed state and national averages with an average ACT score of 24.8 and SAT score of 1261. During the 2009-2010 school year, the number of free and reduced lunch students was approximately 18.8% of the entire school population. The other was a small rural high school, High School 2, with approximately 360 students in grades 9-12. The high school had a graduation rate of 100% during the 2009-2010 school year. Students from this school had an average ACT score of 24.2 with 13% scoring over 30. During the 2009-2010 school year, the number of free and reduced lunch students was approximately 5.2% of the entire school population.

The target population of this study was 10th and 11th grade students, but the participants ranged from grades 9 through 12. Many students in these grades are studying and preparing to take the SAT or ACT exam, thus this app offered another tool to assist them in their preparations. Thirty-one students participated in the study. Once the data were collected and reviewed, it was revealed that six participants did not log any usage with the iPod Touch and app. These participants were excluded from the data analysis. This left a sample of 25 students (9 males, 16 females) from two high schools that participated in the study. From this study group, 11 (3 male and 8 female) belonged to High School 1 and 14 (6 male and 8 female) belonged to High School 2. The age of participants ranged from 14 to 17 with an average age of 16. The average GPA of the students at High School 1 was 3.96 (on a 4.0 scale) and High School 2 was 3.73 (on a 4.33 scale). The majority of participants were in
11th grade: with 8% (n=2) in 9th, 24% (n=6) in 10th, 60% (n=15) in 11th, and 8% (n=2) in 12th. The students were from a variety of ethnic backgrounds with the majority most closely identifying with Asian American/Asian and Caucasian (see Figure 5).

Since the Vocab Challenge App is designed as a tool to use for preparing for the SAT, it was also important to note which participants had previous experience using SAT or ACT preparation materials. Overall, only one had taken a formal preparatory course. A larger percentage, 32% or eight participants, had used some other materials, such as the *Collegeboard* SAT prep book, *The Real ACT* book, *The ACT Practice* book, *ACT Princeton Review* Standard Study Book, and the *Kaplan* Review Book. There were still a large number of participants, 64% (n=16), that had not used any previous SAT or ACT study materials. Also, only five participants had previously taken the SAT or ACT prior to their participation in the study.

![Figure 5. Ethnic background of participants (n=25)](image)

The participants varied in their ownership of an iPod Touch. Seven owned their own iPod Touch while eighteen did not. Out of all the iPod Touch owners, there were very few,
29% (n=2), that had actually downloaded or purchased educational apps. Some educational apps owned included human anatomy, Spanish dictionary, and dictionary/thesaurus.

**Research Procedures**

Participation in the study lasted for three weeks and involved two sessions where each participant met with the researcher. After recruiting participants, parents would email or call the researcher to set up a time, date, and location for an initial meeting. These initial meetings with individual participants and their parents occurred either on the university’s campus or at another location agreed upon, such as the family’s home. The parent(s), participant, and researcher all were present at this meeting. First, the parent(s) and participant received a consent form, which they read and signed (see Appendix G). The participant was then given a unique ID number and letter to use throughout their participation in the study. For example, depending on the participant’s number, they were given the corresponding letter in the alphabet (i.e., 1a, 2b, 3c, etc…). This participant ID number was used to track the usage characteristics while each participant used the app and for the vocabulary pre- and post-test results.

The participant also completed two brief online activities during this initial meeting. The first activity involved taking the twenty-item, multiple-choice vocabulary pre-test. This pre-test involved choosing the best answer for questions that fell into the following four categories: antonym, synonym, definition, and connotation. Once completed, the participant then answered a brief online survey entitled, *Vocabulary Acquisition via iPod Touch 1*, that gathered information, such as demographics and technology usage practices (i.e., year in school, iPod Touch comfort level, and frequency of use of different technologies).
Once these two activities were completed, the participant was introduced to using the iPod Touch and to accessing the Vocab Challenge App. For those students who already owned an iPod Touch, they were able to participate immediately and were given the money (i.e. $5.00) to purchase the app and download it onto their device. Those students who needed to borrow one participated on a rolling basis since there were a limited number of iPods that could be borrowed. Together, the researcher showed them the home screen and the screen where the game’s statistics could be found. Next, the researcher went through one of the four games in the app with the participant. The researcher showed them how to play, using his/her finger on the screen to make selections (see Figure 7).

![Game screen of Vocab Challenge App during antonym game](image)

**Figure 7.** Game screen of Vocab Challenge App during antonym game

The participant learned how the screen would produce a green frame when a correct response was given and a red frame when given an incorrect response. The timer was also highlighted as it would count down from ten seconds for each exercise and how answer speed would relate to the points earned. For example, the closer to ten seconds that the item
was correctly solved the more points the participant earned. If an item was incorrect, points were taken away, and if no response was made, the item would be passed.

After the game was completed, the summary page was reviewed (see Figure 8). This page provided a summary for the words previously encountered in all the games. The page displayed a green check mark if the item was answered correctly, a red X if answered incorrectly, or was blank if it was not encountered in a particular game yet. The participant could view the correct answer for each vocabulary item by touching the small letter “i” circle by each word. This action would open an information menu about the word. The following details would be available: correct pronunciation, definition, synonym, antonym, connotation, and a sample sentence.

![Index of Words](image)

*Figure 8. Word summary screen following game play*

Once the participant understood the details of the app, the researcher referred him/her to a web location where the Daily Log Form was located. The Form was reviewed by the participant and the researcher to note the information required, such as, the participant’s ID number, date, amount of time played, locations where played, and app game statistics (see
Appendix E). The participant was given a small paper with the URL address on it and an email was sent to the participant with the same link following the session. The participant was then instructed to use the app as much as possible for the next three weeks, but there was no specific amount of time stated that they needed to use it each day. The researcher stressed that the Daily Log Form was to be completed each day the app was used. Finally, any remaining questions the parents or child had regarding the study were answered. For example, a common question asked was whether or not the child had to use the app everyday. Also, a date and time were scheduled for a follow up session, which was written on a card and also an email was sent as a reminder (see Appendix H).

For the next three weeks, the participants used the Vocab Challenge App and tracked their daily progress using the Daily Log Form. Periodically, the researcher checked to make sure the participants were filling out the form. If they were not, an email was sent reminding them to do so. At the end of the participant’s three-week session, a follow-up meeting was held. An email reminder was sent out to each participant a few days prior to remind the participant about the meeting.

The follow-up meeting occurred in two ways. Those participants who owned an iPod Touch were given the options of meeting again face-to-face to complete the final two, online activities or they could complete the activities on their own. The format of this meeting was determined at the first session and agreed upon among the parents, child, and the researcher. This method proved helpful for some, since high school students’ schedules become very busy as the school year unfolded. Those participants, who did not own an iPod Touch or preferred the face-face interaction, met again with the researcher for thirty minutes.
Regardless of the format selected for the follow-up meeting, both groups completed the same two activities. The first activity required the participant to complete the twenty-item post-vocabulary test. After completing the vocabulary test, the participants completed a brief survey entitled, *Vocabulary Acquisition via iPod Touch 2*, about the design of the game. These questions specifically addressed the participants’ experiences with the app, such as the difficulty encountered, overall experiences with the different games, helpfulness of the feedback, emotions experienced while playing, and techniques used to figure out the words. Participants were also given the chance to write brief essay responses regarding their experience with the app and any suggestions for redesigning the app (see Appendix C). The final survey question allowed the participant to enter his or her email address for a drawing to win one of two $25 iTunes Gift Cards. The email address was not linked to participants’ responses and entering the drawing was optional. Throughout this follow-up meeting, parents were given the opportunity to provide written comments that they may have had about the study. Finally, a debriefing statement was made that reminded the participants that their participation and data would remain completely anonymous and any remaining questions were answered.

**Data Analysis**

The data collected from the university participants were analyzed in multiple ways. The 40-item multiple choice test was computed to determine those words, which were easiest and those, which were hardest. This involved gathering information, such as, item analysis, response statistics, frequency distribution, and Cronbach Alpha to measure reliability. Two 20-item tests were made from these words of equal difficulty. These two tests then served as the pre-test and post-test used with the high school students in the study.
To discover the impact the iPod Touch and Vocab Challenge App had on high school students’ vocabulary development and word knowledge over time the data (vocabulary tests, daily form, and surveys) collected from the high school students were analyzed. Descriptive statistics were performed on the demographic information (i.e. gender, classification, age, etc…). Using statistical software, the vocabulary pre- and post-tests were analyzed using dependent paired samples t-tests in order to determine any statistically significant differences in means between the pre- and post-tests for the group. Based on the correct responses, the items were analyzed to note specific item statistics, frequency distribution, and test statistics. The data collected on the daily form involved gathering descriptive statistics. For example, patterns were looked at in regard to the amount of time the app was used. Other information collected and analyzed involved the game statistics, such as, the average percentage earned on all the games in the app.

A regression analysis was used to determine the relationship between one dependent variable (i.e., post-vocabulary test score) and several independent variables (i.e., student engagement, pre-test score, number of word encounters, type of game, scores within the app) addressed in the study. The level of student engagement was calculated using a principle components analysis. In order to determine if certain word study strategies influence students’ success in vocabulary mastery, the techniques used by the participants were analyzed via descriptive statistics. A thorough data analysis led to the ability to discover important findings related to the research questions.

Results

The purpose of this study focused on three goals: 1) to examine how portable media devices might impact vocabulary growth with high school students over time, 2) to explore
the influence that word study strategies have on their vocabulary mastery, and 3) to discover the perceptions of high school students regarding learning vocabulary on a mobile device.

To examine the first question, *regression analysis* was implemented to discover the factors that had an effect on the vocabulary post-test scores. The results suggest that the score on the pre-test was a good indicator of the score on the post-test. The second and third research questions focused on using *descriptive statistics* to provide an explanation of the difficulties, experiences, and techniques used while mastering new vocabulary using a mobile device. This analysis provided clues that process of elimination, guessed, and roots word study strategies had the strongest impact on vocabulary mastery.

**Portable Media Device and Gaming Application Impacts on Vocabulary Development and Word Knowledge Over Time**

The first research question was, “How does a portable media device (i.e. iPod Touch) and a gaming application (i.e. Vocab Challenge App) impact students’ vocabulary development and word knowledge over time?” This question focuses on the development of vocabulary that may have occurred during the study. All participants (n=25) in this study completed two vocabulary tests of similar difficulty levels. Each test contained twenty items, five questions in the following categories: antonym, connotation, definition, and synonym. One test occurred at the beginning of the study, *the pre-test*, and the other test, *the post-test*, occurred three-weeks later after the participants’ use of the Vocab Challenge App. The mean score for all participants (*High School 1 and High School 2*) on the pre-test was 13.80 (SD=2.02) with a minimum of 9 and a maximum score of 18. The mean on the post-test was 14.16 (SD=2.81) with a minimum score of 7 and a maximum score of 19.
Figure 9 illustrates the relationship between the pre-test and post-test score variables using a scatter plot. A scatter plot of this shape indicates that there is a slight positive association between the score on the pre-test and the score on the post-test (Wiersma, 1995). A paired sample t-test was run to compare the differences between the pre-test and post-test scores for the participants. The t-test results indicated that there was no significant increase between the two tests, p=0.23, α=.05.

Both tests contained 5 questions of each type (antonym, connotation, definition, and synonym). Figure 10 provides mean scores per question type on both the pre-test and post-test items. Participants experienced a slight decrease in their performance in the mean scores between the pre-test and post-test on the connotation and definition items. There was an increase in the mean score on the antonym items and a slight increase on the synonym items between the pre- and post-tests. Scores on the antonym post-test were .88 higher than on the pre-test. A t-test was used to determine the significance of the difference between these two
tests. The results indicated there was a significant difference in the antonym pre-test items and the antonym post-test items $t(24) = -3.23, p = .0018$. 95% CI: (-1.44, -0.32).

![Bar chart showing mean scores for pre- and post-tests](image)

**Figure 10.** Participants’ mean scores on the pre- and post-tests based upon question type

An ordinary least squares regression analysis was calculated on the vocabulary post-test data to determine which variables held statistical significance. This technique was used to display the relationship between the dependent variable and several independent variables, such as the pre-test score and the level of student engagement. In order to discover the overall level of student engagement, a principal components analysis was performed on the following survey items that denoted students’ emotions: bored, challenged, confused, frustrated, pressured, and satisfied. These emotions were rated on a five-point scale from never to always. A graph of the proportion of variance (where scree plot leveled off)
indicated that these variables fell primarily on three components, thus confused (0.71), unsatisfied (-0.75), and challenged (0.69) were calculated (Statsoft, Inc., 2011). The components together created a level of student engagement. The first component indicated the participants felt confused during the game play of the app. The second component, called unsatisfied, loaded on the satisfied variable with a high negative value indicating the engagement level was far from satisfied. The third component primarily loaded on challenged indicating that the content of the games appeared challenging for the participants.

These three components detected the structure that existed in the relationships among the variables. For each component, the measures were linearly combined that resulted in a score for each participant (Decoster, 1998).

The regression was run with the dependent variable of the post-test score and the independent variables of the pre-test score and the confused, unsatisfied, and challenged variables. The regression indicated the pre-test score was a significant predictor of the post-test score, $b = 0.77, t(24) = 2.98, p = .007$. This indicated that depending on the score earned on the pre-test would result in a .77 increase on the post-test, $R^2 = .42, F(4, 20) = 3.55, p = .0241$.

The app itself tracked specific information related to game play. Two types of information recorded by means of a built in feature of the app) included the percentage of performance on each game and the number of words students encountered while using the app. Participants tracked and recorded these two variables during their participation in the study. The percentage performance for each game was combined and averaged for each participant in order to give them an overall performance level within the app (see Table 2).
Table 2

*Game performance (reported as percentages) from the App*

<table>
<thead>
<tr>
<th>Participants’ Game Performance</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition Game</td>
<td>56%</td>
<td>.12</td>
</tr>
<tr>
<td>Antonym Game</td>
<td>60%</td>
<td>.17</td>
</tr>
<tr>
<td>Synonym Game</td>
<td>68%</td>
<td>.14</td>
</tr>
<tr>
<td>Connotation Game</td>
<td>74%</td>
<td>.09</td>
</tr>
<tr>
<td>Average Performance on the App games</td>
<td>65%</td>
<td></td>
</tr>
</tbody>
</table>

A regression was run to examine the potential relationship between the post-test score (dependent variable) and the two items that were tracked through the app: number of words encountered and the performance average of the games (independent variables). The performance average of the games in the app significantly predicted the post-test scores, $b = .10, t(24) = 2.27, p = .033$. This indicated that for every one unit increase in the performance average, there is a .10 point increase in the post-test score holding all other explanatory variables constant.

In order to further investigate the relationship of the pre-test and post-test scores, the data were analyzed based upon the difference between the pre-test and post-test. Two subgroups were created from the participants: those whose score *increased or stayed the same* (n=15) from the pre-test to the post-test and those whose scores *decreased* (n=10) from the pre-test to the post-test. Table 3 displays the pre- and post-test means, standard deviation, and minimum and maximum values of each group. The vocabulary test data for the
subgroups were analyzed through a dependent sample t-test. The test was used to help account for the within-group variation based upon the individual difference from the first test to the second. For the *increase or same* group, there was a significant difference in the scores for the pre-test (M=13.80, SD=1.66) and post-test (M=15.73, SD=1.49) conditions; $t(14) = -4.49$, $p < .0003$. These results suggest that the score on the pre-test does have an effect on the score on the post-test.

Table 3

*Pre- and post-vocabulary test values based on the two groups*

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
<th></th>
<th>Post-test</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Increase or Same</td>
<td>13.80</td>
<td>1.66</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>Decrease</td>
<td>13.80</td>
<td>2.57</td>
<td>9</td>
<td>18</td>
</tr>
</tbody>
</table>

*M = Mean; SD = Standard Deviation; Min = Minimum; Max = Maximum*

**Influence of Word Study Strategies on Vocabulary Mastery**

The second research question was, “How do certain word study strategies influence students’ success in vocabulary mastery?” The purpose of the second research question was to examine the types of word study strategies that students expressed using in mastering vocabulary. This involved exploring the various strategies the participants said they used when attempting to figure out the words they encountered while using the app. Based on a 6-point Likert scale ranging from never (1) to very frequently (6), participants rated the word
study strategy they used the most frequently. For each strategy, they were given the option to rate how often that strategy was used. This meant all participants gave each strategy a frequency rating. Taking all of the participants into account (n=25), the means indicated they tended to use process of elimination the most (4.60), then guessed (4.24), which was followed closely by roots/word parts (4.20).

The word study techniques were then explored based upon the two participant subgroups created. The goal was to determine which techniques proved the most helpful for the members of these groups while using this app. Figure 12 notes the frequency of the different strategies employed by the participants in the subgroups during game play. The participants in the increase and same group tended to use the strategies of process of elimination, guessed, and remembered it from the summary page the most often. The decrease group tended to use the strategies of process of elimination, roots/word parts, and guessed the most often. The participants were given the option to enter any “Other” strategies that they used. Some “Other” responses included the following: reading books, general conversation, and remembered definitions.
To determine if the use of these strategies had an effect on the mastery of the vocabulary words (implementation of the strategy), an OLS (Ordinary Least Squares) regression was used. With the dependent variable of the post-test score the six pre-set strategies (guessed, learned at school, process of elimination, roots/word parts, remembered it from the summary page, and remembered it from a different game) were entered as the independent variables. The order of the variables for each subgroup was determined based upon the means of the frequency levels for each study strategy (most commonly used to least commonly used). The table below reveals the results. Note that for the decrease group the strategy of learned it in school is approaching significance, p=.067.
### Table 5

*Regression of word study strategies based upon the post-test scores*

<table>
<thead>
<tr>
<th></th>
<th>Increase or Same</th>
<th>Decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guessed</td>
<td>0.42</td>
<td>-1.32</td>
</tr>
<tr>
<td></td>
<td>(0.35)</td>
<td>(-1.64)</td>
</tr>
<tr>
<td>Learned at school</td>
<td>-0.04</td>
<td>1.53</td>
</tr>
<tr>
<td></td>
<td>(-0.09)</td>
<td>(2.81)</td>
</tr>
<tr>
<td>Process of elimination</td>
<td>0.25</td>
<td>2.36</td>
</tr>
<tr>
<td></td>
<td>(0.23)</td>
<td>(2.22)</td>
</tr>
<tr>
<td>Roots/word parts</td>
<td>-0.59</td>
<td>-2.34</td>
</tr>
<tr>
<td></td>
<td>(-0.65)</td>
<td>(-2.32)</td>
</tr>
<tr>
<td>Remembered it from the summary page</td>
<td>0.30</td>
<td>-0.19</td>
</tr>
<tr>
<td></td>
<td>(0.23)</td>
<td>(0.22)</td>
</tr>
<tr>
<td>Remembered it from a different game</td>
<td>0.26</td>
<td>-0.22</td>
</tr>
<tr>
<td></td>
<td>(0.47)</td>
<td>(-0.21)</td>
</tr>
<tr>
<td>Constant</td>
<td>13.16</td>
<td>12.23</td>
</tr>
<tr>
<td></td>
<td>(2.29)</td>
<td>(1.74)</td>
</tr>
<tr>
<td>Observations</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>R-squared</td>
<td>.13</td>
<td>.85</td>
</tr>
</tbody>
</table>

t statistics in parenthesis

*p. < .05  **p. < .01  ***p. < .001
Participants’ Perceptions of the Learning Experience

The third question was, “Based on high school students’ self-perceptions, what impact does a mobile device have on learning vocabulary?” This question focused on the participants rating their self-perceptions of the learning experience with a mobile device. In order to determine if the vocabulary words participants encountered were mastered, descriptive statistics were performed on questions relevant to vocabulary learning (see Table 6). These questions centered on the aspects of mastery learning and active learning. Each statement was rated by participants using a 5-point Likert scale of strongly disagree (1) to strongly agree (5). Overall, participants tended to agree (M=3.88) that they remembered the words more by working with them in 4 ways and that they felt actively involved in their learning (M=3.60). However, the participants were not as confident (M=3.28) that they had mastered the words using the app.

Table 6

Agreement level related to learning based on App experience

<table>
<thead>
<tr>
<th>Learning Based on App Experience</th>
<th>Level of Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
</tr>
<tr>
<td>By working with the words in 4 ways, I remembered them more.</td>
<td>3.88</td>
</tr>
<tr>
<td>By having to use the touchscreen or shake the iPod, I felt actively involved in my learning.</td>
<td>3.60</td>
</tr>
<tr>
<td>I feel like I know the words I mastered on the app.</td>
<td>3.28</td>
</tr>
</tbody>
</table>
The level of difficulty that the participants experienced while using the iPod Touch and the various activities within the Vocab Challenge App was analyzed to see the effect this may have had on performance (see Table 7). Based on a 7-point scale ranging from very difficult (1) to very easy (7), participants did not report having any difficulty navigating the iPod Touch, rating the item between quite easy and very easy (M=6.56, SD=0.58). They also did not have any difficulty navigating the pages of the app (M=6.24, SD=0.78). Participants also found it very easy to read the font in the app (M=6.50, SD=0.73). Overall, the participants found the difficulty level of the app quite easy (M=6.20, SD=1.00).

Participants also ranked their satisfaction level of using the app using a 5-point scale ranging from very dissatisfied (1) to very satisfied (5). The overall satisfaction level with the app (M=4.04, SD=0.45) indicated the participants were satisfied with their experience (see Table 8). Some of the items had a high correlation level between them. Hinkle, Wiersma, and Jurs (2003) explain the following levels of correlation: .90-1.00 very high positive, .70-.90 high positive, .50-.70 moderate positive, .30-.50 low positive, and .00-.30 little if any correlation. There was a high positive correlation between definition game and the synonym game (.74). There was also a moderate correlation between satisfaction level on the antonym and synonym game (.63). Both of these correlations indication that a satisfaction in the synonym game was related to both the definition and antonym game at the p<.001 level.
Table 8  

*Satisfaction levels with the App*  

<table>
<thead>
<tr>
<th>Item</th>
<th>Level of Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall experience with the app</td>
<td>4.04  0.45</td>
</tr>
<tr>
<td>The antonym game</td>
<td>3.40  0.71</td>
</tr>
<tr>
<td>The connotation game</td>
<td>4.06  0.81</td>
</tr>
<tr>
<td>The definition game</td>
<td>4.29  0.64</td>
</tr>
<tr>
<td>The synonym game</td>
<td>3.97  0.81</td>
</tr>
</tbody>
</table>

The data gathered through the vocabulary tests, surveys, and daily log provided the evidence to answer the major research questions. The questions investigated how portable media devices might impact vocabulary growth with high school students over time, explored the influence that word study strategies have on vocabulary mastery, and discovered the perceptions of high school students’ regarding learning vocabulary on a mobile device.

**Discussion**

The participants’ experiences that occurred while using a portable device might offer a glimpse of the possibilities of using educational mobile games as a tool for informal learning. The Vocab Challenge App used for this study offered a portable way to learn vocabulary. The participants engaged in the use of the app primarily in three locations (from most frequent to least reported): home, car/bus, and school/study hall for a varying amount of time during the 3-week time period. The aspects of informal learning, mastery learning,
transfer, and engagement all emerged as contributing factors to the results obtained through a thorough data analysis.

**Informal Learning**

This study focused on the effects that using the portable media device might have on high school students’ vocabulary development during a 3-week time period. The participants took a vocabulary pre-test in the beginning of the study and post-test at the end. The results indicated that there was a slight positive association between the score on the pre-test and the score on the post-test. In general, there was a slight increase between the participants’ pre-test and post-test scores. This result may be due to the fact that participants entered with differing prior knowledge. For example, those from *High School 1* had an average GPA of 3.96 out of 4.00 where as *High School 2* had an average GPA of 3.57 out of 4.33. Every person has a different composition of vocabulary that connects with previous experience and knowledge (Pearson, Hiebert, & Kamil, 2007). The difference in the amount of participants’ prior knowledge may have played a role on the amount of vocabulary words correctly identified on the two tests resulting in no significant difference between the performance on the two tests. Breaking the participants down into the subgroups based upon the outcome of the post-test score reaffirms this idea. A t-test indicated that for the increase or same group an increase in the pre-test would cause an increase in the post-test. This suggested that based upon the pre-test results, the variation in vocabulary knowledge of each participant predicted the amount of growth that would occur on the post-test.

Further information was gathered on the specific items on the pre-test and post-test. The questions were analyzed according to the type of question (definition, antonym, synonym, and connotation) presented in the app. The four question types engaged the
students in a variety of word activities, which is essential in learning new vocabulary (Graves, 2008). The definition and connotation performance was higher on the pre-test than the post-test. This finding indicates that the knowledge of the words (definition and connotation) students encountered was not achieved prior to the taking of the post-test. The words may not have been encountered for a few reasons. The fundamental property of informal learning is to allow learning to happen anywhere and anytime (Shaffer et al., 2005). The individualized and self-guided experience within the gaming environment allowed for the participants to work at their own pace whenever they had free time. One limitation of this flexibility in this study was that the window of game play was only three weeks. The amount of time the participants engaged in with the app varied greatly. Graves (2008) explains that students should work with a word more than once to aid in vocabulary building. Some participants self-reported only a small amount of time using the app, thus limiting the amount of interaction with the words in between the two tests. Some only used the app for 10 minutes whereas others used it for 500 minutes. This large variation in the time of interacting with the word could account for the large standard deviation (2.81) in the post-test scores.

Another important component related to the amount of time used is the aspect of self-reporting. After each game play session, participants were instructed to record the amount of time the game was played to the nearest five minutes. They were also to record the number of words encountered within the app (this number was cumulative). The amount of time positively correlated (0.61) with the number of words encountered. Unfortunately, the self-report aspect limited the precision provided by this recording measure. Since this type of data could not be verified by means of an external validation measure (amount of words that
should be mastered during any given time period), the number of minutes and words encountered across all participants were analyzed. This is how discrepancies were found. For example, one participant noted using the app for around 20 minutes encountering 78 words and another who also recorded 20 minutes encountered 635 words. This occurred on the high-end also where one participant recorded 230 minutes and encountered 2,457 words whereas another participant who logged 10 minutes more (240) only encountered 938 words. The lack of a consistent and built-in timer in the game may have skewed the amount of time played and how this related to the number of words encountered.

The inability of the post-test scores increasing for all participants was reflected in the variation in the amount of time played, number of words encountered, and the average scores achieved on the games within the app. Without full immersion in the gaming environment, mastery of the vocabulary words was not able to occur. The game was built upon the principles of mastery, which could only be achieved by interacting with a word in four games and correctly answering the questions related to it (Modality, 2010). This related back to the time used because a participant may have used the app for a large amount of time but did not answer many of the words correctly or even ever achieve mastery on many words. The app did not provide a tool to log the number of words mastered.

To explain the level of mastery and active participation in the learning process, the participants answered a series of three questions. The participants agreed (3.88) that working with the words in four ways helped them to remember the words. The goal of mastery learning is to allow the learner to interact with the material as much as needed before being able to move on from it. This rating indicates the repeat nature of interacting with the words assisted in the students remembering them. However, participants were then asked if they
felt like they had mastered the words by using the App. Participants rated this as neutral (3.28). Gee (2008) explains that within the gaming environment the player needs to become an active participant in order to gain the full environment. If the participants did not feel that they were actively involved in the learning experience, this would connect with their rating of also not really feeling that they had mastered the vocabulary words. Thus, participants in this study didn’t really feel like the app helped them master the vocabulary words, which was actually reflected in the little difference between the pre- and post-test results.

**Vocabulary Mastery**

This study looked at the strategies that influenced vocabulary mastery. The authentic nature of the vocabulary words within the game (found on the SAT) create an environment where the learning tasks were authentic, which Hsu and Wang (2010) note is an important feature of a game. Also of importance is the informal learning environment that encourages engagement that is not too structured and puts the control into the hands of the learner (Marsick & Watkins, 1990).

The level of commitment and investment in the learning process was reflected in the techniques that were frequently used in order to play each game. As the literature indicates, vocabulary acquisition requires a variety of techniques and methods that can lead to learning (Nagy & Anderson, 1984). The top three techniques used most frequently by all participants in descending order included: process of elimination, guessed, and roots/word parts. The use of process of elimination was the strategy that the app maker, Modality, and the Princeton Review had designated and promoted as the strategy to use, thus this result of “frequent use” correlates with this. Another strategy used was the roots/word parts. This is a skill participants may have learned through the previous SAT/ACT study materials used or
through English classes they have taken as a technique to employ when taking a test.

Association to previous encounters and connections to other words can assist the building up of vocabulary word knowledge (Murphy, 1991). The other strategy most used was guessed. This is important to note since if they were just guessing, this may indicate no true vocabulary mastery had occurred during the course of the study. Guessing involves the learner taking into account the context clues, which in this case were the word answer choices provided (Nation, 2001). Before formulating a guess, the player first has to take a look at the possible answer choices and if these words were not part of their vocabulary or if only one word was, then a guess was made based on the amount of knowledge known at the present time. This may have occurred during the game play as twenty words were encountered in a game before receiving corrective and informational feedback.

The strategies used to determine the correct answer for each word varied. From the subgroups, the participants in the decrease group were approaching significance between their post-test score and the word study strategy: learned in school. This indicated that learning the word in school for this group helped them with the vocabulary words as opposed to learning the word through their interactions in the app. This missing connection with the app could have contributed to the decrease in the post-test score.

The participants in the two subgroups (increase or same and decrease) utilized different strategies to varying degrees in order to play the games and learn the vocabulary words. For example, the slight increase in the scores on the synonym post-test from the pre-test as well as the slight decrease in the scores on the definition and connotation games could have been related to the technique used. One of the top techniques was guessing, which could account for some of the variance of the scores. The connotation game differed from
the other games in allowing the participant to choose whether or not they felt it was positive or negative. This 50/50 option of only two selections may have contributed to the use of the guessing strategy, thus why the participants noted they used it so frequently. The variation in the participants’ strategies displayed the potential that informal learning provides, where the learners use the tools they deem suitable to meet the goal. It also displayed the fluctuation in strategy use that may be related to the strategies the learners had previously learned. Barron (1980) pointed out that strategies must be introduced in the educational environment, so that they can effectively build up their vocabulary knowledge using them at later times. For example, if the participants did not know to look for roots/word parts or how to effectively use process of elimination, they may have not used this strategy during the course of the study.

**Transfer**

Learning new vocabulary words can be done through games, repetition, and practice. Gee (2005) noted good games get the players actively involved in the experience through their actions and decisions. Games that are successful offer a combination of active and enjoyable learning experiences (Blachowicz & Fischer, 2008; Child, 1993; Gee, 2008). This game had the players interacting with the words in multiple ways. For each game (antonym, connotation, definition, and synonym) the player earned a score, which indicated the percentage of words correctly answered. These four percentages were averaged for all participants. This new overall app game score had a significant relationship with the post-test score. The participants by actively engaging in the games on the app would increase their scores on the post-test. This implies that the learning experiences students had using the app were transferred to a new environment (taking a test). Games can provide opportunities
to practice with the material informally and later apply this information in a formal environment (Kumar & Lightner, 2007). Transfer involves linking one experience to another, if the participants gained the vocabulary knowledge experience from the app, they will then be able to apply it to another scenario (Gee, 2003; Hunter, 1995). Although there was only a slight increase in the post-test scores overall, for a subgroup of the participants (n=15) that increased or stayed the same (13.80 to 15.73), the difference was significant.

The transfer of knowledge gained from the app to the post-test may have been exemplified by the results on the post-test for the antonym game. Statistical significance was noted between the antonym pre-test score and the antonym post-test score, $t(25) = -3.23, p < .01$. Based upon the participants’ self-reported game statistics, this game also ranked as the most difficult and the least satisfying. This difficulty may have caused the participants to increase their attention during the game since it required them to think about what the word meant and then determine which of the three selections provided was the opposite. The interaction within the game may have reintroduced them to what an antonym is and refine the skills to determining what one is in a testing situation. This interactivity, player positioning and choice may have assisted in the significant increase of the score for this type of question (Dickey, 2005).

Another explanation for the transfer of the word knowledge as well as the skills employed while playing the game may be explained using Vygotsky’s Zone of Proximal Development. This theory noted that the leaner enters with present knowledge, which in this study was captured through a vocabulary pre-test (Vygotsky, 1978). Then the participants engaged in activities on the app, which provided the vocabulary scaffolding (type of assistance offered to support learning). Finally, there was a post-test measure at the end of
the study that provided evidence of whether or not the interaction with the words on the app had an effect on vocabulary development. The ability to transfer the knowledge that previously was unknown, but then was achieved through the information presented in the app indicates the potential of learning on a mobile device. A majority of the participants performed better on the post-test, which was of equal difficulty as the pre-test. This indicated that some word learning took place during the 3-week time period that was transferred onto the post-test.

The Zone of Proximal Development also included the participants’ knowledge of using the iPod Touch. The participants did not experience any difficulty with navigating on the iPod Touch. This indicated they were already at the independent level regarding the use of this technological tool. The researcher did provide limited assistance with navigating to the location of the app as well as a brief explanation of the basic rules of the app itself. The remainder of the learning process involved the information provided by the app and varied at the individual level based upon the amount of engagement exhibited and emotions felt.

Engagement

The level of engagement throughout the study varied among the participants. The principal components analysis indicated that the factors of confused, unsatisfied, and challenged were the most prevalent. The level of engagement that the student felt affected the testing outcome. In order to make sure participants did not give this rating based upon a technical difficulty as opposed to the content of the app, the participants rated the difficulty encountered in navigating the iPod Touch, rating it very easy (6.56). Games have the potential to provide word interactions in a context that is enjoyable (Blachowicz & Fischer, 2008). There was a medium correlation (0.52) between the ability to navigate the iPod
Touch and navigate the pages of the App. If the player was able to use the tool itself, he/she was also able to seamlessly move through the activities engaged with on the tool. They found the activities in the app closest to quite easy (6.20) with the three easiest games being the definition (6.50), connotation (6.32), and synonym (6.20).

The results indicated that the participants did not have any difficulty navigating the iPod Touch and playing the app, but the level of engagement that they felt toward their experience was lacking an emotional connection. A player’s decisions in a game affect the future outcomes in the game (Nitsche, 2008). If the player felt confused from the beginning, this would have continued to transfer throughout their entire experience. Also, successful games combine enjoyment and competitiveness through active discovery learning (Blachowicz & Fischer, 2008; Child, 1993; Gee, 2008). The participants’ emotional rating indicated that overall they were unsatisfied with the experience. The lack of intellectual engagement and a feeling of competition may have caused the participants to feel this way. Another reason for a lack of satisfaction goes along with the third emotion exhibited, challenged. If the game was too difficult, for example outside the Zone of Proximal Development, the participants may have felt overwhelmed and provided multiple incorrect answers related to the words, which led to the emotions reported as unsatisfied and challenged. The level of these emotions would be affected if the post-test score shifted. The most successful games possess a balance of competitiveness and enjoyment through an engaging environment (Jonassen & Reeves, 1996; Nitsche, 2008). If the participants did not feel emotionally engaged, this impacted the performance on the post-vocabulary test.

The use of a mobile device provides a way to construct knowledge and gain meaningful experiences related to learning tasks (Rogers, 2009). The opportunity to learn
vocabulary on a mobile device displayed the potential of informal learning for high school students. As Blachowicz and Fischer (2008) explain games and word play provide a way to develop word knowledge. The results illustrate that the app has the ability to provide a vocabulary learning experience by means of promoting informal learning, mastery learning, transfer, and engagement. As Kittl, Edegger, and Petrovic (2009) explain it is the combination of digital games and quality learning content that engages the player. The actions of personal engagement, satisfaction, and motivation are necessary to achieve a high level of success with gaming on a mobile device (Kittle et al., 2009; Ryu & Parsons, 2009).

Conclusion

The results of this study suggest there are more variables involved with learning via a mobile device besides having access to the software. The use of a mobile device offers learners an opportunity to build their vocabulary knowledge at a pace that suits them best. Through repeat encounters with the vocabulary words incrementally over a period of time, the potential exists to develop a stronger more robust vocabulary (Graves, 2008; Pearson et al., 2007; Pressley et al., 2007). The amount of prior vocabulary knowledge that the players began with was a significant factor relating to the performance on the post-test. Differences emerged on the performance on the post-tests taking into account the factor of time. This factor varied greatly across the participants with the overall range anywhere from 10 to 500 minutes. It is important to take into account the amount of time required to interact with the words that would allow for them to be transferred from the device’s simulated learning experience to practical uses in reading, writing, and testing activities.

There were a few limitations to the study. First, the lack of equipment owned by the participants and thus available for use from the researcher restricted the number of students
who could participant at any given time. Second, the motivation behind participating may have influenced the attention to detail when it came down to the self-reported data collected. For example, all participants who provided an email were entered into the drawing for the iTunes gift cards. This meant that regardless if the app was used for 10 minutes or 500 minutes they would have the same possibility of winning the card. For some, the lack of a specific amount of time required may have effected the motivation behind using the app more as opposed to less. This could be addressed in a follow-up study with a focus still on informal learning, but there would be a set minimum of minutes participants are required to spend using the app. The game play would vary across participants and the times and days used, but this minimum level required may assist in motivating the participants to engage more. Also, if attempting to replicate this study, the lack of consistency of the self-reporting measure of time versus the number of words encountered needs to be investigated. Possibly, if the software received an update that would internally record the amount of time used, this would reduce the amount of inaccuracy in the reporting of this measure.

Further research may explore the transfer possibilities that occur from the vocabulary interacted with on this app. With more school districts implementing one-to-one initiatives, portable devices are getting into the hands of learners within formal learning environments (Holcomb, 2009). The participants in this study did not generally own their own iPod Touch, thus borrowing one and having to return it has limited the potential of future and continued use with these vocabulary words. This study took place in an informal learning environment, but future studies could investigate what would happen if the mobile device was used not only informally but also formally and if this resulted in larger gains in vocabulary knowledge.
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CHAPTER 4. MOBILE DEVICE LEARNING: AN EXPLORATION OF THE PROCESSES INVOLVED IN HIGH SCHOOL STUDENTS’ VOCABULARY DEVELOPMENT

A paper to be submitted to Computers in the Schools

Jennifer Redd

Abstract

Mobile devices are becoming increasingly more common, thus the potential exists to use these tools for educational purposes. Mobile devices allow for informal learning to occur anytime and anywhere. This research study investigated the potential of building vocabulary word knowledge by means of a mobile device (i.e., iPod Touch) and vocabulary app. Following a pre-test/post-test design, twenty-five high school students participated by using a mobile device and vocabulary app over the course of three weeks. The results indicated there was no significant difference in performance between the tests, although the amount of time in using the app was important. The participants offered suggestions related to the design characteristics of the app and how this affected the overall experience.

Keywords: technology use, teenagers, mobile devices, vocabulary, memory

Introduction

Mobile devices such as the iPod Touch allow users to access information anywhere without any geographical restrictions. Over the past few years, the influx of the use of these devices by high school-age students—with 87% of 16-18-year-olds having their own iPod or Mp3 player—presents the opportunity to take learning outside of a classroom and into
informal learning environments (Rosen, 2010). Today’s students carry their mobile devices with them at all times (Rosen, 2010). As more and more applications are designed for such devices, the design characteristics presented should be explored to discover, which components help to lead to information retention. It is equally important to explore how students’ previous technology usage might impact performance in a game while using this type of device. Thus, this study explored game design characteristics and psychological principles of encoding, retrieval, and attention that are inherent in the iPod Touch App called the Vocab Challenge and the impact this had on secondary students’ mastery of vocabulary.

**Literature Review**

The use gaming on a mobile device creates new opportunities for learning in a non-traditional way. Prensky (2005) notes, “Students certainly don’t have short attention spans for their games, movies, music, or Internet surfing. More and more, they just don’t tolerate the old ways—and they are enraged we are not doing better by them” (p. 64). Children growing up today demand not just an education that is relevant but one that engages, excites, and encourages active participation in the learning process (Prensky, 2005; Rosen, 2010; Wellert, 2008). Games allow users to be involved in learning at various levels of intensity. They work off natural desires to develop new skills, explore new roles, or better understand the world from a different perspective (Squire, 2005). Based upon an individual’s preferences, a player constructs his/her own knowledge. Greeno (2005) recommends using technological tools to enhance learning by developing learning scenarios, previously not possible, and using them to promote active learning. Games are tools, which are creating new and possibly even more powerful methods of educating a generation of students that have grown accustomed to technology.
By engaging with a game on a mobile device, the time for using the device becomes flexible and accessibility to it is endless (Schachter, 2009; The New Media Consortium & EDUCAUSE Learning Initiative, 2010). Play can occur in various lengths of time, in various locations, and during any time of day – not just restricted to times that occur during a typical school day. Using mobile devices for gaming purposes offers students a way to extend their learning to after school hours in an engaging and motivating manner (Ching, Shuler, Lewis, & Levine, 2009).

**Technology Use by Teenagers**

Technology use by teenagers has steadily been increasing over the years. In 2002, a study of over 2,000 parents and guardians with a child between the ages of 12 and 17 found that 83% of American households owned a computer (The Corporation for Public Broadcasting, 2002). From those surveyed, 65% of these children were using the Internet from home, school, or another location (The Corporation for Public Broadcasting, 2002). Forrester Research (2005) surveyed 5,000 youth ages 12-21 and found that 88 percent of boys and 63% of girls ages 12-17 own a game console. Similarly, Mahoney and Laszczak (2009) surveyed 550 individuals from ages 8-22 who indicated they regularly use technology as a way to communicate, complete homework, and play games with 60% of those surveyed playing online or computer games everyday.

Even though the access and availability of technological devices has been increasing, the prices of these same technologies are decreasing. The technologies teenagers are using are not confined to the home. Rosen (2010) notes that 92% of teenagers ages 16-18 have their own cell phone and 87% have their own iPod or Mp3 player. In fact, Lenhart, Smith, Macgill, and Arafef (2008) explain that teens are heavily immersed in a tech-rich world with
85% between 12-17 year-olds engaging at least occasionally in electronic communication (i.e., email, text messaging, social networking).

With this increase in portable device ownership, what teenagers are doing with these technologies is important to investigate. Lenhart (2009) conducted telephone interviews with 1,102 teens ages 12-17 and their parents. She (2009) found that teens’ daily activities include the following: 38% send text messages daily, 26% post messages via social networks daily, 24% send IM (instant message) daily, and 16% send email daily. Rosen (2010) explains that teens ages 16-18 are using a wide variety of technologies throughout the day, most commonly listening to music, texting, and surfing the Internet (see Table 1).

Table 1

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time (Hours:Minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet</td>
<td>2:24</td>
</tr>
<tr>
<td>Computer (not online)</td>
<td>1:59</td>
</tr>
<tr>
<td>Email</td>
<td>1:19</td>
</tr>
<tr>
<td>IM/Chat</td>
<td>2:16</td>
</tr>
<tr>
<td>Telephone</td>
<td>1:50</td>
</tr>
<tr>
<td>Texting</td>
<td>3:32</td>
</tr>
<tr>
<td>Video Games</td>
<td>1:17</td>
</tr>
<tr>
<td>Music</td>
<td>3:33</td>
</tr>
<tr>
<td>Television</td>
<td>2:10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20:20</strong></td>
</tr>
</tbody>
</table>
Teens are obviously using a variety of technological tools in a variety of ways. Schiano, Chen, Ginsberg, Gretarsdottir, Huddleston, and Isaacs (2002) surveyed 65 teenagers and conducted ethnographic interviews with 13 participants ages 12-17. The students interviewed noted that they checked their email about once a day but were constantly instant messaging. Grinter and Palen (2002) concluded that teens instant message to communicate but also to collaborate and coordinate with peers as a form of homework support. The data indicate that mobile devices are in the hands of teens. Peowski (2010) explains, “These teens have grown up with video games and the Internet not just as tools for entertainment, but also as platforms for learning, creating, collaborating, and effecting social change.” Teens need to engage in an intellectual partnership with technology to maximize the potential for learning (Ben-David Kolikant, 2009). Thus, the possibilities of developing apps for these devices that allow teens to receive individualized educational support (i.e. vocabulary growth) on their own and at their own pace (informal learning) is one of the budding possibilities behind the use of mobile devices as an educational tool.

**Informal Learning**

Gaming on mobile devices provides the opportunity for learning in an informal environment. These activities are not constrained by time, space, or specific organizational elements found in the traditional learning environment, but rather are controlled by the person (Goodyear, 2008; Willoughby & Wood, 2008). Informal learning occurs whenever and wherever the learner feels the need, motivation, and opportunity to do so (Marsick & Watkins, 2001). Learning is individualized and the use of mobile devices offers a way to “re-engage a generation of informal learners who cannot find satisfactory ways to apply their skills in the formal learning context” (Peters, 2008, p. 106). Informal learning provides
opportunities for learners to interact in ways that best suit their own learning styles (Oblinger & Oblinger, 2005; Peters, 2008).

Informal learning differs from formal learning due to the control being solely in the hands of the learner and a teacher is not necessarily involved. Most activities completed in an informal environment are exploratory and inquisitive in nature (Colley, Hodkinson, & Malcom, 2003; Zürcher, 2010). It is learning that is intentional but lacks structure (Marsick & Watkins, 2001). The learner decides the objective and investigates issues and ideas they feel are important to know when they need to know them (Cross, 2006; Oblinger & Oblinger, 2005). For example, Selwyn (2007) noted that Second Life offers players the chance to engage, collaborate, build, and share content in areas of interest. Knowledge on topics is learned as well as social skills are refined, all under the guise of an informal learning environment. Learning is constructed through experiences by means of observations, problem solving, and trial and error (Cross, 2006; Quinn, 2009). Facer, Furlong, Furlong, and Sutherland (2003) suggest educational activities (i.e., homework) should take on a less structured format and be replaced by using formats students are growing up accustomed to with an emphasis on the control and choice being in the students’ hands.

Smith (1999, 2008) suggested that informal learning is “learning beyond the classroom” (para. 5). Mobile devices extend the classroom to apply to any environment where the learner engages in activities that prompt the development of skills and knowledge that will later prove helpful and useful to success in educational endeavors. By tapping into the learning that occurs in the informal environment and connecting it with the information presented in the formal environment, learners can make meaning and draw connections (Finger & Lee, 2010). Informal learning embodies the pursuit of understanding information
deemed necessary and important at the time in order to fully comprehend and grasp the content experienced (Livingstone, 2001). Within the informal learning environment, the presentation and composition of the information encountered holds importance regarding the rate and capacity that the learning and memorization of the information can materialize. The informal learning environment can provide the opportunity for vocabulary growth and development to occur.

**Vocabulary Development with Gaming**

Of particular interest is the area of vocabulary acquisition, which is the manner at which new words are learned (Glencoe/McGraw Hill, 2005). The design of a vocabulary game needs to take into account features of the human memory in order to encourage and promote successful retention of the knowledge being encountered. The first component to take into account is the way that a vocabulary word is introduced. Child (1993) noted that in terms of learning vocabulary it is important to create meaning and connections between the words and the patterns they represent. Haslerud (1972) described that as our eyes take in print impressions, the brain then encodes the information by translating it into meaningful patterns. The meaningful pattern bridges the transition of information from the unknown to the known. This is accentuated by using a variety of reading methods that assist in the building of connections and patterns to make the learning activities meaningful (Child, 1993; Ericson, 2001; Mayer & Moreno, 2002). This includes vocabulary word learning activities such as sight word knowledge (seeing and saying), decoding (pronouncing a word silently), and structural analysis (recognizing patterns based on prefixes, suffixes, and roots) (Ericson, 2001; Lieven & Tomasello, 2008). Students learn meaningfully when they are engaged in meaningful tasks (Jonassen, Peck, & Wilson, 1998).
Full engagement in a task utilizes psychological principles that tap into learning and memory retention. Of great importance in terms of vocabulary building, is the visual representation of words. Gill (1992) noted that visual memory for words results from exposure and knowledge of words. One example of this involves providing a definition where all components require attention (unimportant words are omitted). McKeown (1991) found that using precise wording is essential when writing up definitions intended to draw the user’s attention. The use of definitions requires concise and direct terminology that is easily understandable.

Feedback within a vocabulary game offers responses and suggestions to assist the player in the building of word knowledge. The use of feedback during the learning process assists the learner as he builds knowledge and provides evidence of learning (Deubel, 2006). Wachowicz and Scott (1999) explain that when learning language the use of feedback encourages the learner to make subsequent attempts in the game based on the information he has been provided with. O’Connor, Swanson, and Geraghty (2010) investigated the effect of repeated reading of a text and words of varying difficulty levels with struggling readers either with or without the assistance of an adult listener. Those participants who received feedback from the adult regarding the difficult words produced a significant difference in word comprehension and word recognition at the conclusion of the study. When engaging in vocabulary activities that offer the chance for repetition and practice, feedback becomes important in guiding and informing the learner of the desired information. For example, Lu (2008) found that the use of short, easily understandable definitions as opposed to wordy materials increased the amount of vocabulary recognized on a post-test. Feedback provides a way to monitor a learner’s progress as new material is encountered (Deubel, 2006).
Vocabulary is a process that builds upon itself. In lower grades basic words are learned and as the years go by the difficulty in the words gradually progresses. Gill (1992) conducted a study on 1st, 2nd, and 3rd graders’ word knowledge and found that the three primary factors affecting recognition were present stage of knowledge, frequency of exposure, and attention. By introducing new vocabulary intertwined with already known words helps to build links between old and new knowledge. Marsh, Friedman, Welch, and Desberg (1980) note other strategies to learn vocabulary include substitution, decoding, analogies, and phonemes. They conclude it takes many years of reading and spelling experiences to build up an expansive visual store. Learning new words incrementally is useful to gauge the development and understanding of words as opposed to an all or nothing manner (Read, 2000). Experience and conscious engagement in a multitude of activities promote the growth of one’s vocabulary.

The design of a game on a mobile device takes certain psychological components into consideration during the development process. A well-designed game is based on the way the human memory works regarding encoding, retrieval, and attention. Keeping these things in mind allows for the creation of a game that can aid in the learning and retention of material.

**Game Design**

The design of a game takes into account the characteristics of the way people learn. This involves developing a game with rules, feedback, and scaffolding to assist the learner during the process of mastering new information (Botturi & Loh, 2008). There are rules built into the game, a closed formal system, that funnel the players’ actions to have specific consequences (Crawford, 1984). The player then makes decisions in the game that result in
varying paths (Poundstone, 2006; Salen & Zimmerman, 2004). The decisions made are based on prior knowledge and experiences that have occurred in the game (Kremers, 2009). As the player progresses, his interactions within the game help to evolve into strategies that maximize the chance of success at reaching predetermined goals (Birdwell 2006; Bjork & Holopainen, 2006; Crawford, 1984). As the levels shift, the effort and skill mastery required by the player to reach the goal also increases (Holland, Jenkins, & Squire, 2003; Loftus & Loftus, 1983).

A player has multiple ways to make progress in a game by making choices based on individual strengths and learning styles (Gee, 2003). Correct answers result in rewards and may vary depending on the complexity of the action performed. The rewards and consequences are customized based on the player’s movements (Crawford, 1984). Through output from the game, the player can gather information regarding his performance and discover changes that need to be made in order to become successful (see Figure 1). The game provides a controlled environment where missteps and mistakes can lead to learning opportunities (Child, 1993; Garris, Ahlers, & Driskell, 2002; Jonassen, Carr, & Yueh, 1998; Koubek, 2004).

Figure 1. Cycle a player engages in during a game (Garris, Ahlers, & Driskell, 2002)
While designing a game, the developers must anticipate the potential decisions that the player will make and offer rewards and feedback to keep the player’s interest. The use of rewards can increase motivation and the drive to do well in a game. Malala, Major, Maunez-Cuadra, and McCauley-Bell (2007) describe, “One way to generate interest on the part of students is to institute a rewards system that promises immediate gratification to performance” (p. 4). This can occur by means of an increase in points and the difficulty of the game. Also, if a game begins with a “hook” which is subsequently followed by engaging decision making activities related to strategy, resources, and time, the player’s interest will be kept throughout the entire learning activity (Howland, 2002).

The design components that go into a game that provide feedback and assessment through scoring and level difficulty variability are developed based upon the player’s cognitive properties. The development of a cognitive assessment program (game development) involves four phases based on the information processing approach of transitioning information from the immediate state into long-term memory (Gierl, Leighton, & Hunka, 2005). The cognitive science behind a game not only takes into account the mental characteristics used, but also the unobservable mental operations (Miller, 2002; Newell & Simon, 1972). The first phase requires development of a hierarchy of the skills required to perform that tasks within the game. This involves transitioning from easier items to more complex ones. This essential component is creating a delicate balance where the player is progressing in the game but also while acquiring the cognitive processes required to do so. Once the skills necessary to progress through the game are laid out, the second phase involves developing the specific items that will take the player through the game. The items need to match up with the complexity levels that have been predetermined to occur at certain
stages within the game. For example, the skill required to advance in the game must be taught prior to the spot in the game where it would be necessary to use it. The third phase takes the developed items and analyzes them based on the player’s actions within the game. Looking at both the expected response and the actual response a score is calculated which can give validity to the design completed in the two prior phases (Gierl et al., 2005). Finally, the scores that have been achieved through playing the game are reported. The scores provide valuable diagnostics regarding the state of the player’s cognitive skill level and should be easy to read, interpret, and visually appealing (clearly described and labeled information without being overwhelming) (Gierl et al., 2005).

Developing a game that challenges and motivates a player while simultaneously building up knowledge and skill requires certain components to be included. Loftus and Loftus (1983) note games should possess the three essential characteristics of challenge, fantasy, and curiosity. A challenging game shifts in complexity based on performance and time spent in the game. Fantasy in a game creates mental images in the player’s mind that can connect back to prior knowledge and awakens the senses (Loftus & Loftus, 1983). Curiosity encourages players to immerse themselves in the game based on the optimal level of engagement - not overwhelmed. Through these interactions with games, player’s knowledge is then constructed and skills are developed. The skills can take the form of declarative knowledge, facts required to complete the task; procedural knowledge, ways to approach the task; and strategic knowledge, reasoning behind the task and creative solutions (Kearney & Pivec, 2007). As players enter a game, they bring with them varying levels of prior knowledge and skills related to gameplay. Games need to be developed that take the variety of learner’s needs and levels of prior knowledge into account (Malone, 1984; Squire,
Then, using this as the starting point, the player can engage in game play after learning to recognize the symbols and rules of the game (Hsu & Wang, 2010). Recognition and knowledge continue to grow upon further immersion and interaction within the game environment.

Based upon the behaviorist perspective, Skinner’s Theory of Operant Conditioning concludes that effective learning occurs in short spurts that grow out from previously learned behaviors (Child, 1993; Skinner, 2005). It is the building of experience, connecting the old with the new, in small increments that can make the task of increasing knowledge more manageable (Erickson, 1974; Papert, 1993). The design of a game takes the basic skills necessary to advance in the game and introduces them in the beginning. Then later on the difficulty and skill levels advance. The act of learning involves taking new information presented and intertwining it with previous knowledge in a meaningful way (Donovan, Bransford, & Pellegrino, 1999; Hunter, 1995). Through experience, behaviors are learned simultaneously with the reward and punishment associated with them (Skinner, 2005). The rewards and punishments are written into the programming of the game as a way to give feedback to the player.

Feedback provides immediate information, thus promoting and shaping desired behaviors (Skinner, 2005). This feature in a game is the message or display presented once a response is made (LeBlanc, 2006; Steinberg, 1991). Feedback includes providing overall results, correct answers, and a rationale for why a response is wrong (Child, 1993; Narciss, 2008; Steinberg, 1991; Sweetser & Wyeth, 2005). The implementation of feedback and a rewards system are also both essential components to learning via gaming technologies. Within the gaming realm, feedback can be individualized and immediate. Steinberg (1991)
explains feedback lets the learner know why a response was wrong and provides feedback on how to correct it. The close proximity of the feedback to the content is instrumental and beneficial (Child, 1993; Clark & Mayer, 2007). Feedback helps a player progress by offering up corrective information and emotional support (Dempsey & Sales, 1993; Shneiderman, 1992). It also permits the situations to be reperceived with attempts at closer approximations to be made (Haslerud, 1972). The amount and extended opportunities of practice are instrumental components of the design of a game to aid in memory (Gee, 2008; Kumar & Lightner, 2007). Estes (1972) confirmed that retention of a string of characters is greatly increased when the string is divided into chunks of information separated by pauses and rehearsal. Extended and repeated practice enhances the possibilities of retention. By repeating words for brief periods of time over many days can aid in the long-term memory and retention of the information (Loftus & Loftus, 1983).

Feedback is a component of a game that serves as an aid to learning. The game itself should not be linear but rather branching (Lumsden, 1975). The paths that the learner takes within the game is not predetermined but rather user-based. The learner through stimulus discriminations should be able to discover the most likely path to success (Child, 1993; Kolb, 2008). Allowing the player to be in full control of his destiny within the gaming realm aids in the successful retention of knowledge. A game is well-designed when no two students follow the exact same pathway through the learning experience (Kolb, 2008). A game creates the opportunity for an individualized educational experience where a series of choices can be made (Kremers, 2009). The features of the game assist in the learning and remembering of the information that it presents.
Memory

Educational video games should present the information in an engaging and motivating manner in order to engage the brain and encourage learning (Boehmer, 2011). As Hunter (1995) suggested, material has a greater chance of being remembered when it has a meaningful connection to the learner. Just simply presenting the content in a game is not enough. The foundational principles that promote learning must be present. Child (1993) noted that learning occurs when behavior patterns are modified in a way that will influence future performance or attitudes. This idea falls back upon the psychological principles of memory. It also includes the creation of a learning environment that supports and stimulates learning while encouraging an in-depth degree of original learning to encourage efficient memory practices (Hunter, 1995; Seel, 2008). Understanding the way that memory works is helpful in determining the best way to learn and retain knowledge of new vocabulary words. Kornell and Bjork (2009) found stability bias occurs in human memory. In a study that involved test cycles of 24 word pairs, it was concluded that the “participants underestimated both their potential to forget and their potential to learn” (Kornell & Bjork, 2009, p. 464). The participants erroneously inferred that since a word is known now, it will be known in the future, which it turned out not to be the case. Results also indicated that participants by more than 50 percent underestimated the effect of studying. Thus, participants did not feel that studying would aid in their memory retention, but in actuality it did.

Findings from Kornel and Bjork (2009) are important to keep in mind when assigning a learner new vocabulary to master. Although a word is known in the present state, it does not mean it will be remembered in the future. When games are designed, they should possess a clear structure (Robertson & Good, 2004). It should take into account the way the human
memory operates. Games require the full attention, active filtering of important and unimportant information, in the player’s sensory memory in order for progress to be made (LaBerge & Samuels, 1974). Loftus and Loftus (1983) describe, “Since performance in video games depends, in large part, on the speed at which you’re able to do things, the question of how fast you can shift your attention from one set of information to another is quite important” (p. 48). Through the actions of rehearsal and practice, items shift from sensory memory to short-term memory thus allowing for the prevention of forgetting. The amount of practice and rehearsal has an impact on remembering (Grodal, 2003; Hunter, 1995). Loftus and Loftus (1983) explain the manner in which something was remembered impacts how long it will remain in the memory. The manner that information is remembered can occur by means of three processes: encoding, retrieval, and attention.

**Encoding**

The development of a robust vocabulary involves more than just interacting with a word once. It involves a deeper process called encoding. This process involves the storing of the symbols of a language into memory in a form easily retrievable for later use (Miller, 1972). Underwood (1972) believed that this process could be broken down into three types. The first is through *superficial transformation*, which is when the way the word is to be remembered differs from the encounter or manner with which it was learned in the first place. The second type is a *representation change*. For example, if an object was remembered because of a picture, try remembering it as a word. The third type, and most inclusive, is *encoding* the information including all of the additional surrounding information. Remembering a term may include outside influences such as the page it was on and where you were while learning it. Also, whether or not the term is considered high
frequency or low frequency, the placement of the word in relation to the other words, and the overall classification of the words impacts the way it is encoded into memory (Merritt, DeLosh, & McDaniel, 2006). Further effects can be caused by the content of material itself (words and pictures), the spatial condition, the clustering of the words, and the use of distractors (Bonk & Healy, 2010).

The building of a strong vocabulary requires encoding the new words into your memory in a manner that will allow for later recall. The meaning of a word is a result of the way it was encoded into the memory along a number of dimensions (Wickens, 1972). Inglis, Ankus, and Sykes (1975) agree that memory depends on the storage stage of the learning process itself. Through engagement with a word through a pedagogical technique, which allows for multiple interactions with new vocabulary words, allows for the encoding of the word to take place on multiple dimensions. The repeated interaction promotes the vocabulary growth by providing multiple opportunities to interact with the word through varying activities (Rekrut, 2006). After encoding the word into the memory, the next step involves the ability to retrieve this information at a later time.

**Retrieval**

Once a word is encoded into the memory storage, it is important to be able to retrieve it when necessary. Retrieval occurs based on a cue from an external stimulus or a person’s effort to search through their memory and make connections with previously learned material (Haslerud, 1972). The ability to retrieve information about a word is based off the manner it was encoded in the first place. For example, Underwood (1972) explained if a set of words were placed in front of a person and they were told there will be a memory test on these words, the methods and devices used to learn them will differ from what will actually appear
on the test. This implies that although the participant is learning the vocabulary words to achieve a high score on a test, this does not mean the words are learned in the same manner as they would appear on the test. Rather, the words are still encoded in a manner that will allow the later retrieval and application in a different scenario.

One other factor that affects retrieval is time. The amount of time that lapses between when the material was learned and when it tested plays a factor. Ballard (1913) found that reminiscence, “the remembering again of the forgotten without re-learning,” varies based upon when the test is given (p. 16). He found that recall increased when a brief amount of time lapsed between the learning activities and the test itself. Farrington-Flint, Stash, and Stiller (2008) had a similar finding. In regards to improvements in spelling accuracy over time, the participants shifted from a reliance on the phonological constructs of the words toward the retrieval of the words from memory. This implies that repeated exposure to words helps to transfer the word knowledge from recognition via sight toward recognition via memory storage. Findings by Sénéchal and Cornell (1993) concur in that four and five-year-olds following a vocabulary reading activity were able to recall the same amount of words on the immediate post-test, but one week later the amount of words retrieved by five-year-olds increased. Time and exposure play an instrumental role in the retrieval of information, but to even begin to retrieve information it must be encountered by paying attention to the stimuli.

Attention

The third influential component to memory is attention. Lots of visual stimuli are encountered but it requires focus upon the task at hand in order to move the concept into one’s consciousness (LaBerge & Samuels, 1974; Wolfe, 2000). Everything cannot be
processed, thus information is acted upon based on visual input (Wolfe, 2000). There is a bottleneck of information and only a certain amount can be learned at a time (Child, 1993). Attention in general involves the ability to perceive and focus on a stimulus of interest while blocking outside variables (Kellogg, 2007). Visual attention works similarly - comparable to a spotlight - by becoming focused on a central stimulus and adjacent stimuli are ignored (Kellogg, 2007).

Gaming technologies intend to focus the visual attention of a player by restricting the amount of information present on the screen while simultaneously displaying the information in an eye-catching, stimulating manner (Clark & Mayer, 2007). Dual representation, the act of presenting information in two forms, provides another layer of attention. Liberman, Mattingly, and Turvey (1972) concluded that information is best transmitted in one form and stored in another. Another essential component of a game is the placement of the text on the screen. The organization of the directions and how many instructions are given per screen is important. By focusing one’s attention toward the screen of a game, the tasks necessary for completion are clearly identified. The use of precise wording and clear font selections help the player to focus his or her attention on the important information. Keeping in mind the amount of information that can be retained in memory and the way it is represented can impact how it is remembered.

The amount of attention paid to the information relates to the multimedia theory. This theory explains that presenting information both visually and verbally will offer the learner greater opportunity for recall and recognition (Kearsley, 2009). As the information is presented, the mind selects, organizes, and integrates the information moving it through sensory memory to working memory to long-term memory (Mayer & Moreno, 2002) (see
Figure 2. Theory of multimedia learning and information processing

Presenting information in two ways creates more opportunities for the learner to process the information. Also, by providing information in two ways attention can be paid in both formats, increasing the possibilities of retention. Meanings are built up through various modalities (Gee, 2003). This in turn can be stored in a way that works best for the learner.

The capability of memory is dramatically influenced by the amount of attention given to the information in the first place. As Kellogg (2007) noted, particular skills can only become automatic after extensive practice using them. By allotting time for the students to construct their own experiences, they are able to focus their attention on the task. Attention is affected by a multitude of factors (Wolfe, 2000). Some of the external factors that affect attention include the intensity and variability of the stimulus, colors and sounds generated, regularity of the stimulus (time constraints), and the unusual or irregular nature of the stimulus (Child, 1993). Some internal factors revolve around level of interest, amount of boredom, fatigue, and personality characteristics (Child, 1993; Desurvire & Wiberg, 2008). These factors can influence the amount of information remembered.
This literature review intended to identify the main elements that surround the idea of using a mobile device as a tool to learn new vocabulary. First, the context of technology usage by teens was identified. Next, an exploration of the informal learning environment that mobile learning taps into was reviewed. Then, the current research on the potential of vocabulary learning through gaming was analyzed with a special emphasis on the elements of game design. Finally, the psychological principles that would contribute to the remembering of the new information encountered, such as encoding, retrieval, and attention, were identified.

**Methodology**

This study investigated the impact on using an iPod Touch App called Vocab Challenge with high school students. This study explored the growth and transfer of high school students’ vocabulary by analyzing the tools used, an iPod Touch and a vocabulary app, and the students’ technology usage characteristics. The research questions explored were:

1. How can portable media devices (i.e. iPod Touch) impact vocabulary development with high school students?
2. How do certain technology use characteristics affect high school students’ vocabulary mastery?
3. How do certain game characteristics affect the memory and retention of the information presented?
The App: Vocab Challenge

This study examined possible implications of using a portable media device to build high school students’ vocabulary knowledge. The vocabulary words used were based on the Vocab Challenge App. Apps are applications made by third-party developers for use on portable media devices (Black, 2010). This app was developed by Modality, a company composed of educators, technologists, and designers, who specializes in making digital learning, assessment, training, and reference software for Apple mobile devices (Modality, 2010). The app was designed in conjunction with The Princeton Review. The 250 words that appear in this app were selected from the Hit Parade’s list of words most frequently tested on the SAT test, a standardized test used for college admission in the United States.

Vocab Challenge includes four games (i.e., synonym, antonym, connotation, and definition) that address the 250 vocabulary words most commonly found on the SAT test. This game involves the user working with a particular vocabulary word until mastery. One can master the word by having correct answers via repetition and practice on all of the synonym, antonym, connotation, and definition activities. By repeating the same vocabulary words in the different games each day, this rehearsal can aid in the long-term memory of the words by aiding in the speed of retrieval as well as allowing the memory to utilize mental rotations (Loftus & Loftus, 1983). Thorough knowledge of a word must be acquired before the player can move on to new words.

The Vocab Challenge App follows a branching design format. There is a predetermined list of words the player encounters, but depending on his performance with each word, the following words he interacts and works with will vary and rotate continuously until mastery. The player interacts with the same twenty words randomly in each of the four
games with feedback between each game. After the twenty-words are encountered in each game, a summary screen displays feedback about each word. This screen offers feedback to the player by providing a checklist of correct (green check) and incorrect (red X) responses at the end of each of the games (see Figure 3).

Figure 3. Word summary screen following the completion of a game

The player can view in-depth details regarding each vocabulary item by touching the small letter “i” circle by each word. The player can then review the full definitions and other pertinent information about each of the words encountered; such as correct pronunciation, synonym, antonym, connotation, and a sample sentence. Essentially, the game provides a feedback loop by having game play immediately followed by feedback (Haslerud, 1972). New words are phased in once mastery has occurred on the previously encountered words, ultimately leading up to the mastery of all 250 words found in the app.
The Vocab Challenge App contains built in scaffolds to promote retrieval. Haslerud (1972) notes, “Recall depends upon the active remembering of performances learned previously” (p. 130). Retrieval cues, such as incorporating the same word via multiple game types, assist in recall. The app does this by offering multiple game interactions, such as, synonyms, antonyms, connotations, and definitions, all within predetermined time constraints. Also, each of the four games are similar in font, color scheme, and layout. This helps players with consistency of locating features and presenting only the necessary information without being bombarded with other distracting items. The player is actively involved with game play requiring the finger movements across the screen. The hand-eye coordination helps in the development of the skills necessary to reach the goal sought (Loftus & Loftus, 1983).

The Vocab Challenge App includes the use of rewards. Points are earned for correct responses with an increase in the number achieved based on the rapidness of the responses. The number of points earned varied depending on the quickness of the player’s response. As soon as an item would appear, a timer would start ticking down from ten seconds. The closer to ten seconds that a player correctly answered an item, the more points earned. The timed aspect of the game intends to replicate the timing constraints that are present when taking the SAT and ACT (Kaplan, n.d.).

Measurements

Three instruments were used in this study to collect data from participants. Demographic surveys were used to gather participants’ baseline information, a pre- and post-vocabulary test were administered to discover participants’ knowledge and understanding of
words, and a daily log form was used to track participants’ usage of the Vocab Challenge App.

Demographic Surveys

Two demographic online surveys were administered to participants. The first survey, *Vocabulary Acquisition via iPod Touch 1*, gathered basic demographic data about each participant. This included items like year in school, age, ethnicity, primary language, previous ACT/SAT materials used, familiarity with an iPod Touch, and frequency of use related to different technologies (see Appendix B). The design of the demographic questions was based on questions that appear on the *National Survey of Student Engagement* (Indiana University Center for Postsecondary Research, 2009). The frequency scale was based upon the work of Fowler (1995) who provided helpful techniques of designing survey questions. Some questions constructed were based on the items used in the *Survey of Technology Use at Penn State by Faculty, Staff, and Students* (Sonak & Williams, 2008) and the *Illinois Instructional Technology Data Portal* (Oyer, 2009).

The second survey, *Vocabulary Acquisition via iPod Touch 2*, was administered at the end of the study (see Appendix C). This survey collected data about the participants’ overall experience with the iPod Touch and the Vocab Challenge App. It included items about level of difficulty using the iPod Touch, overall experience using the Vocab Challenge App, helpfulness of the feedback the app provided, emotions felt while playing the app (Bakera, D’Mello, Rodrigoc, & Graesser, 2010; Gow, Cairns, Colton, Miller, & Baumgarten, 2010), and techniques used to figure out the different vocabulary words (Allen, 1999). These questions were all multiple-choice format. There were two final short answer questions where participants could write a brief descriptive explanation of their overall experience with
the app, and they could also discuss any suggestions for redesigning the app. Collectively, these two surveys gathered data from the participants that documented their experiences using the iPod Touch and the Vocab Challenge App.

Vocabulary Tests

The vocabulary pre- and post-tests were created based upon the words found within the app. Every time the app was opened it would draw from the first 50-100 words out of the possible 250 words. The researcher played the four games on the app noting the twenty words used for each. A cumulative list of 80 word items (20 synonym, 20 antonym, 20 definition, 20 connotation) was created. From these words, duplicates were taken out and the first ten words remaining in each game were used to formulate the vocabulary test. This formed a forty-item vocabulary test constructed of 10 questions of each type (synonym, antonym, definition, and connotation).

The 40-item vocabulary test was administered and completed by 61 undergraduate students at a large Midwestern University who volunteered to participate (see Appendix D). These students were targeted because many had recently taken or were about to take the PPST: Pre-Professional Skills Test for Teachers. This test possesses similar components to the SAT and ACT in terms of vocabulary development and reading comprehension. The vocabulary test was administered online and was completely anonymous. The participants had to click and select the correct choice regarding antonyms, synonyms, connotations, and definitions. For example, the first section asked participants to match the definition to the correct word (e.g., definition: vacant, lacking ideas or intelligence, answer choices: nonsensical, abstracted, vacuous). The results of this test were used to determine the difficulty level of the words.
Based on the participants’ answers, information about each individual word was acquired to allow for the creation of the two vocabulary tests that were used later in this study. The mean score on the test was 65.33%. Each individual test item was analyzed by determining the percentage of participants who answered it correctly.

First, values for each item ranged from 100% (every participant answered it correctly) to 16% (only about 10 participants answering it correctly). Based upon these numbers (percentage correct), the pre-test and post-test were created. Five questions of each type (synonym, antonym, definition, and connotation) were placed on each test depending on the difficulty level. The questions selected to be on the pre-test and post-test consisted of similar correct percentages. The figure below outlines the similarity in the correct percentage of each type of question on both the pre-test and post-test (see Figure 54).

![Figure 4. Average percentage values pre-test and post-test based on question type](image-url)
As a reliability check, Cronbach’s alpha was computed resulting in a reliability coefficient of 0.65 on the pre-test items and .62 on the post-test items to determine the internal consistency among items. A value over .60 meets the minimum acceptable level of inter-item reliability (Klassen, 2004). Overall, these results helped validate the instruments, the 20-item pre-test and 20-item post-test that were used by the high school participants during the study.

Daily Log

A daily log form was created using Google Forms so participants could keep track of the total time they spent each day using the game during a three-week time period (see Appendix E). This provided an online access point where participants could track their daily usage with the Vocab Challenge App. Information collected included their ID number, amount of time played, where played, and number of new words mastered. In addition, participants would copy down the information off the game stats section of the app.

Participants

Participants were actively recruited at their respective high school. They were recruited for the study by means of school counselor referrals, in-class presentations, and flyers. Students did not need to own an iPod Touch to participate. At one high school, High School A, the school counselor met with the researcher to discuss the details of the study. Then the school counselor, who typically offers SAT and ACT review activities for students, announced the study over the daily announcements at the school. Participants then spoke with the counselor about participating in the study. The researcher then followed this up by attending multiple homerooms sessions to meet with the participants.
At another high school, *High School B*, the researcher gave a brief presentation in several high school English classes that explained the study, answered students’ questions, and passed out flyers to students who expressed interest. The flyers highlighted basic study information (tool to assist in the preparation for the ACT and SAT exams), noted the researcher’s contact information (email and phone number), and discussed possible compensation (i.e., entered into a drawing, free app) (see Appendix F). Students were encouraged to take the flyers home and share them with their parents. The parent or student then contacted the researcher through email or by phone in order to answer any remaining questions and to set up a time to meet and begin participation in the study. The actual orientation for the study took place in a variety of locations that included the university campus and participant homes. The location was agreed upon by the researcher, participant, and parent.

Thirty-one students participated in the study. Six of these participants did not record any use with the app during the 3-week time period between the vocabulary pre- and post test. As a result, these participants were dropped since it could not be verified whether or not they used the app at all. This left twenty-five students (9 male, 16 female; $M = 16$ years, $SD = .87$) who volunteered to participate in this study. From the overall group of participants, 14 were from *High School A* and 11 from *High School B*. Overall, the majority of the students were in 11th grade, with 60% (n=15) in 11th, 24% (n=6) in 10th, 8% (n=2) in 9th, and 8% (n=2) in 12th. English was the native language of all participants, who came from a variety of ethnic backgrounds: 68% (n=17) White/Caucasian, 24% (n=6) Asian American/Asian, and 8% (n=2) African American/Black.
Since the Vocab Challenge App is designed as a tool to use for preparing for the SAT, it was also important to note which participants (1) already took the SAT/ACT, and (2) had previous experience using SAT or ACT preparation materials. Five participants had already taken the test. Out of all the participants, 40% (n=10) had taken a formal preparatory course or used some other materials such as books (i.e., Collegeboard SAT prep book) to study for the exam.

**Research Procedures**

Participation in the study randomly occurred over the course of eight months. For each participant, his/her involvement lasted for three weeks and involved two sessions where each participant met with the researcher. Parents would email or call the researcher to set up a time, date, and location for an initial meeting. The parent(s), participant, and researcher all were present at this meeting. Also, parents in some instances would receive the consent form ahead of time, sign it, and then the participant and researcher would meet on the high school campus for the sessions. Once consent was attained, the participant was then given a unique ID number and letter to use throughout their participation in the study (see Appendix G). For example, depending on the participant’s number, he/she was given the corresponding letter in the alphabet (i.e., 1a, 2b, 3c, etc…). This participant ID number was used to track the usage characteristics while each participant used the app and for the vocabulary pre- and post-test results.

The participant completed two brief online activities during this initial meeting. The first activity involved taking the twenty-item, multiple-choice vocabulary pre-test. Once completed, the participant then answered a brief online survey entitled, *Vocabulary Acquisition via iPod Touch 1*, that gathered demographic and technology usage information.
Next, the participant was introduced to using the iPod Touch and the Vocab Challenge App. For those students who already owned an iPod Touch, they were able to participate immediately and were given the money (i.e., $5.00) to purchase the app and download onto their device. Together, the researcher and participant went through the components of the app, how to navigate it, and played through one or two of the games (see Figure 5).

![Game screen of Vocab Challenge App during antonym game](image)

*Figure 5. Game screen of Vocab Challenge App during antonym game*

The participant learned how the screen would produce a green frame when a correct response was given and a red frame when given an incorrect response. Participants were also alerted to the fact that they needed to answer questions within the ten-second time limit in order to gain a greater number of points.

Once the participant understood the details of the app, the researcher referred him/her to a web location where the Daily Log Form was located. The form was reviewed by the
participant and the researcher to note the information required, such as, the participant’s ID number, date, amount of time played, locations where played, and app game statistics. The participant was given the URL address via email. The participant was then instructed to use the app as much as possible for the next three weeks, but there was no specific amount of time stated that they needed to use it each day. The researcher stressed that the Daily Log Form was to be completed each day the app was used. For those participants who lacked at-home Internet access, they were given a paper copy of the daily log form and asked to keep track of their usage on a piece of paper.

For the next three weeks, the participants used the Vocab Challenge App and tracked their daily progress using the Daily Log Form. At the end of the participant’s three-week session, a follow-up meeting was held. Those participants who owned an iPod Touch were given the options of meeting again face-to-face with the researcher to complete the final two online activities or they could complete the activities on their own. Those participants, who did not own an iPod Touch or preferred the face-face interaction, met again with the researcher for thirty minutes. Regardless of the format selected for the follow-up meeting, both groups completed the same two tasks. The first activity required the participant to complete the twenty-item vocabulary post-test. After completing the vocabulary post-test, the participants completed a brief survey, *Vocabulary Acquisition via iPod Touch 2*, about the design of the game. These questions specifically addressed the participants’ experiences with the app, such as the difficulty encountered, overall experiences with the different games, helpfulness of the feedback, emotions experienced while playing, and techniques used to figure out the words. Participants were also given the chance to provide brief written responses regarding their experience with the app and any suggestions for redesigning the
app. The final survey question was optional and allowed the participant to enter his or her email address for a drawing to win one of two $25 iTunes Gift Cards. The email address was not linked to participants’ responses.

**Data Analysis**

To discover the impact the iPod Touch and Vocab Challenge App had on high school students’ vocabulary development and word knowledge over time the data (vocabulary tests, daily form, and surveys) collected from the high school students were analyzed. Descriptive statistics were performed on the demographic information (i.e. gender, classification, age, etc…). Using statistical software, the vocabulary pre- and post-tests were analyzed using dependent paired samples t-tests to determine any statistically significant differences in means. The data collected on the Daily Log Form involved gathering descriptive statistics. For example, patterns were examined to document the amount of time the app was used as well as the location of where the App was played. Other information collected and analyzed involved the game statistics, such as, percentages of the scores in each game type (antonym, connotation, definition, and synonym).

A regression analysis was used to determine the relationship between one dependent variable (i.e., post-test vocabulary test score) and several independent variables (i.e., iPod ownership, frequency of Internet use, frequency of composing documents, frequency of designing artistic projects, frequency of playing computer or video games, frequency of sending and receiving email, frequency of listening to and downloading music, frequency of researching and gathering facts for school work, frequency of social networking, and frequency of viewing simulations) addressed in the study. The iPod ownership and
frequency levels were all collected through survey data provided by each participant at the beginning of the three-week period.

Finally, the open-ended question responses regarding each participant’s overall experience were read. After reading through each response, general themes emerged, were noted, and given a numerical code. Next, each response was assigned the numerical code that was based upon the theme present in the response. The response was also cross-compared with the similar question of selected response format in order to check for consistency. In order to determine if certain word study strategies influence students’ success in vocabulary mastery, the techniques used by the participants were analyzed via descriptive statistics. A thorough data analysis led to the ability to discover important findings related to the research questions.

**Results**

The results of the quantitative data collected were analyzed by using t-tests, a regression, and descriptive statistics. Results will be presented for each research question individually. Research question 1 investigated the impact of portable media devices on vocabulary development. Research question 2 analyzed the impact of the participants’ technology usage on performance. Research question 3 looked at the design characteristics and psychological principles inherent in the app.

**Impact of Portable Media Devices on Vocabulary Development**

The first research question was, “How can portable media devices (i.e. iPod Touch) impact vocabulary development with high school students?” The pre- and post-vocabulary test scores were available for 25 students from two schools. From High School A, fourteen students participated and from High School B, there were eleven participants.
The vocabulary test scores were analyzed through a dependent samples t test. There was not a significant difference in the scores for the pre-test (M=13.80, SD=2.02) and post-test (M=14.16, SD=2.81); t(24)=-0.74, p=0.23. The t-test effect size, Cohen’s d, was -0.15 with a Pearson r value of -0.07. An effect size of .2 is considered small (Cohen, 1988). The r value indicates that with a correlation coefficient of .396, there is no statistically significant relationship between the pre-test and post-test, r (24) = -0.07, p =.23. This result was also verified through a Fisher’s Exact Test, which indicated a p-value =.66. Table 2 illustrates the various scores achieved by the participants at the different high schools.

Table 2

*Pre- and Post-Vocabulary Test Scores*

<table>
<thead>
<tr>
<th>School</th>
<th>Pre-Test M (SD)</th>
<th>Post-Test M (SD)</th>
<th>Gain M (SD)</th>
<th>Cohen’s d</th>
<th>Effect Size r</th>
</tr>
</thead>
<tbody>
<tr>
<td>High School A</td>
<td>13.71 (2.49)</td>
<td>13.79 (2.83)</td>
<td>-.07 (2.23)</td>
<td>-0.03</td>
<td>-0.02</td>
</tr>
<tr>
<td>High School B</td>
<td>13.91 (1.30)</td>
<td>14.50 (2.84)</td>
<td>.73 (2.76)</td>
<td>-0.27</td>
<td>-0.13</td>
</tr>
<tr>
<td>All</td>
<td>13.80 (2.02)</td>
<td>14.16 (2.81)</td>
<td>0.36 (2.45)</td>
<td>-0.15</td>
<td>-0.07</td>
</tr>
</tbody>
</table>

M = *Mean*; SD = *Standard Deviation*; d = *Effect Size*

Although the vocabulary test data displays the average growth of vocabulary knowledge during the course of the study, it is also important to take a look at the emotions and experiences endured by the participants. Figure 6 displays the various emotions that were felt during the course of the study.
Participants were asked to rate their emotional experiences while playing the different games within the app. Selections were based on a 5-point scale: never, seldom, about half the time, usually, and always. A principal components analysis was used to classify the relationships between the six emotion variables. The eigenvalues and scree plot indicated the components loaded primarily onto three factors. The loadings after a varimax rotation indicated that the first component indicated the participants felt confused (0.71). The second component indicated that the participants had a high negative level related to the satisfied variable (-0.75) with the games in the app. The third component indicated the participants felt challenged (0.69). These three values together indicated the level of engagement that the participants felt while playing the different games on the app. Overall, they felt challenged but also unsatisfied and confused at times with their experiences.
Similarly, the motivating factor behind the participation comes into account. All short answers were read and coded (1, 2, 3, etc…) based upon the context of the response. Four primary themes emerged with two responses falling into the “Other” category. The other responses were not related to each other or any of the other respondents’ comments. The participants described their reasoning to participant according to four common themes: to improve vocabulary knowledge, to practice for the SAT/ACT, to learn something new, and to have the opportunity to use an iPod Touch (see Figure 7).

![Bar graph showing reasons for participation](image)

**Figure 7.** Major reasons for participation in the study

Both the felt emotions, as well as the motivation behind participation, contribute to the participants’ overall experience with the Vocab Challenge App. On a 5-point scale of very dissatisfied (1) to very satisfied (5), participants rated their experience with the app as satisfied (M=4.04, SD=0.45). These numerical responses were matched with the textual
responses the participants provided. The two items highly correlated with the numerical ratings. Those who rated the experience with the app as neither dissatisfied nor satisfied (n=2) described the experience as too fast-paced and due to the repetitiveness of the game, gradually lost interest. Those who rated the experience as satisfied (n=21) described on average that they had a good experience and enjoyed the interactive nature of the games. Those who rated the experience as very satisfied (n=2) described it as fun and that they learned a lot of new vocabulary words (see Appendix I).

Impact of Participants’ Technology Usage on Performance

The second research question was, “How do certain technology use characteristics affect high school students’ vocabulary mastery?” Prior knowledge and the comfort level with technology had the potential to impact the students’ performance and their vocabulary test results. Taking the post-test scores into account varying factors were explored to explain the potential outlying impact that technology use could have. The participants varied in their ownership of an iPod Touch. Only seven, 28%, (two male and five female) out of the twenty-five participants owned their own iPod Touch. Out of the seven iPod Touch owners, only two had previously downloaded or purchased educational apps. Some apps owned by participants included human anatomy, Spanish dictionary, and dictionary/thesaurus. The comfort level of the participants using an iPod Touch was M=3.96, SD=0.98 (close to comfortable =4). This indicates participants leaned more toward feeling comfortable with using an iPod Touch. Although only a small number owned iPod Touches, there was no correlation (0.06) between the post-test score and owning an iPod Touch.

A regression analysis was conducted to determine the impact the frequency of use of varying technological tools had on the post-vocabulary test score. The technology usage was
rated using a 7-point scale with the following headings: more than once a day (7), almost every day (6), a few times a week (5), about once a week (4), two or three times a month (3), about once a month (2), and less than once a month (1). The variables were listed in their order of frequency of means from highest to lowest. The frequency of researching and gathering facts online for school work significantly predicted the post-test scores, $b = 1.08$, $t(23) = 2.33, p < .035$. The frequency of designing artistic products (graphics, video, and/or sound) also significantly predicted the post-test scores, $b = -0.74$, $t(23) = -2.24, p =0.042$. However, the results do suggest that owning an iPod Touch and the frequency of use regarding the remaining technologies did not have a significant impact on the post-vocabulary test score. Although not significant, it is important to note the varying technologies the participants are using on a regular basis. Table 5 shows that participants were accustomed to using all of the different technologies with the most common of using the Internet (almost every day) and least common of designing artistic products (two or three times a month).
Table 5

*Means of technology use by participants*

<table>
<thead>
<tr>
<th>Means of Technology Use</th>
<th>Level of Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use the Internet (logging on, search engines, bookmarks)</td>
<td>6.44</td>
</tr>
<tr>
<td>Compose word processing documents, spreadsheets, and/or databases (Word, Excel, Access)</td>
<td>4.32</td>
</tr>
<tr>
<td>Design artistic products (graphics, video, and/or sound)</td>
<td>2.76</td>
</tr>
<tr>
<td>Play computer or video games</td>
<td>4.08</td>
</tr>
<tr>
<td>Send and receive e-mail</td>
<td>5.84</td>
</tr>
<tr>
<td>Listen to and download music</td>
<td>5.92</td>
</tr>
<tr>
<td>Research and gather facts online for school work</td>
<td>5.44</td>
</tr>
<tr>
<td>Networking and sharing resources with others (blogging, instant messaging, podcasting, wikis, discussion boards, and community websites)</td>
<td>5.44</td>
</tr>
<tr>
<td>View simulations or models (math and physics)</td>
<td>3.36</td>
</tr>
</tbody>
</table>

Subsequently, the amount of time spent utilizing the app on the portable learning device was also analyzed to determine the effect it may have had on the post-test score.

Participants noted that during the study they utilized the portability of the iPod Touch by engaging in game play on the app in various locations, such as at home, in a car or bus, and at school/study hall. The amount of time the app was played was divided into 4 primary categories depending on the number of minutes self-reported by the participants. The self-report data was gathered through the daily form (Google document) the participants filled out each time they played the app. Twelve reported 1-99 minutes, nine reported 100-199
minutes, two reported 200-299 minutes, and two reported 300+ minutes. The figure below displays the amount of time in relation to the growth level between the pre- and post-vocabulary test of the participants. The scores peaked with the strongest positive relationship of usage between 100-199 minutes. The groups of participants who reported usage between 200-299 minutes and 300+ included a very small group, thus only a limited amount of information can be drawn from these two groups.

![Graph showing relationship between time with app and pre/post vocabulary test difference](image)

**Figure 8.** Relationship between time with app and pre/post vocabulary test difference

The time recorded also related to another factor that the participants recorded while playing the app. They had noted (based on the built in game statistics feature) the number of words encountered throughout the entire game play. This number related to the amount of time in a positive manner (more minutes, more words). These two numbers were tracked in different ways. The amount of time was recorded by means of the participant estimating how much time they spent playing to the nearest five minutes. In contrast, the number of words
encountered was cumulatively tracked as a built in program within the game. The lack of an accurate relationship consistent across all participants may indicate that the participants did not accurately record the number of minutes spent with the app. Figure 9 displays the amount of time recorded versus the number of words encountered for each participant.

Figure 9. Cell plot of time and number of words encountered by each participant

The lack of consistency of time and words encountered reveals two things: (1) that participants had the ability to move at their own pace during game play and (2) that the estimated amount of the time played was not a 100% accurate measure since this was self-reported and relied on the judgment of the participant as opposed to a standard statistic gathered through the device.
Design Characteristics and Psychological Principles Inherent in the App

The third research question was, “How do certain game characteristics affect the memory and retention of the information presented?” The design characteristics and psychology principles inherent in the iPod Touch app, Vocab Challenge, were investigated to determine the influence these components had on learning. Descriptive statistics were used to gather information regarding the level of difficulty the participants encountered while participating using a difficulty scale where 1=very difficult to 7=very easy. The first question asked participants to rate the difficulty experienced while navigating on the iPod Touch itself. Participants found navigating the iPod Touch quite easy (M=6.56, SD=0.58) with all participants responding between slightly easy (5) to very easy (7). The subsequent questions looked at the difficulties of the app in general and then broke it down by the understanding of the rules behind each game (synonym, antonym, definition, connotation). The final two questions looked specifically at the design feature of the app (ease of navigating the pages and the ability to read the font). Table 6 outlines the mean and standard deviation for the difficulty rating for each item. Overall, participants found the basic design components of the app between slightly easy to very easy to navigate and understand.
Table 6

Difficulty Rating Regarding App Design

<table>
<thead>
<tr>
<th>Item</th>
<th>Level of Difficulty</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Playing the app overall</td>
<td>6.20</td>
</tr>
<tr>
<td>Understanding the rules of the definition game</td>
<td>6.50</td>
</tr>
<tr>
<td>Understanding the rules of the antonym game</td>
<td>5.76</td>
</tr>
<tr>
<td>Understanding the rules of the synonym game</td>
<td>6.20</td>
</tr>
<tr>
<td>Understanding the rules of the connotation game</td>
<td>6.32</td>
</tr>
<tr>
<td>Navigating the pages</td>
<td>6.24</td>
</tr>
<tr>
<td>Reading the font</td>
<td>6.50</td>
</tr>
</tbody>
</table>

Participants also commented on their overall experiences with the app. To examine these experiences, descriptive statistics were calculated. The questions (i.e., experience with the antonym game, connotation game, etc…) were based on ranking the experiences within the app on a 5-point scale ranging from very dissatisfied (1) to very satisfied (5). The data were analyzed to generate average values experienced by the participants in each of the four games. The data suggest participants were overall satisfied (4.04) with each game: definition (4.29), antonym (3.40), synonym (3.97), and connotation (4.06) respectively. Participants also responded to how their experience would connect with future use of the app based upon a 5-point scale ranging from strongly disagree (1) to strongly agree (5). On average (M=3.24, SD=0.88), participants were neutral regarding whether or not they would continue
to use the app after their participation in the study ended. They also were exactly in between neutral to agree, but closer to agree (M=3.67, SD=0.76) regarding the idea of recommending this app to a friend.

The way the app was designed could contribute to the potential impact on the amount of information retained. Taking the psychological principles of encoding, retrieval, and attention into account can help explain why the vocabulary presented and interacted with was remembered. After working with the app for three weeks, participants were asked to answer two brief questions. The first emphasized the helpfulness of the feedback that the app provided. This was rated on a 5-point scale ranging from very unhelpful (1) to very helpful (5). The mean rating of the feedback the app provided was 3.44. This mean response is in between neither unhelpful nor helpful (3) and helpful (4). Additionally, participants were asked to offer suggestions of ways that the app would be better designed to assist them in learning and remembering new vocabulary words. These two items were reviewed to look at any relationships between a low ranking on the feedback item and suggestions about changes that could be made to the app having an emphasis on feedback as opposed to other components (see Appendix J). Those who ranked the app unhelpful (2), shared the following comments: “Show the right answer, and give more directions for the antonym and synonym parts” and “It would tell you the correct answer if you got a word wrong.” In contrast, those who gave the feedback a high rating, very helpful (5), focused more on the design elements of the app, such as: “I would maybe make it so you slide the answer off the screen instead of sliding the two wrong answers off. Sometimes I would forget and slide the answer off instead of eliminating the other two” and “Maybe have one game on which was more of a fun game to review the words after they were mastered, or just a section to review mastered words.”
The participants who fell around the mean, giving the rating of neither unhelpful nor helpful (3) or helpful (4) offered suggestions that both dealt with the feedback component as well as the intricacies of the app functions and capabilities in general. For example, two participants giving a 3 rating stated: ‘The only thing I would really focus on changing would be when the answer is wrong, to show the right answer. I think this would help enhance the learning from the games. I would also have the timer be optional. Sometimes I just really needed more time to think through the words and their different meanings, especially when I first began playing the games’ and ‘I don’t like how I have to swipe to [sic] words away. I would rather just be able to double tap the word I want to choose.’ Two participants that gave a rating of 4 suggested: ‘I would keep the same 4 games. However, instead of jumbling 250 words for the participant to memorize, I would use less words (e.g., 10). Then, the participant could first choose to use flashcards to study the words. After finished with studying, they would then play the 4 games to master the words’ and ‘I would make levels with different games with the vocab words so you’re not always doing the same games over and over. Also, I would maybe add some color or visual appeals to the game.’ Participants generally found the feedback helpful while simultaneously feeling that design elements of the game could be adjusted to maximize learning potential.

The three research questions provided the context for which the data were gathered. The results suggest the potential of portable media devices impact on vocabulary development of high school students, how certain technology use characteristics affect high school students’ vocabulary mastery, and how certain game design characteristics affect the memory and retention of the information processed.
Discussion

The Vocab Challenge App provided a portable way for the participants in this study to interact with new vocabulary words in an informal learning environment. The post-vocabulary test indicated there was no statistically significant difference between the performance on the vocabulary test prior to the use of the Vocab Challenge App and the performance on the test after, although the scores did increase. Other variables may have contributed to the lack of consistency across all participants to achieve a higher score on the post-test. Some of these variables included the memory characteristics of the participants, their technology use patterns, and the design elements of the game.

Memory

Two factors that Gill (1992) found that influenced word knowledge included present stage of knowledge and attention. The pre-test with only twenty items may not have been able to accurately represent the participants’ present level of knowledge at the beginning of the study. Also, it is important to note the smaller standard deviation on the pre-test as opposed to the post-test. This implies there was greater variance on the post-test, which may be a limitation of the test construction itself. The amount of attention paid to each question in the first place and the shift of the knowledge into long-term memory varied across participants.

Attention

Vocabulary acquisition defines the way that new words are learned (Glencoe/McGraw Hill, 2005). The inability for all participants to gain substantive vocabulary word knowledge through participation with the app is a cause for further exploration into the reasons behind this. One explanation explored involves the act of
attention. Attention involves the ability to perceive and focus on stimuli while blocking outside variables (Kellogg, 2007). The participants noted they played the app in the car, on the bus, and in school. Although this is an affordance of informal, mobile learning, in this case it may have provided distractions. For example, one participant had even noted that she had felt distracted while playing the app.

The participants had also noted that the games within the app were all consistent but the repetitive nature of the design may have been a distraction. For example, one participant suggested, “I would make levels with different games with the vocab words so you’re not always doing the same games over and over. Also, I would maybe add some color or visual appeals to the game.” An important aspect of grabbing the attention of the player involves using eye-catching and stimulating visual cues (Clark & Mayer, 2007). The format of the game needs to vary or else runs the risk of becoming repetitious and basically a “skill and drill” application. Howland (2002) noted games need a hook that engage decision-making and keeps the player’s interest. It appears the game needed to vary in the design elements to offer the players an experience that would draw in these participants and hold their attention. These design and usage distractions could have affected the amount of attention paid to the words.

Retrieval

Another aspect of vocabulary acquisition involves the ability to retrieve the learned information when necessary. The post-test served as measure to determine the amount of information that was learned within the app and the ability to transfer it to the post-test. The amount of time playing the app in between the two tests may have had an effect on the post-test scores. Since learning on a mobile device allows learners to move at their own pace,
some participants may have encountered a word during the first week and another during the third. This was reflected in the great variation in the number of words that were encountered by the participants. Ballard (1913) concluded that the amount of time between when the material was learned and when the test was taken can play a factor.

One limitation to the retrieval process that was noted by many participants was the feedback design of the game. In order to build the vocabulary knowledge until mastery, the app would provide feedback to the participants after each game (synonym, antonym, etc…). As Skinner (2005) noted, feedback provides immediate information thus shaping future behaviors. The feedback in the game was designed to aid in the retrieval of the words and assist with the learning of the correct information surrounding each word. The participants rated the feedback in between neither helpful nor unhelpful (3.44). This becomes problematic since as the theory of Law of Effect explained that the player chooses a path in a game and then the feedback and responses that the game provides, thus shapes the future decisions and choices made in the game (Thorndike, 1913). Learning occurs through trial and error with feedback providing the necessary information to shape future behaviors and decisions (Simpson & Stansberry, 2008). If the feedback in the app was not helpful or unhelpful, the amount of interaction the learners had with the game in shaping future vocabulary responses became limited.

Participants also entered suggestions and ideas regarding the components of the app that could be improved. Garris, Ahlers, and Driskell (2002) note that the game cycle follows a three-step process: user judgment, user behavior, and system feedback. Many suggested having prompt feedback regarding an incorrect response instead of waiting until going through all twenty words until discovering the correct information. For example, a
participant explained, “If a person gets a question wrong, I would redesign the App to show them the right answer right after they get it incorrectly.” This may have impacted the ability to retain and remember the correct vocabulary word information due to the long distance between responding and receiving the feedback. The literature indicated that having feedback in close proximity to the item answered is instrumental and beneficial to the learning process (Child, 1993; Clark & Mayer, 2007). The feedback feature of the game relates directly back to how it was designed.

**Game Design**

The design characteristics present within the app could have impacted the learning potential. Overall, participants found the iPod Touch quite easy (6.56) to navigate. The low level of ownership (28%) of iPod Touches did not have an affect on the performance on the post-test. Thus, the performance on the post-test was not influenced on whether or not the participants had owned their own iPod Touch or borrowed one from the researcher. Also, the design of the app regarding the font selection and the ability to navigate among the pages was deemed as quite easy. When a game is designed, it needs to possess a clear structure (Robertson & Good, 2004). The participants’ responses indicated that the overall game structure provided an environment that was clear and understandable.

A game is composed of rules that funnel the players’ actions to have specific consequences (Crawford, 1984). The participants’ ability to understand the rules of the game was important to the amount of success they would have while playing the game. A firm understanding of the rules is critical to meeting the expectations of the game (Berger, 2002; Hsu & Wang, 2010). Each game was reviewed for the difficulty level of understanding the rules as understood by the participants. The rules of each game were found to be slightly
easy (5) to very easy (7) for participants to understand: definition (6.50), antonym (5.76), synonym (6.20), and connotation (6.32). Once the rules were understood and a general idea was formulated on how to achieve the goal, the game play could then focus more on the content of the game itself (vocabulary words). This involved the process of encoding the rules and expectations in to the memory as a process by which the later encountered words could be subsequently moved into the memory.

The design of this game included the feature of creating a unique experience for each player. The words encountered would shift in order every time the app was opened. This was a drawback for some participants who had wanted to engage more deeply with the same words before moving on. For example, a participant stated, “Maybe an additional section could be added to actually teach the user the about the words.” It is a flaw in the design of the game if they player does not feel engaged or connected with a learning experience regarding the new vocabulary words. Another participant similarly explained:

If I could redesign this app, I would make the frequency of the words I missed the most appear more frequently. I also want the mastered words to be harder to master by making me do the tests at least twice for the same word of the same way of testing. For example, if I were to master the word inarticulate, I would have to get test correctly for the antonyms, synonyms, definition, and connotation of the word twice in order to master the word.

The mastery aspect of the app was important to help contribute to the learning of the word, but without repeated interactions through practice and rehearsal, the potential of forgetting greatly increases (Grodal, 2003; Hunter, 1995). Another participant explained:
It was nice that you were exposed to a certain word 4 times before you could master it. However, even after mastering a previously unknown word, I didn't feel as if getting the word mastered (sometimes by luck) ingrained it in my memory. Overall, it was a good review of words I had already mastered, and a good introduction to some new words.

This confirms that the design of the app was based on learning vocabulary until mastery, but even with achieving this level, the participant may not have genuinely learned the vocabulary word.

Game design also includes the use of rewards and consequences. In this app, the rewards (increase in points and achieving master status) and consequences (decrease in points and buzzing sound) varied depending on the actions of the player. None of the participants mentioned the points feature of the app (more points earned the faster the questions were answered), but some participants would have liked more time to think about their response. The pressure of answering quickly and correctly may have limited the learning potential. Also, the sound used when an incorrect answer was given was not that appealing to the player. It was a loud “buzz” that a participant suggested should be changed. The reward and consequence features inherent in the design of this app provided informative information to the player immediately regarding a correct or incorrect answer allowing the participant to acknowledge an incorrect response.

**Technology Use**

This study explored the impact of the participants’ technology usage on their performance. The heart of the question wanted to get at what technologies high school students were using and how often they were using them. The research suggested that
teenagers are very accustomed to using a variety of technologies (Lenhart, 2009; Rosen, 2010). A very low percentage of the participants actually owned their own iPod Touch (28%) with very few of those participants (22%) having purchased any educational apps. The literature read suggested that this age group has a high percentage of iPod/MP3 ownership, but in this study these items did not necessarily include the Touch. Even taking the lack of ownership into consideration, participants felt comfortable (3.83) using them.

The frequency of use regarding the various technologies, such as using the Internet, composing documents, and networking were all things the participants were commonly doing. These findings coincide with the literature that suggests teenagers are using technologies primarily for browsing the Internet and social networking activities (Lenhart, Smith, Macgill, & Arafeh, 2008). Researching and gathering facts online for school work and designing artistic products (graphics, video, and/or sound) were the two factors that had a relationship with the post-test scores based upon the regression results. An increase in engaging in these two activities predicted an increase in the post-test score. The game had very strict rules and did not allow for much artistic creativity (deigning or writing). The lack of these components in the game and through the testing measure may explain this finding.

If the participants are accustomed to using technologies, it was important to note the amount of time they spent engaged with the iPod Touch and app during the three-week time period. Participants tracked their usage on a daily basis or as often as possible (days the app was used). In general, a trend began to emerge with the participants who tracked 0-100 minutes of time using the app as they experienced a .5 increase in their post-test scores. The group who tracked 100-200 minutes of usage increased by 2 points from the pre-test to post-test. Interestingly, there were four participants that tracked between 200-300 minutes and
300 or more minutes (two in each group). These participants did not have an increase in their post-test scores. The great variation in the amount of time recorded between participants indicated that without a precise standardized measure to record the time spent, participants could have inaccurately estimated the amounts of time spent playing the app.

The variation in the amount of time of game play may have been caused by the unique schedules of high school students. Some participants that recorded more game play used the app during a school break whereas others used it during the school year. The time limitation was compounded by the participants only having three weeks to play the app. The participants may have needed a longer period of time to interact with the app in order to reach mastery on the words that appeared on the post-test. Mastery could only occur through correctly answering the information for a word on all four games. Even if a word was mastered, the game would still incorporate it, and if the player incorrectly answered the word item, it would no longer be labeled as mastered. This challenged the player to actively work with the word and transition it into their memory for later use.

**Engagement**

Participants’ emotional investment in the study and the purpose of the app could have impacted their performance. As Bandura’s Social Learning Theory explains, the effects of a behavior are related to the consequences of the behavior (Bandura, 2006). For example, the two largest groups of students participated to learn new vocabulary and as practice for the SAT/ACT. Since the intention was to learn vocabulary to achieve success in future encounters, the attention, remembering, and reproduction of the content encountered within the app would be of more importance to those with this goal. This theory also noted the importance of the motivational incentive (Child, 1993). These students were highly
motivated and thus may have taken more care in the amount of time playing the app and the process of completing the vocabulary post-test. On the other hand, some participated in order to use/borrow an iPod Touch for the three-weeks. These students were not as motivated to learn something as others and this could have affected their post-test scores.

There were three emotions that were primarily exhibited by the participants that indicated their level of engagement. The first explained that the participants felt confused. The open-response answers provided by the participants confirmed this. For example, a participant stated, “It was confusing. I messed up on synonym and antonym quite a bit because I didn't remember which was which.” If the participant could not figure out which game he was playing, this would have resulted in incorrect responses. A level of confusion can lead to a lack of enjoyment and engagement in the game, which was more clearly exemplified by the second emotional level, unsatisfied. The emotions indicated that participants in relation to the other components had a strong negative rating of satisfied. If unsatisfied with the experience, this would indicate the app was not effective in providing a environment that promoted learning in a fun and enjoyable manner. One participant explained, “It was okay I probably wouldn't do it again.” If the app was redesigned, a response like this would prove helpful in determining how to adjust the games to make them more satisfying to play.

Another emotion articulated by participants was that they felt challenged. Loftus and Loftus (1983) explain that a challenging game shifts in complexity based on performance and time spent. The words within the app included many not commonly used everyday, but rather that would show up on a standardized test (SAT). Participants explained that the challenging nature of the app helped them to get better at the vocabulary words over time. It
also helped participants remember words they already partially knew, but that it was moderately difficult to learn new words. Developing an app that can appeal to all knowledge levels is difficult, but perhaps if the app was able to adjust the difficulty level (easy, medium, hard) depending on which the player choose, the participant could gradually build up his confidence and vocabulary at a more convenient and realistic pace.

Games have the potential to provide word interactions in contexts that are enjoyable (Blachowicz & Fischer, 2008). That potential exists, but the design of the game needs to take players’ characteristics into account when developing them. This includes investigating the way that the human memory works related to the content and learning principles, the technologies the potential game players are using, and the level of engagement that the game intends to provide.

**Conclusions**

This study offered preliminary findings of learning new vocabulary words on a mobile device. Learning words in an incremental form on the portable device allowed for snippets of informal word learning to occur whenever and wherever (Read, 2000). The repeated nature of the word interactions relied on the principles of mastery learning. The pedagogical implication was that the learning of words on the mobile device had the potential to transfer to later word learning scenarios (post-test). A variety of factors influenced this potential; most prominently the amount of time the app was used. For example, some participants used the app for a high number of minutes (500) where as others did not log very many minutes (10). Also, the participants were given the freedom to use the app as often as they could during the 3-week time period. This allowed for great fluctuations in daily use with some using it every day and others only using it once or twice. A follow-up study could
tackle this problem by setting more rigid guidelines regarding the use of the app on a daily basis.

A possible cause of the varying amounts of time usage goes back to the fundamental design components of the game. Loftus and Loftus (1983) described that games need to possess challenge, curiosity, and fantasy. This gaming app might have lacked in the fantasy category. Future studies could investigate games that incorporate all of the categories not just two. Another component of the game that could be improved involved the game design features. The game screens were all very similar (same design), which after a while could become monotonous for the user. Possibly, the game could include a bit of variation in the overall color and game structure (not exactly the same types of movements and screens for all games). And also offer different types of interactions (maybe varying levels based on the number of words mastered as opposed to just a star).

Also, it would be important to update the feedback component, closer to the time the words are answered incorrectly. A game moves in a cyclical fashion: user judgments, user behavior, and system feedback (Garris, Ahlers, & Driskell, 2002). The proximity of the corrective information is instrumental in the encoding of the information into the memory to later be correctly retrieved. This would allow for the transitioning of information from the immediate state into the long-term memory (Gierl, Leighton, & Hunka, 2005).

A study of this nature is easily replicable. Educators could have the use of the app connected to the high school classroom as a mode of beginning to learn something during the day and expanding upon it more during after school hours. One limitation of this study was that it was completely voluntary, thus not all students in a given grade level/class at a certain school participated. This could be overcome by having the tools within the school system
that students could check-out for usage or even if the district has a one-to-one initiative where the students have their own portable devices throughout the school year. As the development of educational apps become more advanced, so do the possibilities within the classroom and beyond as a tool for teaching and learning.
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CHAPTER 5. GENERAL SUMMARY

“Just enough, just in time, and just for me”

--(Peters, 2009, p. 114)

Providing educational opportunities through the implementation of mobile devices presents a way to engage learners anytime and anywhere. The use of mobile devices has become part of the normal daily interaction for young people (Peters, 2009). Traxler (2009) explains mobile learning is best characterized as “personal, spontaneous, opportunistic, informal, pervasive, situated, private, context-aware, and bite-sized” (p. 13-14). The learning environment is flexible and portable allowing for the possibility of educational sessions to occur here and there. Learning becomes individualized, which allows for activities to be completed at a pace best suited for the individual. The activities and tasks engaged in on the mobile device are personalized, authentic, and situated while also relevant, interesting, rigorous, and efficient (Traxler, 2009). In particular, games on mobile devices offer students the opportunity to pick up where the classroom teacher left off and more thoroughly explore a topic of interest all through an immersive and active experience. These experiences provide the opportunity for learners to build a solid foundation of understanding (Kolb, 2008). Learning through a mobile device by means of a game, puts the player in active control of new possibilities. The game adjusts and adapts to meet the individual’s needs and uses this as the starting point from which to build their knowledge and skills up from.

The three journal articles tapped into the essential components surrounding the dissertation’s focus of secondary students’ vocabulary development by using a mobile learning device and gaming app. The first article, “Using Mobile Devices and Gaming as a
Means of Building Vocabulary” provided an extensive literature review. The main topics that emerged include theoretical frameworks, game theory and design, gaming in education, vocabulary learning techniques, and mobile devices. Each of these factors impact the way information is developed, presented, and ultimately learned on a mobile device.

The second article, “The Potential of Building High School Students’ Vocabulary Using an iPod Touch and Gaming App” actively explored the effectiveness of using a mobile learning device and a vocabulary application with high school students. The research methodology investigated the impact a mobile learning device had on high school students’ vocabulary development and word knowledge over time, concluding that based on the regression results, over the course of the study the performance on the pre-test and the performance within the app were statistically significant with the result on the post-test. The participants were divided up into two subgroups depending on the difference between the pre-test and post-test. It was discovered that the participants used a variety of word study strategies while working with the words in the app, such as process of elimination, guessed, and roots/word parts.

In the third article, “Mobile Device Learning: An Exploration of the Processes Involved in High School Students’ Vocabulary Development” reviewed the current literature on game design and psychological components surrounding the development of educational games. This was then further investigated via survey data to examine if certain technology use characteristics influence students’ success in vocabulary mastery and how certain game characteristics influence the memory and retention of the information presented. The results indicated that technology fluency with the specific device did not have a direct impact on the performance on the post-test although designing artistic products and researching and
gathering facts online for school work both had a significant relationship with the post-test score. The ease of use and helpfulness of the feedback provided by the app did have an impact on the overall experience (level of engagement) with the app and whether or not the participants would use the app following their participation in the study.

The three articles provided an analysis of the relevant literature and thoroughly explored the research questions that were posed. A thorough data analysis provided evidence regarding the impact of mobile learning devices as a tool for learning vocabulary. In general, main conclusions can be drawn from this study. This includes the following: the pre-test score had a significant relationship with the post-test score, the amount of time and number of word encounters impacted the results of the post-test score, and the design of the app had an effect on the overall experience and satisfaction levels of the participants. Mobile devices provide the opportunity for learners to move at their own pace and interact with the material as they see fit. This aspect of informal learning accounts for some of the variation that occurred during this study.

**Recommendations for Future Research**

This dissertation provided a starting point for future educational research that explores mobile learning, informal learning environments, and how they relate to the learning and vocabulary acquisition of high school students. Some possible future studies could explore different types of vocabulary games available for play on mobile learning devices. Various games could be explored to determine if a specific format of gaming causes a stronger growth in vocabulary knowledge. Also, further research could investigate the impact mobile devices would have on elementary and middle school students vocabulary building as opposed to high school students. Another topic that could be explored is the
motivating factors behind the use of the mobile device. For example, if the game
environment contained a social aspect to allow for collaboration and the chance to develop a
community of practice would have an impact on the amount of learning attained (Wenger,
2007). Also, if possible a larger sample size might prove to display stronger results, so
incorporating a study of similar design or replicating this study with multiple classes that are
equipped with iPod Touches would help to reaffirm the results that this study presented.

Through the analysis of the literature and an in-depth exploration, the components
essential and necessary in the design of educational games that motivate and encourage
active participation in the learning process were discovered. Future game designers, content
developers, educational professionals, and secondary school teachers can incorporate the
findings into their own designs and in-class activities. This dissertation is just the beginning
of my exploration into the importance of mobile learning and how it can positively impact
the learning experiences of the students within the K-12 environment.
References


APPENDIX A. IRB APPROVAL LETTER

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Institutional Review Board
Office for Responsible Research
Vice President for Research
1138 Pearson Hall
Ames, Iowa 50011-2207
515 294-4500
FAX 515 294-4787

Date: 3/7/2011
To: Jennifer Redd
N062 Lagomarcino

CC: Dr. Denise Schmidt
N031 Lagomarcino Hall

From: Office for Responsible Research

Title: Vocabulary Acquisition via iPod Touch

IRB Num: 10-177

Approval Date: 3/4/2011 Continuing Review Date: 5/19/2011
Submission Type: Modification Review Type: Expedited

The project referenced above has received approval from the Institutional Review Board (IRB) at Iowa State University. Please refer to the IRB ID number shown above in all correspondence regarding this study.

Your study has been approved according to the dates shown above. To ensure compliance with federal regulations (45 CFR 46 & 21 CFR 56), please be sure to:

- Use only the approved study materials in your research, including the recruitment materials and informed consent documents that have the IRB approval stamp.

- Obtain IRB approval prior to implementing any changes to the study by submitting the “Continuing Review and/or Modification” form.

- Immediately inform the IRB of (1) all serious and/or unexpected adverse experiences involving risks to subjects or others; and (2) any other unanticipated problems involving risks to subjects or others.

- Stop all research activity if IRB approval lapses, unless continuation is necessary to prevent harm to research participants. Research activity can resume once IRB approval is reestablished.

- Complete a new continuing review form at least three to four weeks prior to the date for continuing review as noted above to provide sufficient time for the IRB to review and approve continuation of the study. We will send a courtesy reminder as this date approaches.

Research investigators are expected to comply with the principles of the Belmont Report, and state and federal regulations regarding the involvement of humans in research. These documents are located on the Office for Responsible Research website [http://www.compliance.iastate.edu/irb/forms/] or available by calling (515) 294-4566.

Upon completion of the project, please submit a Project Closure Form to the Office for Responsible Research, 1138 Pearson Hall, to officially close the project.
Date: 6/22/2010

To: Jennifer Redd
N062 Latham Hall

CC: Dr. Denise Schmidt
N031 Latham Hall

From: Office for Responsible Research

Title: Vocabulary Acquisition via iPod Touch

IRB Num: 10-177

Approval Date: 6/17/2010

Continuing Review Date: 5/19/2011

Submission Type: Modification

Review Type: Expedited

The project referenced above has received approval from the Institutional Review Board (IRB) at Iowa State University. Please refer to the IRB ID number shown above in all correspondence regarding this study.

Your study has been approved according to the dates shown above. To ensure compliance with federal regulations (45 CFR 46 & 21 CFR 50), please be sure to:

- Use only the approved study materials in your research, including the recruitment materials and informed consent documents that have the IRB approval stamp.
- Obtain IRB approval prior to implementing any changes to the study by submitting the "Continuing Review and/or Modification" form.
- Immediately inform the IRB of (1) all serious and/or unexpected adverse experiences involving risks to subjects or others; and (2) any other unanticipated problems involving risks to subjects or others.
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- Complete a new continuing review form at least three to four weeks prior to the date for continuing review as noted above to provide sufficient time for the IRB to review and approve continuation of the study. We will send a courtesy reminder as this date approaches.

Research investigators are expected to comply with the principles of the Belmont Report, and state and federal regulations regarding the involvement of humans in research. These documents are located on the Office for Responsible Research website http://www.compliance.iastate.edu/IRB/forms/ or available by calling (515) 294-4669.

Upon completion of the project, please submit a Project Closure Form to the Office for Responsible Research, 1138 Pearson Hall, to officially close the project.
Date: 5/21/2010  
To: Jennifer Redd  
    N062 Lagomarcino  
CC: Dr. Denise Schmidt  
    N031 Lagomarcino Hall  
From: Office for Responsible Research  
Title: Vocabulary Acquisition via iPod Touch  
IRB Num: 10-177  
Approval Date: 5/21/2010  
Continuing Review Date: 5/19/2011  
Submission Type: New  
Review Type: Expedited  

The project referenced above has received approval from the Institutional Review Board (IRB) at Iowa State University. Please refer to the IRB ID number shown above in all correspondence regarding this study.

Your study has been approved according to the dates shown above. To ensure compliance with federal regulations (45 CFR 46 & 21 CFR 56), please be sure to:

- Use only the approved study materials in your research, including the recruitment materials and informed consent documents that have the IRB approval stamp.
- Obtain IRB approval prior to implementing any changes to the study by submitting the "Continuing Review and/or Modification" form.
- Immediately inform the IRB of (1) all serious and/or unexpected adverse experiences involving risks to subjects or others; and (2) any other unanticipated problems involving risks to subjects or others.
- Stop all research activity if IRB approval lapses, unless continuation is necessary to prevent harm to research participants. Research activity can resume once IRB approval is reestablished.
- Complete a new continuing review form at least three to four weeks prior to the date for continuing review as noted above to provide sufficient time for the IRB to review and approve continuation of the study. We will send a courtesy reminder as this date approaches.

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Upon completion of the project, please submit a Project Closure Form to the Office for Responsible Research, 1138 Pearson Hall, to officially close the project.
APPENDIX B. SURVEY PART I

Vocabulary Acquisition via iPod Touch 1

Page One

Demographic Information

1. Please enter your participant ID number. (Required)

2. What is your gender?
   ○ Female
   ○ Male

3. What is your current classification?
   ○ Freshman
   ○ Sophomore
   ○ Junior
   ○ Senior

4. What is your age?

5. Select the race you identify with.
   ○ American Indian/Alaska Native
   ○ Asian American/Asian
   ○ African American/Black
   ○ Mexican American/Chicano
   ○ Native Hawaiian/Pacific Islander
   ○ Puerto Rican
   ○ Other Latino
   ○ White/Caucasian
   ○ Other

6. What is your primary language?

7. Which school do you currently attend?
   ○ Ames High School
   ○ Boone High School
   ○ Nevada High School
   ○ Home School
   ○ Other
8. What is your current G.P.A.? 


9. Have you already taken the SAT/ACT? 
   ○ No 
   ○ Yes 

10. Have you taken any SAT/ACT Prep classes? (e.g., private or small group tutoring and online courses) 
   ○ No 
   ○ Yes 

   What have you taken? 

11. Have you purchased any SAT/ACT study materials? (e.g., preparation books and software) 
   ○ No 
   ○ Yes 

   What have you purchased? 

12. Do you own an iPod Touch? 
   ○ No 
   ○ Yes 

   Please list the Educational Apps. you currently have on your iPod Touch.
13. Rate your comfort level with using an iPod Touch.

<table>
<thead>
<tr>
<th>Very uncomfortable</th>
<th>Uncomfortable</th>
<th>Neutral</th>
<th>Comfortable</th>
<th>Very comfortable</th>
</tr>
</thead>
</table>

14. Please rate the frequency of use.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Frequently</th>
<th>Almost every day</th>
<th>A few times a week</th>
<th>About once a month</th>
<th>About twice a year</th>
<th>Less than twice a year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use the Internet (logging on, search engines, bookmarks)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Compose word processing documents, spreadsheets, and/or databases (Word, Excel, Access)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Design artistic products (graphics, video, and/or sound)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Play computer or video games</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Send and receive e-mail</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Listen to and download music</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Research and gather facts online for school work</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Networking and sharing resources with others (blogging, instant messaging, podcasting, wikis, discussion boards, and community websites)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>View simulations or models (math and physics)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Thank you for taking our survey. Your response is very important to us.
# APPENDIX C. SURVEY PART II

## Vocabulary Acquisition via iPod Touch 2

### Page One

Please enter your participant ID number. (Required)

1. Rate the level of difficulty you encountered with

<table>
<thead>
<tr>
<th>Activity</th>
<th>Very difficult</th>
<th>Quite difficult</th>
<th>Neither</th>
<th>Quite easy</th>
<th>Very easy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navigating the iPod Touch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Playing the App overall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understanding the rules of the antonym game</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understanding the rules of the connotation game</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understanding the rules of the definition game</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understanding the rules of the synonym game</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Navigating the pages</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading the font</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Rank your experiences with the Vocab Challenge App.

<table>
<thead>
<tr>
<th>Experience with the App.</th>
<th>Very difficult</th>
<th>Quite difficult</th>
<th>Neither</th>
<th>Quite easy</th>
<th>Very easy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The antonym game</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The connotation game</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The definition game</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The synonym game</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. If you got a word wrong, how helpful was the feedback?

- [ ] Very unhelpful
- [ ] Unhelpful
- [ ] Neither unhelpful nor helpful
- [ ] Helpful
- [ ] Very helpful
4. Based on your game play, rate how often you felt the following emotions.

<table>
<thead>
<tr>
<th></th>
<th>1-6GB</th>
<th>16-32GB</th>
<th>32-64GB</th>
<th>64-128GB</th>
<th>128GB+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bored</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Challenged</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Confused</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Frustrated</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Pressured</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Satisfied</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
5. How frequently did you use the following techniques to figure out each word?

<table>
<thead>
<tr>
<th>Technique</th>
<th>Never</th>
<th>Very rarely</th>
<th>Rarely</th>
<th>Occasionally</th>
<th>Frequently</th>
<th>Very frequently</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guessed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learned at school</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process of elimination</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roots/word parts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remembered it from the summary page</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remembered it from a different game</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other. Please specify below:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Rate your level of agreement with the following statements.

By working with the words in 4 ways, I remembered them more.
By having to use the touchscreen or shake the iPod, I felt actively involved in my learning.
I feel like I know the words I mastered on the App.
I will continue to use this App. after my participation in this study.
I will recommend this App. to a friend.

7. Briefly describe your experience with the Vocab Challenge App.
8. If you could redesign the App (each game), what would you change?

9. Briefly state the main reason that you chose to participate in this research study.

Optional: What is your email address?

Thank you for taking our survey. Your response is very important to us. By completing all the parts of the study, you are entered into a drawing to receive a $25 iTunes Giftcard.
APPENDIX D. VOCABULARY TEST QUESTIONS

Definitions

Fill in the bubble that corresponds to your answer choice.

Section 1: Definition
Match the definition to the correct word.

1. having to do with the curing of disease or injury
   ○ therapeutic
   ○ benevolent
   ○ advantageous

2. vacant, lacking ideas or intelligence
   ○ nonsensical
   ○ abstracted
   ○ vacuous

3. pulsing with life or energy, bright
   ○ chaotic
   ○ bellowing
   ○ vibrant

4. needy or impoverished
   ○ peevish
   ○ indigent
   ○ doleful

5. conforming to standards or proper behavior
   ○ strictness
   ○ propriety
   ○ canonical

6. dependent upon circumstances beyond one's control
   ○ chaotic
   ○ precarious
   ○ befuddled

7. to stimulate to action
   ○ galvanize
   ○ conjecture
   ○ solicit
8. possessing keen perception and judgment
   □ ardent
   □ sagacious
   □ pert

9. courteous, warm, and friendly
   □ ingratiating
   □ cordial
   □ verbose

10. relating directly and significantly to the matter at hand
    □ plausible
    □ pertinent
    □ adjacent
Antonyms

Section II: Antonym
Antonyms are words with opposite meanings. In this section, match the word in bold to its antonym.

11. abundant
   ○ exclusive
   ○ widespread
   ○ scanty

12. extol
   ○ acclaim
   ○ gather
   ○ criticize

13. haughty
   ○ deliberate
   ○ meek
   ○ inept

14. abhor
   ○ adore
   ○ rebuff
   ○ loathe

15. paucity
   ○ yield
   ○ plethora
   ○ deficiency

16. pugnacious
   ○ valiant
   ○ corpulent
   ○ agreeable

17. serene
   ○ agitated
   ○ fixated
   ○ unsupported
18. confound
   - alleviate
   - clarify
   - tantalize

19. magnanimity
   - yearning
   - stinginess
   - privation

20. morose
   - vacuous
   - bountiful
   - lighthearted
Synonyms

Section III: Synonym
Synonyms are words, which have similar meanings. In this section, match the word in bold to its synonym.

21. hackneyed
   - original
   - mangled
   - banal

22. disgruntled
   - stingy
   - jealous
   - cranky

23. anarchy
   - cataclysm
   - insecurity
   - lawlessness

24. jaded
   - wrapped
   - worn
   - adorn

25. durable
   - crushed
   - low-cost
   - long lasting

26. intransigent
   - remorseless
   - itinerant
   - obstinate

27. acumen
   - experience
   - technique
   - insight
28. exasperation
   ○ feebleness
   ○ vexation
   ○ egotism

29. competent
   ○ inept
   ○ capable
   ○ esteemed

30. disparage
   ○ embarrass
   ○ ridicule
   ○ discharge
Connotation

Section IV: Connotation
Connotation refers to the associated meaning of a word. In this section, choose whether the word has a positive or negative connotation associated with it.

31. intransigent
   - positive
   - negative

32. sullen
   - positive
   - negative

33. candor
   - positive
   - negative

34. impropriety
   - positive
   - negative

35. eradicate
   - positive
   - negative

36. diplomatic
   - positive
   - negative

37. demeaning
   - positive
   - negative

38. inundate
   - positive
   - negative

39. prudent
   - positive
   - negative
40. novel
   ○ positive
   ○ negative
APPENDIX E. DAILY FORM

Vocab Challenge

Please enter this information daily.

* Required

What is your participant ID number? *

What is today’s date? *

Estimate amount of time spent playing: *
Round to the nearest five minute increment.

Where did you play? *
Locations

Game Statistics

This information can be found on the statistics page.

Number of word encounters: *

Time per correct encounter: *

Time per incorrect encounter: *
Performance by Game Type

Antonym *

Synonym *

Definition *

Connotation *

Submit

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iPod Touch Research Study

Tired of your parents nagging you to stop using your iPod Touch? Getting ready to take the SAT or ACT?

- If you answered YES to either of these questions, you can become a part of an important 3-week study that looks at using the iPod Touch along with an App as a means to facilitate the mastery of vocabulary words.

- All 10th and 11th grade students are eligible to participate. No experience required, and you do not need to own your own iPod Touch. At the end of the study, you will be entered to win one of two $25 iTunes gift cards!

Contact information for you and your parents is below. I look forward to hearing from you.

Jennifer Redd
(860)833-6693
jredd@iastate.edu
APPENDIX G. INFORMED CONSENT DOCUMENTS

Vocabulary Acquisition via iPod Touch - Vocabulary Test

Page 1 Questions

INFORMED CONSENT DOCUMENT

Title of Study: Vocabulary Acquisition via iPod Touch
IRB #10-177

Investigators: Jennifer Redd, Principal Investigator
Denise Schmidt, Major Professor

This is a research study. Please take your time in deciding if you would like to participate. Please feel free to ask questions at any time.

INTRODUCTION

The purpose of this study is to investigate the learning potential an iPod Touch and the Vocab Challenge App can provide. This study will explore the growth and transfer of a student’s vocabulary from the pretest to the posttest as well as explore technology usage characteristics and demographic criteria. The main research question is the following, “How can portable technology (i.e. iPod Touch) facilitate vocabulary development with high school students?” Other questions investigated include: To what extent does using the Vocab Challenge App impact students’ word knowledge over time? How do certain technology use characteristics influence students’ success in vocabulary mastery? How do certain word study strategies influence students’ success in vocabulary mastery? In an effort to look at the vocabulary, creating a pretest and posttest of equal difficulty is essential. You are being invited to participate in this study because you are a student in CI 201: Digital Learning in the PK-6 Classroom, CI 202: Digital Learning in the 7-12 Classroom, or CI 456/556 Integrating Reading and Technology into the Language Arts Curriculum.

DESCRIPTION OF PROCEDURES

If you agree to participate in this study, your participation will last for one session of twenty minutes. It involves taking a 40-item multiple choice vocabulary test. This online test is completely anonymous and will involve reading through antonyms, synonyms, connotations, and definitions and then selecting your choice.

RISKS

While participating in this study you may experience the following risks: Overall, there are no foreseeable risks since you are engaging in activities that would occur normally in an English classroom.

BENEFITS

If you decide to participate in this study, there may be no direct benefit to you. It is hoped that the information gained in this study will benefit society by providing a new way for students to learn vocabulary. By increasing the student's vocabulary, he may have more success in reading and comprehension activities throughout the rest of his academic career.
COSTS AND COMPENSATION

You will not have any costs from participating in this study. You will not be compensated for participating in this study.

PARTICIPANT RIGHTS

Your participation in this study is completely voluntary and you may refuse to participate or leave the study at any time. If you decide to not participate in the study or leave the study early, it will not result in any penalty or loss of benefits to which you are otherwise entitled.

CONFIDENTIALITY

Records identifying participants will be kept confidential to the extent permitted by applicable laws and regulations and will not be made publicly available. However, federal government regulatory agencies, auditing departments of Iowa State University, and the Institutional Review Board (a committee that reviews and approves human subject research studies) may inspect and/or copy your records for quality assurance and data analysis. These records may contain private information.

To ensure confidentiality to the extent permitted by law, the following measures will be taken: All subjects will be given a unique ID number and letter that will be used on all forms instead of their name. My major professor and myself are the only people that will have access to the data. Paper Documents will be kept in my desk drawer in a locked office.

QUESTIONS OR PROBLEMS

You are encouraged to ask questions at any time during this study.

• For further information about the study contact Jennifer Redd at 860-833-6693 or Denise Schmidt at 515-294-9141.
• If you have any questions about the rights of research subjects or research-related injury, please contact the IRB Administrator, (515) 294-4566, IRB@iastate.edu, or Director, (515) 294-3115, Office for Responsible Research, Iowa State University, Ames, Iowa 50011.

Continuing to the next page indicates that you voluntarily agree to participate in this study, that the study has been explained to you, that you have been given the time to read the document and that your questions have been satisfactorily answered.
INFORMED CONSENT DOCUMENT

Title of Study: Vocabulary Acquisition via iPod Touch

Investigators: Jennifer Redd, Principal Investigator
Denise Schmidt, Major Professor

This is a research study. Please take your time in deciding if you would like to participate. Please feel free to ask questions at any time.

INTRODUCTION

The purpose of this study is to investigate the learning potential an iPod Touch and the Vocab Challenge App can provide. This study will explore the growth and transfer of a student's vocabulary from the pretest to the posttest as well as explore technology usage characteristics and demographic criteria. The main research question is the following, "How can portable technology (i.e. iPod Touch) facilitate vocabulary development with high school students?" Other questions investigated include: To what extent does using the Vocab Challenge App impact students' word knowledge over time? How do certain technology use characteristics influence students' success in vocabulary mastery? How do certain word study strategies influence students' success in vocabulary mastery? You are being invited to participate in this study because you are a student in 10th or 11th grade, which is around the years when the SAT test is typically taken.

DESCRIPTION OF PROCEDURES

If you agree to participate in this study, your participation will last for three weeks and will involve two sessions of approximately thirty minutes each where you meet with me. In between the two sessions, you will be asked to play with the iPod Touch App, Vocab Challenge, and fill out an online form daily. This daily form will take less than five minutes to complete. It asks you to record the amount of time played, where played, number of new words mastered, and record the information off the game stats section. During the study you may expect the following study procedures to be followed: You will be asked to complete a survey about yourself and your technology usage. Next you will be asked to take a multiple choice vocabulary pretest. After a discussion of the equipment, iPod Touch, we will go through the Vocab Challenge App's different features. For the next 3-weeks, you will be asked to play the App. and record the information daily on the online form. Then you will be asked to come back and take a vocabulary posttest and an online survey on the game design.

RISKS

While participating in this study you may experience the following risks: Overall, there are no foreseeable risks since you are engaging in activities that would occur normally, learning vocabulary, but just in a different format, iPod Touch.
BENEFITS

If you decide to participate in this study, there may be no direct benefit to you. It is hoped that the information gained in this study will benefit society by providing a new way for students to learn vocabulary. By increasing the student's vocabulary, he may have more success in reading and comprehension activities throughout the rest of his academic career.

COSTS AND COMPENSATION

You will not have any costs from participating in this study. You will not be compensated for participating in this study. Participants, if providing their own iPod, will receive the Vocab Challenge App. (which has a $4.99 value). All participants will be entered into a drawing for a $25 iTunes gift card.

PARTICIPANT RIGHTS

Your participation in this study is completely voluntary and you may refuse to participate or leave the study at any time. If you decide to not participate in the study or leave the study early, it will not result in any penalty or loss of benefits to which you are otherwise entitled.

CONFIDENTIALITY

Records identifying participants will be kept confidential to the extent permitted by applicable laws and regulations and will not be made publicly available. However, federal government regulatory agencies, auditing departments of Iowa State University, and the Institutional Review Board (a committee that reviews and approves human subject research studies) may inspect and/or copy your records for quality assurance and data analysis. These records may contain private information.

To ensure confidentiality to the extent permitted by law, the following measures will be taken: All subjects will be given a unique ID number and letter that will be used on all forms instead of their name. My major professor and myself are the only people that will have access to the data. Paper Documents will be kept in my desk drawer in a locked office. The online resources, forms and surveys require a user login name and password only known to me. If the results are published, your identity will remain confidential.

QUESTIONS OR PROBLEMS

You are encouraged to ask questions at any time during this study.

- For further information about the study contact Jennifer Reel at 860-833-6693 or Denise Schmidt at 515-294-9141.
- If you have any questions about the rights of research subjects or research-related injury, please contact the IRB Administrator, (515) 294-4566, IRB@iastate.edu, or Director, (515) 294-3115, Office for Responsible Research, Iowa State University, Ames, Iowa 50011.

*****************************************************************************

Revised 07/08/09
PARTICIPANT SIGNATURE

Your signature indicates that you voluntarily agree to participate in this study, that the study has been explained to you, that you have been given the time to read the document and that your questions have been satisfactorily answered. You will receive a copy of the written informed consent prior to your participation in the study.

Participant’s Name (printed) __________________________________________

(Participant’s Signature) ____________________________________________ (Date)

(Signature of Parent/Guardian or Legally Authorized Representative) 

(Date)

INVESTIGATOR STATEMENT

I certify that the participant has been given adequate time to read and learn about the study and all of their questions have been answered. It is my opinion that the participant understands the purpose, risks, benefits and the procedures that will be followed in this study and has voluntarily agreed to participate.

(Signature of Person Obtaining Informed Consent) ________________________________ (Date)
### iPod Touch Study

**Website:**
http://www.public.iastate.edu/~jredd/Research.html

**Session #2**
**Date:**
**Time:**

---

### iPod Touch Study

**Website:**
http://www.public.iastate.edu/~jredd/Research.html

**Session #2**
**Date:**
**Time:**

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**Time:**

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**Time:**

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**Time:**

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### iPod Touch Study

**Website:**
http://www.public.iastate.edu/~jredd/Research.html

**Session #2**
**Date:**
**Time:**
## APPENDIX I: DESCRIPTION OF OVERALL EXPERIENCES

<table>
<thead>
<tr>
<th>Neither satisfied nor dissatisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well, I thought it was a very unique way to learn vocabulary words. If found it pretty easy after a while to guess words correctly. At first, I was using the App every day but then I got really bad about remembering to do it. I think the reason it was fun was because it was on an IPOD touch but I lost interest after a while of doing the same things over and over. The game was a little too fast-paced for me, but I like to concept of the app and it certainly helped me learn a few words.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>I thought the antonym and synonym parts were hard. I should have been less distracted while doing it, which might have helped. I also thinking showing the right answer after getting it wrong would help greatly for the next time. It was a fun way to practice vocabulary! I was a little frustrated when I got an answer wrong because I didn't know what the right answer was, and by the time I looked at the glossary, I rarely remembered it. Otherwise, I think it was quite helpful. I would keep using the App if I had an Ipod Touch of my own. My feeling with this app is that it helped me learn many new words that I had never even heard of before and the app go in depth with each words because it doesn't just have just the definition but also antonyms, synonyms, and connotation. I also like how this app put each word in a sentence and have a voice that enunciate each word. It was nice that you were exposed to a certain word 4 times before you could master it. However, even after mastering a previously unknown word, I didn't feel as if getting the word mastered (sometimes by luck) ingrained it in my memory. Overall, it was a good review of words I had already mastered, and a good introduction to some new words. I felt the App was helpful to reinforce words I already had a partial grasp on but was moderately difficult to learn new words on. The program is very good, but I didn't always find myself motivated to play it. There are definitely some words that have stuck with me, and I think if I had completed the challenge even more would have. It would be a very good way to study for the SAT. It was overall a positive experience. I played during small breaks between my activities. I sometime got frustrated because I didn't know what was the right answer to the question I got wrong. It was a good experience overall. The game was fun and easy to understand. I felt that I didn't know many words. I also came across many new words that never heard before. It started of very easy with words that I know very well and eventually turned into words that I have never seen or heard before. The Connotation game was one of the easiest because it was very easy to use context clues to figure out most of the words. The Antonym and Synonym games were sometime very difficult because there would</td>
</tr>
</tbody>
</table>
be words that we right but it was not the word the App. was looking for so it would reject it. Definition was a little on the easy side because it did not have confusing answers but would sometimes give it away with obvious wrong answers.

| It was okay I probably wouldn't do it again                      |
| i had a good experience. it was a good way to get involved.    |

I liked using it. Pressured me to concentrate when playing. Seeing as how I don't have my own iTouch, I probably won't be using the Vocab Challenge App.

| It was a good base program. The antonym and connotation challenges were a little hard to understand. |

I started playing it the weekend I received it, and was slightly addicted for that weekend. After that, I used it casually.

| It was fun and I learned quite a bit                          |

I found that I learned well while being able to interact with the ipod. Also, if I was bored and saw my ipod laying around the house, I would pick it up and start playing the game. I will keep using it and hopefully this will help me on my vocabulary in the future.

| My experience was fine                                      |

It was confusing. I messed up on synonym and antonym quite a bit because I didn't remember which was which.

| It was a good experience and I certainly learned words that were previously challenging for me. I know it will help when I take the ACT because usually vocab. is my weakest area. I liked the touchscreen ability and the noise when you get it right or wrong...it reinforced the word for me. It was very helpful to see the information on words when done with the game. |

**Very satisfied**

I really liked using the Vocab Challenge Application. I believe I am more familiar with new vocabulary words and I have refreshed my memory on ones I already knew. I liked learning the words in four different ways because it helped me to remember certain words easier.

| It was fun to test myself and learn words that I’ve seen before but have never really known the meaning of. |

It was great. I wasn't sure what to expect at first, but it was much better than I thought it would be. It helped me a lot, and if I were to use it for longer and more frequent periods of time, I would probably gain a lot out of it. The app was a fun way to study.
APPENDIX J: EXPANDED APP REDESIGN SUGGESTIONS BASED UPON FEEDBACK RATING

### Unhelpful

<table>
<thead>
<tr>
<th>Suggestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Show the right answer and give more directions for the antonym and synonym parts.</td>
</tr>
<tr>
<td>Maybe an additional section could be added to actually teach the user about the words.</td>
</tr>
<tr>
<td>Possibly telling the correct answer after getting one wrong.</td>
</tr>
<tr>
<td>It would tell you the correct answer if you got a word wrong.</td>
</tr>
<tr>
<td>I wish they would've given me some sort of explanation before I played the games, for example rules and direction. I had to figure it out on my own which made it more difficult.</td>
</tr>
<tr>
<td>I would put what an antonym and what a synonym was at the beginning.</td>
</tr>
</tbody>
</table>

### Neither unhelpful nor helpful

<table>
<thead>
<tr>
<th>Suggestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>The only thing I would really focus on changing would be when the answer is wrong, to show the right answer. I think this would help enhance the learning from the games. I would also have the timer be optional. Sometimes I just really needed more time to think through the words and their different meanings, especially when I first began playing the games.</td>
</tr>
<tr>
<td>More feedback when you got a word wrong maybe</td>
</tr>
<tr>
<td>I don't like how I have to swipe to words away. I would rather just be able to double tap the word I want to choose.</td>
</tr>
<tr>
<td>By telling the answer if they were wrong.</td>
</tr>
<tr>
<td>I wouldn't change it, it was fun</td>
</tr>
</tbody>
</table>

### Helpful

<table>
<thead>
<tr>
<th>Suggestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>If I could redesign this app, I would make the frequency of the words I missed the most appear more frequently. I also want the mastered words to be harder to master by making me do the tests at least twice for the same word of the same way of testing. For example if I were to master the word inarticulate, I would have to get test correctly for the antonyms, synonyms, definition, and connotation of the word twice in order to master the word.</td>
</tr>
<tr>
<td>I would keep the same 4 games. However, instead of jumbling 250 words for the participant to memorize, I would use less words (e.g., 10). Then, the participant could first choose to use flashcards to study the words. After finished with studying, they would then play the 4 games to master the words.</td>
</tr>
<tr>
<td>I didn't really like the negative sound that it made when I got a word wrong, so I would probably change that.</td>
</tr>
<tr>
<td>I would maybe change the feedback page when it tells you how many you got wrong. I think I would make it more obvious to the ones missed, i.e. putting them up on a separate page for each word or something with the correct information about it.</td>
</tr>
<tr>
<td>I would make levels with different games with the vocab words so you're not always doing the same games over and over. Also, I would maybe add some color or visual appeals to the game.</td>
</tr>
<tr>
<td>I liked almost all of it except that I never understood the concept of shaking to choose words</td>
</tr>
</tbody>
</table>
so I just dragged the cards every time. I also wish that in the stats it would factor passed words into the percentages.

**Nothing it is okay for others just not my thing**

I would possibly change the connotation and antonym apps. When I mistakenly got rid of a word I wanted to keep I could not for the life of me understand how to get it back. I would also give the player a little bit more time so he/she could think about which word they could use. And I would eradicate the shaking part.

**If a person gets a question wrong, I would redesign the App to show them the right answer right after they get it incorrectly.**

I would make it so you cannot go backwards on the list of mastered words because I would lose up to 4 words because I would make a mistake and then I had to go back and redo it. I would also change it so there weren't answers that were right but not the perfect answer to make it less confusing to the user. Also I would maybe offer partial credit like for example if they remove one wrong answer they can earn a few point because they do have part of the answer right but it would but show up as correct in the list. I would also have words become highlighted red in the word bank if the user has it wrong under 3 or 4 categories so they would know to study it extra hard because they are getting it mostly wrong.

I would more clearly label the antonym and synonym games. I often was confused which game it was because I would guess synonyms during antonyms and get it wrong, etc.

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**Very helpful**

Maybe have one game on which was more of a fun game to review the words after they were mastered, or just a section to review mastered words.

I would maybe make it so you slide the answer off the screen instead of sliding the two wrong answers off. Sometimes I would forget and slide the answer off instead of eliminating the other two.