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Gamification: Badges and Feedback

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GAMIFICATION: BADGES AND FEEDBACK

by

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ABSTRACT

Gamification, the implementation of game elements in a non-game context, is a rapidly growing field of research. One element of gamification that has experienced a rapid growth in popularity is the use of digital badges. Despite widespread adoption in educational settings, there are still gaps in the understanding of their effects on motivation, engagement, learning, and other factors. Furthermore, feedback delivered through badges can include a symbolic reward for successful completion of a task, providing a credential for gaining a skill, or acknowledging mastery of a particular piece of knowledge. This study implemented digital badges in online courses at a large urban two-year college. Badges were used to deliver embedded feedback and analyze the results on motivation, engagement, and learning. An experimental group received badges over the course of a three week module composed of various learning activities targeting course learning outcomes. A control group experienced the same learning activities without receiving the digital badges. Results indicated insignificant differences in perceived motivation, learning gains, and perceived engagement between the two groups. Positive results were observed regarding increased peer-to-peer engagement evidenced by a significant increase in discussion board activity. The increased engagement of peers leads to the subsequent building of a strong learning community. This positive group association can provide a feeling of support which leads to increased effort, persistence, and goal achievement. Potential causes are discussed and suggestions for future research are provided.

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CHAPTER 1: INTRODUCTION

Humans have long engaged in play as evidenced by toys found in multiple excavations of ancient civilizations (Whitebread, Basilio, Kuvalja, & Verma, 2012). Much more recently, in the last few decades, a substantial body of research in anthropology, psychology, and education has posited that play is an important facilitator for children's learning and socialization throughout life (Fu-Hsing Tsai, Kuang-Chao Yu, & Hsien-Sheng Hsiao, 2012). Today, educators and researchers are tapping in to this knowledge of play for the purposes of learning and socialization. There is a large collection of research related to how games can be used to facilitate play in training and education, and the body of research continues to grow (Caponetto, Earp, & Ott, 2014a).

Looking towards future generations, games will be a vital part of entertainment and education. There is a broad range of mobile games and console games that are popular. At home, players are being engaged and entertained through rich graphics or a deep storyline while playing their Xbox (Microsoft) or PlayStation (Sony). There are also simpler logic or puzzle games such as Tetris (Pajitonov, 1984) or Words With Friends (Zynga, 2009). Games also range from first-person story-based games, sports games, or games played asynchronously like chess or scrabble. Games are being played purely for entertainment as well as for educational purposes.

This paper will look at gamification, specifically digital badging and its effects on motivation and learning. In order to effectively design a gamified learning environment, characteristics of the learner should first be considered.

1.1 Who are Gamers?

When utilizing elements of games within a learning environment it is important to understand key learner characteristics. User analysis prior to course design can provide guidance on how to build learning experiences and capitalize on the experiences students bring in to the learning environment. A pre-analysis of students can supply information on ways to best implement and use gamification elements (C. T. Miller, 2008). For example, if user analysis indicates that a majority of learners enjoy the feeling of accomplishment by completing levels, then designers should consider delivering material in multiple modules where users can level-up as they progress through course content. Similarly, if user analysis determines most users don't enjoy competition, then designers should consider leaving out elements that emphasize competition, like a points leaderboard, which may discourage time spent in the learning environment.

Designers should also consider the diversity of possible gameplayers that may exist in a learning environment. As of 2016, the average player is 35 years old. The age distribution is relatively equal with 27% of gamers under 18 years of age, 29% between 18 to 35 years old, 18% are 36-49 and are 26% are over 50. Similar to age, there is not a big gap in the gender of game players with 59% being male and 41% being female. Players are also choosing a diverse group of devices with 56% of gamers choosing to play on a personal computer, 53% play on a dedicated game console, 36% use a smartphone, and 31% use a wireless device such as a tablet (Entertainment Software Association, 2016). Knowing that such a diverse group of people are playing games has led to a growing group of educators who wish to harness the excitement of gameplay in the classroom

1.2 Games in Education

A growing number of educators are using games to enhance learning for their students. In a large survey of K-12 teachers more than 40% are using games to deliver mandated content while about one-third are using games to assess learning (Takeuchi, Vaala, & Joan Ganz Cooney Center, 2014). The current increase in the use of learning games could be an indication of a major transformation in how students learn. Nearly 50% of K-12 administrators said that implementing digital content, including games and simulations, has produced positive student outcomes towards learning (Ascione, 2016). King of Math (Oddrobo Software, 2017) is an example of a game being used by educators that was developed specifically for developing skills in mathematics. Players answer a variety of math questions to earn points and stars in order increase the level of their avatar. Players can also choose to share their scores and compete with friends or other players around the world. This type of game illustrates game design targeted for acquisition of a specific learning outcome.

Not only are educators using games for learning but parents are also downloading games to teach their children. Games are the most popular type of app downloaded on smart mobile devices used by children, with the average device containing approximately 10 game-related apps (Chiong & Shuler, 2015). As of March 2017 the most popular Apple app category was gaming with over 25% of apps being games (Statista, 2018). Not all of these games are specifically advertised as education, however some do provide an educational experience without that being the main design feature. Minecraft (Mojang, 2009) is an example of a game parents download for their children, which is not designed to target a specific learning outcome. Regardless of that fact, Minecraft has been applauded, and won multiple awards, for the use free play to encourage creative thought and cooperation (MacQuarrie, 2013).

In an educational setting, gaming experiences usually involve simpler games that deliver small packets of content allowing students to practice skills (Takeuchi et al., 2014), as seen with Math King . The main reason longer story based games are not used is mostly due to a lack of standardized curriculum and instruction. At the secondary education level, schools within one district may have standardized curriculum, where all courses teach to the same learning outcomes in the exact same manner. However, there is little to no standardization outside of that imposed by individual districts. At colleges or universities; even within the same district, there tends to be even less standardized curriculum and instruction.

In an educational setting that lacks a standardized curriculum, it is difficult for game developers to justify the time, money, and personnel necessary to build a lengthy story based game. The resources and time necessary to develop such a game is not a profitable venture for games targeting specific learning outcomes. Another reason there is not a large number of story based games being developed outside the gaming industry is that an individual educator, or even an institution, does not have the resources necessary to design and build a game that fits the needs of their specific student learning outcomes. Therefore, from an educator's standpoint, it becomes necessary to exploit a few beneficial aspects of gameplay without a long story based game experience. Hence the current surge in research on the topic of gamification.

1.3 Gamification

Utilizing a game in a learning environment is a unique way to actively engage and motivate the learner (Caponetto, Earp, & Ott, 2014). However, it is sometimes difficult to find just the right game which embeds the learner in the perfect experience for a specific learning objective. Therefore, it might be more beneficial to use specific game elements to enhance a learning

experience to have better experimental control of effects being studied. Gamification is a term used to denote the adoption of game elements in a non-game setting (Caponetto, Earp, & Ott, 2014b; Deterding, Dixon, Khaled, & Nacke, 2011; Hanus & Fox, 2015). One reason for gamification's surge in popularity within education is due to the conviction that it supports, engages, and motivates students, and can thus lead to enhanced learning processes and outcomes (Kapp, 2012).

As we will discuss in Chapter 2, the popularity of gamification is quite evident, but the study of its effectiveness is an incomplete piece in the literature. A primary purpose of this dissertation is to make progress in the study of gamification, in an effort to further the conversation about the effectiveness of its design and implementation. In particular, this study will consider the element of digital badges, their use in delivering feedback, and its effectiveness towards motivation, engagement, and mastery of learning outcomes.

The organization of the literature review will present information about game-based learning as well as discuss the differences between gamification and other aspects of using gameplay in a learning environment. The remainder of chapter 2 will discuss digital badges and their current use in education and training. The discussion will summarize the known effects of badge use on motivation, engagement, and learning.

CHAPTER 2: LITERATURE REVIEW

There has been much written about the potential of learning through the use of computer games. In the development of research, quite a few terms have been coined to describe the powerful influence that seems to exist in using games for training or education. Some common terms that have been used are game-based learning, digital game-based learning, serious games, edutainment, and gamification. To the novice reader it may seem as though these terms have the same definition: using games in a learning environment. However, in current research there is a difference in their meaning and application.

Game-based learning is a more general term that can be used to categorize digital games, board games, card games, and strategy games (Felicia, 2013; Pivec & Pivec, 2013). More recently, the study of gameplay that is facilitated through an electronic device has been categorized in publications as *digital game-based learning* (Salen & Zimmerman, 2004). Digital game-based learning considers a wide variety of electronic devices like a desktop or laptop computer, an arcade game, console system, hand held gaming system, and even a cellular phone. *Serious games* is a term used to categorize any type of gameplay for purposes beyond entertainment such as learning, training, business, or social change (Jain, Oikonomou, & Ma, 2011; Michael & Chen, 2006). *Edutainment* is used to describe course design efforts that focus on entertaining the learner in an effort to increase engagement and encourage interaction with instructional content (Rodríguez-Hoyos & Gomes, 2012). Considering the many different ways in which gameplay is being used to facilitate learning, this study will focus on using specific game elements to gamify a learning environment. In order to understand the efforts behind gamification we must first consider the definition of game.

2.1 What is a Game?

Many definitions of games involve a discussion of the elements that make-up a game. In their book *Rules of Play*, Salen and Zimmerman (2004) define a game as "a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome" (p. 80). This definition broadly encompasses the game elements of *conflict*, *rules* and *outcomes*. In addition to the elements of conflict, rules, and outcomes, other definitions of games also include: competition, interaction, challenges, levels, achievements, and an end goal of winning (Kapp, 2012).

These elements exist in most entertainment games that exist today. The element of a story or mission (providing conflict) can be seen in the game Half Life (Valve Corporation; Gearbox Media, 1998). The player is theoretical physicist Gordon Freeman, who has to resolve an alien invasion caused by an accident at his research facility. In this game you move through levels of increasing difficulty (following rules), until reaching the final mission or boss level (achieving the outcome). Other entertainment games such as puzzle or logic games, and some sports games, do not include a deep story that immerses the player; however, they contain similar characteristics such as increasing levels of difficulty, earning points, and competition. For this study, the purposes of feedback provided through the element of achievements, delivered through digital badges, will be utilized within a learning environment.

2.2 Digital Game-Based Learning

Today's applications of digital games in a learning context can be seen within the fields of medicine and health (Graafland, Schraagen, & Schijven, n.d.), military skill and strategy (Chatham, 2007), corporate training (Riedel, Feng, Hauge, Hansen, & Tasuya, 2015), classroom management training (Sawchuk, 2011), and beyond. Digital game-based learning is also being used in the formal halls of educational institutions in almost all subjects including science, geography, mathematics, language and reading development (Miller, 2008).

Similar to the many definitions for a *game*, there are multiple definitions of the term *digital learning game*. For the purposes of this dissertation we use the definition provided by Jenkins, Klopfer, Squire & Tan (2003) in their original report for the Education Arcade at MIT. They define *digital learning games* as those that "target the acquisition of knowledge as its own end and foster habits of mind and understanding that are generally useful or useful within an academic context" (pg. 2). When utilizing a game in a learning environment, the acquisition of knowledge is one of the key aspects to consider when designing a learning experience for students.

Research in game-based learning has begun to investigate each particular element of gameplay. Studies have looked at the effects of story (Fanfarelli, 2014; Padilla-Zea, Gutiérrez, López-Arcos, Abad-Arranz, & Paderewski, 2014), competition (Chen, 2014), and achievements (Blair, Bowers, Cannon-Bowers, & Gonzalez-Holland, 2016; Fanfarelli, 2014), amongst other elements. One advantage to isolating each of these components is it allows researchers to focus on specific variables. Researchers hope this focus leads to discover of the possible connections between the elements of gameplay and the student behaviors that lead to motivation, engagement, and mastery of learning outcomes. Another advantage of this focus is from a design standpoint; there is no need to pour in money, time, and other resources necessary to develop an entire media-

rich game just to test the effects of specific elements. The use of game elements in a non-game setting has given birth to the growing field of research in gamification.

2.3 Gamification

The idea of gamification is often related to game-based learning but there are key differences. The main distinction is that gamification is a term typically used to denote the adoption of game elements in a non-game setting (Deterding, Dixon, Khaled, & Nacke, 2011). Kapp (2012) defines gamification as "using game based mechanics, aesthetics, and game thinking to engage people, motivate action, promote learning, and solve problems" (p. 17). In an educational setting, gamification is being used as a strategy to increase motivation (Hudiburg, 2017), engagement (Drace, 2013) and success towards mastery of learning objectives (Caponetto et al., 2014b). In non-educational settings, gamification is being used to change behavior in employees and customers (Post, 2014).

In the remaining sections, the conversation will focus on results from the use of gamification, and in particular achievements or badges. Achievements can tend to be more of a broad term encompassing other aspects of gameplay, this paper will focus specifically on digital badges and their effects on motivation, engagement, and learning.

2.4 Gamification in Education

As a research topic in education, gamification is beginning to garner more attention. Gameplay has long been a part of training, learning, and psychological development (Whitebread,

Basilio, Kuvalja, Verma, 2012). More specifically, digital game-based learning has been a popular research interest for education and training over the past two decades. However, the study of gamification is still quite new and does not boast the same depth of research as does digital game-based learning. That said, research is accumulating on the theory and application of gamification in education. One reason for the surge in popularity within education is due to the conviction that it supports, engages, and motivates students, and thus can lead to enhanced learning processes and outcomes (Kapp, 2012). There is a call for more empirical research to help parse out the elements of gamification that can be effective, especially considering the use of digital technology and its incorporation as a learning tool in all modes of classroom delivery (Hanus & Fox, 2015). Before the validity or invalidity of this strategy can be further established, more understanding is needed of gamification within education (Bellotti, Berta, De Gloria, Lavagnino, Antonaci, Dagnino, & Ott, 2013).

Having conversations with educators about how to increase student success will usually lead to a discussion on increasing the time students spend engaging with course material (Phelps, 2016). Recently gamification has been proposed as a method to increase student engagement with course content (Denny, 2013). Several studies investigate the connection between gamification and motivation (Kheirkhahzadeh, Sauer, & Fotaris, 2016; Perryer, Celestine, Scott-Ladd, & Leighton, 2016), possible links between motivation and student engagement (Bahji, Lefdaoui, & El Alami, 2013; Denny, 2013; Meyer, 2014), as well as effects of engagement on student success (Huskin, 2016; Kuh, Kinzie, Schuh, & Whitt, 2011; Phan, McNeil, & Robin, 2016). Further studies are still needed in regards to the use of gamification elements such as digital badges and their effectives to deliver feedback in an effort to increase motivation, engagement, and student learning.

2.5 Motivation

Educators alike wish every student in their classroom loved the subject at hand, and thus the need for external motivation would be nonexistent. Students admit that they can be distracted from learning activities to fight boredom or stay connected with friends (McCoy, 2013). Mature students may be able to develop skills to help separate specific tasks related to learning to mitigate the distraction that can come with multi-tasking (Winter, Cotton, Gavin, & Yorke, 2010). However, even though mature students may develop the autonomy of successful student habits, the reality is many students need additional help. Gamification has been explored as a possible tool to help motivate students to stay engaged with learning activities.

Any educator who has spent time in a classroom will tell you of successful and failed efforts to motivate students to learn (Phelps, 2016). Due to this desire to motivate students, many educators are looking towards gamification as a possible solution. Most predominantly in research thus far, studies are looking at the elements of rewards, points, competition, and leaderboards (Hamari, Koivisto, & Sarsa, 2014) within a gamified learning experience. One explanation for the focus on these elements is that implementation of any one (or more) is easier in comparison to the resources needed to develop a full game experience.

In regards to motivation and its effects on learning, much has been written about the differences between extrinsic and intrinsic motivation. Our natural, or intrinsic, motivation is in regards to our curiosity, desire to play and explore, and to be active learners in the environment that surrounds us (Deci, Koestner, & Ryan, 2001). An example of intrinsic motivation lies within the student who wishes to complete their homework in an effort to learn the material. This student

differs from the one who is extrinsically motivated by the amount of grade points they will earn by completing the activity. Further discussion in research on motivation has focused on the difference of autonomy within each of these students (Cameron, Banko, & Pierce, 2001).

In the world of psychological research, not necessarily related to gamification, there are a few well known and frequently referenced meta-analyses about the effects that rewards have on intrinsic motivation. Cameron, Banko and Pierce (2001) as well as Deci, Koestner & Ryan (1999) reviewed existing literature and empirical studies that found varied results. Both analyses looked at papers which studied the effects of rewards on free choice motivation towards low-interest tasks and high-interest tasks as well as delineating between types of rewards used such as verbal and tangible rewards.

In their meta-analysis, Deci et. al. posit that tangible rewards have a negative effect on intrinsic motivation when they are expected or task contingent. Even though they note some results that vary, their overall stance is if a person "feels pressured to receive the reward then their intrinsic motivation will decrease" (pg 658). In comparison, Cameron et al. conclude that despite wide spread belief, they found no conclusive evidence on the detrimental effects of rewards on intrinsic motivation. Cameron et al. posit that the overall category of rewards is "too broad since rewards can have different effects under different applicable conditions" (pg 21). Furthermore Cameron et al. posit that rewards can be used to gradually improve performance, can help develop an interest in activities that lack initial interest (Abramovich, Schunn, & Higashi, 2013), and can maintain or improve effort of persistence (Bellotti et al., 2013). Furthermore, contributing research efforts have found that some conditions in the classroom have negative outcomes on self-determination like competition (Deci, Betley, Kahle, Abrams, & Porac, 1981), commands or directives (Reeve & Jang, 2006), imposed rules ((Koestner, Ryan, Bernieri, & Holt, 1984)), and

deadlines (Amabile, DeJong, & Lepper, 1976). Some conditions that support are acknowledgement of feelings (Koestner et al., 1984), self-direction (Reeve, Nix, & Hamm, 2003), encouragement (Reeve & Jang, 2006), and positive feedback (Pitt & Norton, 2017; Ryan, 1982) .

Due to these general studies on the psychology of motivation, there has been some caution on the reliance of specific game elements such as points or badges as they may have a negative effect on the intrinsic motivation of the learner (Deterding et al., 2011; Kapp, 2012; Seaborn & Fels, 2015). If poorly designed, rewards can tend to have a negative effect on intrinsic motivation, especially with young children. However, there are certain conditions, on certain populations, where rewards can have positive effects on intrinsic motivation (Cameron et al., 2001). Proper implementation of certain game elements may actually fulfill psychological needs for competence and autonomy and thus improve intrinsic motivation (Francisco-Aparicio, Gutiérrez-Vela, Isla-Montes, & Sanchez, 2013; Pe-Than, Goh, & Lee, 2014).

Regardless of whether learners are motivated intrinsically or extrinsically, motivation can enable learners to employ the required effort to acquire skill and knowledge. In fact, using badges in a gamified course would be a way to provide positive feedback thus increasing motivation and reducing a fear of failure (Besser, 2017; Kallevig, 2015). According to Hoska (1993), feedback can help learners recognize that mistakes are not failures but are an important part of the learning process. Research is lacking studies of whether feedback that is delivered to learners via digital badges could reduce the fear of failure that decreases extrinsic motivation.

2.6 Engagement

Engagement in an educational setting is a very broad term (Pike & Kuh, 2005). It can be used to describe student involvement at an institutional level as well as at the course level. At the institutional level engagement describes how a student participates and connects with the overall educational practices at a college or university (Lutz & Culver, 2010). Using a blend of theory and empirical analysis, the National Survey of Student Engagement is used to measure the scope of student involvement in a range of good educational practices with other positive student outcomes (Kuh, 2009). Another method for measuring student engagement at the institutional level is done by the University of Texas. The university collects student surveys on engagement to help colleges focus on improving institutional practices, programs, and services offered to students (University of Texas, 2017).

There are slight variations on how engagement is defined at the student-course level. Most definitions involve forms of activity, involvement, and effort as it is related to their own academic achievement (Kuh et al., 2011). Student engagement in a course can be measured in a variety of ways, especially when utilizing a course management system which tracks the digital footprint of students within the course. With advancements in data analytics, tools can be implemented in a learning management system to collect and display quantitative data related to student engagement (Beer, Clark, & Jones, 2010; Macfadyen & Dawson, 2010; Vogt, 2017). Other studies have also used qualitative survey data to investigate students perceptions of engagement in individual courses and at the institutional level (Pike & Kuh, 2005; Lutz & Culver, 2010; University of Texas, 2017).

Research efforts in course design are beginning to show that high engagement is a key instructional strategy leading to student success (Dabbagh, 2007; Kuh et al., 2011). Meyer (2014)

posits that effective engagement strategies come from learning experiences that are active, collaborative, authentic, and experiential. To implement these strategies current research efforts are utilizing more active learning to shift teaching away from lectures. Current strategies being studied for increasing student engagement include problem-based learning, cooperative learning, the use of role-playing, peer teaching, simulations, and gamification (Koohang, Paliszkiewicz, Klein, & Nord, 2016; LoPresto & Slater, 2016; Nist-Ojejnik & Holschuh, 2000).

There is little work specifically studying the connection between elements of gamification and student engagement (Filsecker & Hickey, 2014). In a literature review on empirical studies of gamification, most of the studies focused on motivation, attitude and enjoyment (Hamari et al., 2014). More work is needed to determine how elements of gamifying a course may help increase student engagement. A key part of that measurement is to collect proper quantitative data, with the use of analytics tools, in conjunction with qualitative survey results based on a participants perceptions of engagement (Kuh, 2009).

2.7 Feedback

One key element of gameplay is providing feedback, which is a primary motivational strategy that allows participants to check one's progress (Kapp, 2012; Michele D. Dickey, 2006). Imagine playing a game where you have to defend your base from falling asteroids. You shoot a missile at a falling asteroid, if the asteroid does not change path or explode how will you know that you hit the asteroid? Receiving proper feedback informs you of whether you made the correct decisions to hit the asteroid. Imagine instead that the asteroid explodes, with visual and auditory feedback, then you have received effective communication that your action had a successful outcome. In a digital game, as in the previous example, the feedback received by the player is

typically in the form of visual and auditory cues. However, in a gamified learning environment a different mechanism for delivering feedback is necessary.

In a learning environment, a student's choices and/or actions will receive feedback that is typically provided via assessments like homework, projects, discussions, and tests. However, the use of badges within a gamified course can also be a tool by which feedback is delivered to the learner. Badges provide a potential communication tool that can inform the learner about successful choices towards achieving specific learning outcomes (Abramovich, Higashi, & Schunn, 2013). A benefit to using varied sources for delivering feedback is it allows the learner to judge the quality of their own performance by encouraging shifts in negative choices or reinforcing successful behavior (Wagner, 1997).

Guskey (2007) posits that both frequent and specific feedback are necessary to support student learning. To address the idea of specific feedback, badges could be used to provide feedback from the perspective of reinforcing student behavior. In other words, badges can provide specific types of feedback to a student on their progress with course material. Specific feedback, especially positive feedback, can have an effect of boosting self-confidence and subsequent effort on future assignments (Pitt & Norton, 2017). With more confidence and motivation, students may become more skilled in self-regulation. A lack of self-confidence, or a failure on an assignment, can lead to anxiety resulting in academic paralysis (Nash, Crimmins, & Oprescu, 2016). Therefore, a system that delivers specific, positive feedback, can encourage similar future choices (Kahu, Stephens, Leach, & Zepke, 2015).

If feedback is controlling in nature, then the effect can be negative on effort and intrinsic motivation (Ryan, 1982). Based on a review of literature related to how feedback effects motivation and self-esteem, Nicol and Macfarlane-Dick (2006) recommend that feedback be

delivered frequently via low-stakes assessments which provide an opportunity for more formative feedback. The authors further discuss feedback in terms of self-regulation, which ultimately is necessary for success in higher education. Furthermore, learners who are more self-regulated are more confident, resourceful, and are high achievers (Zimmerman & Schunk, 2001). This research also shows that even at-risk students can learn to become more self-regulating and engaged in their own learning processes (Pintrich & Zusho, 2002). Badges are a possible tool by which feedback can be delivered via low-stakes assessments, effect self-regulation, confidence, and thus possibly increase motivation.

There is evidence that a student's engagement and performance on future tasks is increased when the student receives feedback that commends effort towards recent performance (Craven, Marsh, & Debus, 1991; Dohrn & Bryan, 1994). Hattie and Timperley (2007) posit that "the focus of feedback is critically important…there are four major levels and the level at which the feedback is directed influences its effectiveness" (pg. 90). The four types of feedback discussed is feedback about the task, about the processing of the task, about self-regulation, and about the self as a person. Feedback is least effective when it is provided solely at the self level, such as "you are a great student" or "nice work". Feedback to self, on its own, is typically not effective since it usually contains no information about the task completed. However, praise that is directed to engagement, self-regulation, or effort on the task can assist in enhancing self-efficacy and can thus be converted by students back into impact on the task (Hattie & Timperley, 2007). An example of such feedback is "You are doing great because you diligently completed this task by applying this concept." This illustrates feedback that involves of a combination of levels of feedback: feedback at the self level: "you are doing great"; combined with feedback at the task level: "you diligently completed this task"; in combination with process level feedback: "by applying this concept".

Hattie and Timperley (2007) posit that using a combination of feedback directed at different levels seems to be the most effective in terms of processing and mastery of tasks. Badges provide a potential communication tool that can deliver a variety of feedback in a timely manner about successful choices and processes implemented towards achieving specific learning outcomes.

Chickering and Gamson (1999) discuss the effectiveness of different forms of feedback in some of their seven principles of good (instructional) practice. One of the seven principles is "give prompt feedback", in which the authors discuss the importance of communication from instructor to student. Feedback should be frequent and delivered in a formative manner to have a positive effect on student learning. Digital badges have the potential of delivering prompt feedback directly after the task

2.8 Badges

In a general sense, badges have been used for quite some time as a reward to encourage human behavior (Halavais, 2012). In industry, certificates have been a commonly used form of a badge to symbolize when an employee achieves a milestone. The achievement could be earned by an employee who had the highest grossing sales that month, reaching a certain number of years of service to the company, or completing a specific training. In youth development sports programs badges can come in the form of a trophy, ribbon, plaque, or a certificate. Typically, these badges are earned for participation or a victory. Similarly, in entertainment and the arts, we see rewards such as trophies and certificates for acting, dancing, singing, and creative accomplishments such as choreography and costume design. In education, rewards can be seen in individual classroom use for the best-behaved student, used at a school level for recognition of being on the honor roll, and at even higher levels such as the All-USA Academic Team ("All-USA Academic Team," n.d.).

Probably the most known use of badge symbols in education can be seen in specialized regalia, diplomas, and degrees. In the military, badges come in the form of ribbons and medals to be worn and displayed on a formal uniform. In different scouting organizations, badges are used to designate achievement of mastering one level and entering the next. Because it is known that motivation can enhance the learning process (Clark, Howard, & Early, 2006), a variety of organizations utilize badges to honor and motivate their members.

Similar to the traditional-use badges just discussed, many organizations are transitioning to the use of digital badges (Iafrate, 2017). The video game industry is probably the most well-known example. Digital badges are used in gaming to indicate an accomplishment, the completion of a goal, or the successful continued progress in a game (Zichermann & Cunningham, 2011). The entertainment game industry quickly adopted the use of badges, and for good reason. When considering badge design in games for entertainment, their use has been shown to produce better review scores as well as an increase in revenue (Hamari, 2017). In fact, Microsoft began requiring that developers include badges for games published for the Xbox console (Jakobsson, 2011). The use of badges has become so prolific in mobile games that some services offer pre-written code to software developers and also provide tips on the use of achievements to monetize a game (Swarmconnect.com, 2013). Not only is there help for developers, there is also an overwhelming amount of support for players. Step-by-step instructions for locating and earning badges for many entertainment games can be found with a simple web search. For example, NBA2K18 (2K Sports, 2017) is a basketball simulation game. An independent website with descriptions of badges and tips for earning them is available for any interested player ("NBA 2K18 Badges Guide," 2017). The belief in the value that badges provide to entertainment games is evidenced by the abundance of available developer and user support.

Educators and course designers are working hard to tap in to the popularity of badges. The general assumption is that badges and achievements would have the same affect in a learning environment as seen in entertainment games. The initial adoption was often based on the idea that badges are 'fun' and intrinsically motivating. In an educational setting, the purpose of badges has typically considered the perspectives of motivation, assessment, engagement, and credentials (Newby, Wright, Besser, & Beese, 2016).

On a large scale, the Khan Academy and Coursera are two examples of digital badging in an educational setting. Some of the criteria to earn a badge in Khan Academy are for achieving levels of mastery, time spent, and streaks for lessons completed. Some younger learners' complete content during the summer as parents assign work to keep their children from forgetting important content. Similarly, full packaged classes of material can be completed by home schooled students who do not attend a traditional school environment. When observing young learners while they complete content, the fun motivational aspects are apparent while the purpose of learning assessment and credentials may be lost (McDaniel, 2019). This could be an example of the badge having a design that is more fun. This may be a desirable result in regards to motivation related to continued engagement since this behavior has been shown to lead to student success (Dabbagh, 2007; Kuh et al., 2011). However, this single-minded approach may ignore the ability for badges to have an influence on self-regulation and also discourage creativity and risk-taking (Faiella & Ricciardi, 2015; Grant, 2014).

Coursera, which is typically focused on higher education, utilizes badges that are used as a micro-credential for mastery of a non-credited specialization. These badges tend to lack an aspect of a fun and whimsical design as they align with the purpose of signaling mastery of content. A secondary purpose is the digital badge plays the role of a certificate and is delivered in the form of

an open badge. Open Digital Badging is a current movement in corporate training and education that intends to make it easier to earn, display, and issue badges across the internet regardless of the environment in which the badge is earned (HASTAC, n.d.). In other words, open digital badges are institution agnostic, meaning they carry value regardless of where they are earned. The participant now has a digital badge on their electronic resume to display and communicate the skill learned (Besser, 2017). An open badge also provides a simpler method for tracking development of employees, participants, or students. The employee manager, or student advisor, can view the progress that is being made and offer suggestions for future development. From the employee or learners view point, a digital badge system can support an easier manner of collection and display of their earned rewards. Open badges also allow the recipient to be more mobile and in turn allows a future employer to see the skills and needs of their new employee. Furthermore, the use of digital badges for credentialing may foster development of self-regulating behavior and life-long learning (Grant, 2014). Learners who are more self-regulated are more confident, resourceful, and are high achievers (Zimmerman & Schunk, 2001).

Abramovich, Schunn & Higashi (2013) examined the use of digital badges and dissected them in to two categories: participatory and skill (or merit). Participatory badges are earned as one progresses through content and are typically not expected by the player. Merit badges are earned by setting a goal and learning a new skill and therefore are expected.

In the digital gaming world, an example of a participatory badge can be seen in the mobile game Pokémon GO (Niantic, 2016). Players can earn a participatory badge for catching 50, 200, 1000 of each type of Pokémon. Even though catching Pokémon is not a difficult task, the first badge is unexpected and the intent is to encourage the player to keep catching Pokémon. In this case, participatory badges are intended to motivate the player to return to the game frequently and

thus stay engaged in the game for longer periods of time. Another example of participatory badges can be seen in the Forza Motorsport (Turn 10 Studios, 2005) racing game played on the Xbox consoles (Microsoft, 2001). While a player is competing in a race, the "Red Tricycle" badge is earned when the player drives a total of 100 miles. Similar to Pokémon, this badge is unexpected, and the intent is to encourage the player to continue spending time in the game. In the Forza game, badges also help players earn coins, serving as a form of currency. Within Forza, this currency can be used to purchase new cars, car upgrades, racing gear, and eventually be utilized to improve the tier level and skill of your driver.

In an educational setting, course designers could use participatory badges as a tool for increasing engagement with course material inside a learning environment. For example, consider a student who is learning statistics by progressing through modules of content. During the first week of the course the student is expected to read the syllabus as well as complete a few other introductory activities. The student clicks to open the syllabus and unexpectedly receives the "Great Start" participatory badge. Receiving the badge, and the positive feedback, may have the effect of increasing time spent with course content. In this role, the use of participatory badges is intended to increase engagement, which increases time on task (Gibson, Ostashewski, Flintoff, Grant, & Knight, 2015). In contrast, Blair (2016) concludes that delivery of a badge or message should be expected and incremental, and suggests that these features were more powerful in unison.

Unlike participatory badges, receiving merit badges is expected by the participant. The name merit badge comes from their use in scouting organizations such as Boy Scouts of America (Boy Scouts of America, 2018). A scout chooses which skill badge to earn, e.g. personal fitness, then must participate in related activities and periodically complete updated requirements. In a

gamified social presence application called Foursquare (Foursquare, 2009), all achievable badges are known to the user. “Checking in” involves opening the application while a person is physically at a specific location, then sharing that “check in” within the application. Some of the Foursquare badges are awarded for checking in to any location after 2 a.m., checking in at 50 distinct locales, or even earning the “King Pin” badge for checking in at a bowling alley. A user could become the mayor of a particular location if they had the highest number of check-ins within a recent timeframe. For Foursquare, this frequent engagement was a benefit for the developer as it increased revenue and helped build partnerships with other companies, e.g. Chili’s Restaurants would provide customers free chips and salsa for checking in during each visit.

In an educational setting, merit badges could have positive effects on certain soft skills such as goal setting, planning, and time management. From a design standpoint, displaying all badges that can be earned has the intent of increasing engagement as the user works towards those goals (Blair et al., 2016). Similar effects may be observed on improving self-regulation which is necessary for student success in higher education (Zimmerman & Schunk, 2001). A few possible applications of merit badges in a gamified course could include:

1) Decrease avoidance motivation in low-performing students (Abramovich et al., 2013; Rouse, 2013).
2) Increase engagement (Ding, Kim, & Orey, 2017; Drace, 2013)
3) Provide feedback that encourages student learning (Besser, 2017) by giving a feeling of success and progress (Kahu et al., 2015; Kickmeier-Rust, Hillemann, & Albert, 2014; Pitt & Norton, 2017)

Both participatory and merit badges have similar intent in regards to engagement with a learning

environment. However, not all studies on digital badges have produced positive results.

In some studies, the use of badges had negative effects. There are applications where the use of digital badges was shown to decrease intrinsic motivation as well as learning performance. External rewards have been shown to have an effect of decreasing motivation with learners who are already interested in a topic (Cameron et al., 2001; Deci et al., 2001). The high interest and engagement that learners can initially possess may decrease over time as the novelty of badges dissipates through the duration of a course (Koivisto & Hamari, 2014), especially if badges are overused and an aspect of saturation renders them ineffective. The requirement of participation can also have negative effects on motivation, engagement, and learning gains; the freedom of choosing to participate has been shown to be more effective (Mollick & Rothbard, 2014). If the delivery system for badges does not provide a clear path to mastery, or offer any visual value, then motivation can be harmed due to a confusing explanation of goals (Caponetto et al., 2014a; Cunningham & Zichermann, 2011; Hanus & Fox, 2015).

As researchers continue building a body of evidence, educators are yearning for a tool to garner positive results from learners. Caution should be taken to avoid poor design or implementation as the result of an urgent desire for an effective tool. If the design of badges just imitates a sticker chart then badges lose their effectiveness to change behavior (Abilock, Harada, & Fontichiaro, 2013). When educators and course designers are considering badges for purposes of learning, a few key questions should be considered (Newby et al., 2016):

1) Who is the target audience?

2) What is the purpose of the badge?

3) What activities(s) will the user complete to earn the badge?

4) What skill has the learner gained from earning the badge ?

All good design processes involve some gathering of information before production begins. Without any information in any of these areas, the effectiveness of the badge design could be reduced.

In addition to the use of design questions, badge designers and practitioners should also consider the underlying delivery and technological systems. With so many different types of learners, goals, and curricula, there is no one best way to design a badge delivery system. The effectiveness of any badge design will be influenced by the delivery system, thus designers should take in to account the interactions between the needs of faculty and students (Jovanovic & Devedzic, 2015). In other words, badge design and delivery are intertwined, and the discussion of research results should take the delivery system in to consideration and when analyzing methodology and aspects of badge design.

Aside from these purposeful design considerations, a balance needs to be struck between learning and fun. If a badge is too fun and whimsical it may tend to be distracting and not lead to the desired change in behavior. In contrast, a badge design that lacks some entertaining aspect may cause users to lose interest. If users perceive the badges as a trail of bread crumbs forcing them to persist, then they may lose their sense of autonomy. Regardless of target audience within a learning application, a best practice in badge design may involve a combination of elements that are fun and whimsical as well as fostering behavior aimed at learning and assessment.

2.9 Purpose of Study

Much of the research on the use of badges has studied their effect on motivation, engagement, and learning. However, the applications have used either skill (unexpected) or merit (expected) badges as an award for an achievement; in other words, the badge simply signals the completion of a task. For example, a childhood student between the ages of five to ten years, may receive a gold-star sticker on the top of an assignment to signal the student has done well on the assignment. This award is intended to boost confidence, hopefully motivating a learner to earn future stars. A sales person at an automobile dealer receives a certificate award for being the top salesperson at the end of the year. Again, this certificate serves to provide motivation, not just for the top salesperson but for the others who may work harder to win the certificate next year.

Digital badges have essentially been used as an adult version of the gold-star sticker: signaling to the learner they have successfully completed a task. Similarly, current research has mainly studied the use of badges as a reward, a signal of completion, mastery of a skill, and as a credential. Deci, Koestner, and Ryan (1999) described rewards as contingencies to activities rather than formative feedback due to the fact they lack detailed information. It is also possible learners have become complacent with the typical form of a badge, possibly due to their overuse (Zichermann & Cunningham, 2011). This study will consider extending the purpose of using badges to also provide formative feedback. This research study will consider the use of badges to deliver specific forms of feedback and the effects on motivation, engagement, and learning.

CHAPTER 3: METHODOLOGY

The use of badges in educational settings has gained popularity in online learning environments such as Khan Academy, Edmodo.com, and Mozilla's P2PU. However, the body of research on the effects of different badge designs on learning outcomes, motivation, and engagement is still relatively new (Muilenburg & Berge, 2016). Chapter 3 aims to precisely define the questions that were asked in this study and detail the methodology used in examining these questions.

3.1 Research Questions and Hypotheses

The following questions guided this study:

RQ1: How does the delivery of positive feedback via digital badges affect perceived self-efficacy?

RQ2: Can the delivery of positive feedback via digital badges be effective in increasing learner engagement?

RQ3: Can the delivery of feedback via digital badges be effective in increasing content knowledge?

Perceived Motivation

H1: Students in the experimental group will have higher levels of perceived intrinsic motivation than those in the control group.

Learner Engagement

H2: Students in the experimental group will have an increase in perceived engagement than those in the control group.

H3: Students in the experimental group will have higher levels of behavioral course engagement data than students who do not receive badges.

H3a: Students in the experimental group will have higher overall page views than those in the control group

H3b: Students in the experimental group will have higher average number of discussion posts than those in the control group

H3c: Students in the experimental group will have higher average number of discussion posts beyond the required number than those in the control group.

Content Knowledge

H4: Students in the experimental group will show greater improvement between pretest and posttest.

3.2 Participants

A demographics survey was given (see appendix A), and found that of the 45 participants that 26 were female and 19 were male. The participants were enrolled in an online college algebra course taught through a leading learning management system. All students were undergraduate

students from the mathematics department at Valencia College. All students in one course/section were considered the control group while the other course/section was the experimental group. In the control group, students received standard forms of feedback through the completion of discussion questions, homework, practice tests, and chapter tests. In the experimental group, students received feedback through the same formative and summative assessment as the control group, but also received additional feedback delivered via digital badges.

3.3 Independent Variables

This section will discuss the badging system, design, delivery, and embedded feedback.

3.3.1 Delivery

Badgr was integrated within the Canvas learning management system. Badges were delivered automatically based on criteria completed within the learning module. For example, when students completed the syllabus quiz the appropriate badge was delivered instantly based on the score the student received. Some badges had to be delivered manually since Badgr did not have the capability of defining all desired triggers as prerequisites.

When a student entered the course, they were taken directly to the page where badges were listed (see Figure 1). On this landing page, called the Trophy Room, a student saw the badges they earned as well as all other expected badges. Badges that had been earned had a check mark next to the name as well as the badge icon being colored. Expected badges did not have a check mark and were grayed out to indicate they had not yet been earned. In this manner, badges were delivered incrementally (e.g. awarded in a series in completing the same task in scaled levels of difficulty), they were expected (i.e. a list of badges was available for students to view before they were

earned), and notification occurred after the task was completed. As noted by Blair (2016), the combination of all three delivery methods is most successful. Furthermore, Fanfarelli (2014) suggests that the effects of badges may be minimal if players do not notice any badges they have received. In other words, badges should be delivered in a very conspicuous manner, hence the design of the trophy room to be the course landing page.

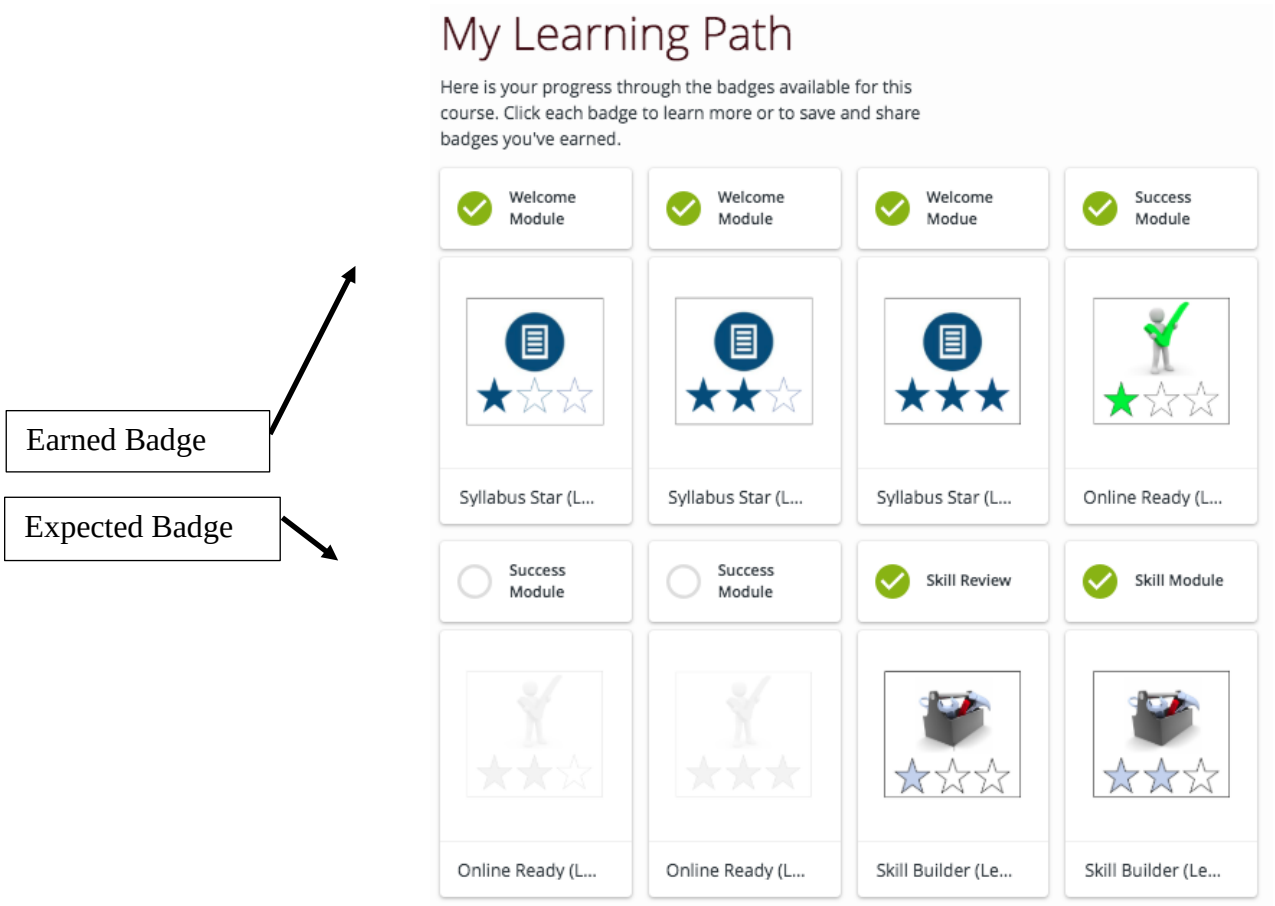


Figure 1: Trophy Room

3.3.2 Design

Badges were customized to contain structured feedback as discussed by Hattie and Timperley (2007). For example, consider the badge awarded for the completion of the skill review activity. The feedback delivered on that badge says “Great work! Your success on this assignment is due to your persistence and ability to utilize class material to improve your mastery of your math foundation.” This message was designed to target the three levels of feedback: self level feedback: “Great work”; feedback at the task: “your success on this assignment”; and at the process level: “your persistence and ability to utilize class material.” Appendix C details feedback received on each badge.

An example of the badge design with embedded feedback can be seen in Figure 2 (all badges shown in appendix C). The top left is the title of the badge. Below the title is the feedback associated with completion of the task. Other information seen on the badge included the module where the badge was earned, the recipient, the criteria, and the issuer.

Figure 2: Badge Design

The student was unable to see all of these details while viewing the list of badges in the Trophy Room. The student had to click on the badge, whether it was earned or not, to see the details and criteria for each badge. Notice in Figure 1 that earned badges have a green check mark next to the name as well as the icon being colored. Additionally, the unearned badges do not have a green check mark and are grayed out.

3.4 Dependent Variables

3.4.1 Motivation

The Intrinsic Motivation Inventory (selfdeterminationtheory.org, nd.; Ryan, 1982) is a subjective measure with multiple sub-scales used to determine participants' interest, enjoyment, effort, and feelings of value/usefulness as they relate to an activity or task (appendix D). The IMI was the instrument used to evaluate H1.

3.4.2 Engagement

Engagement was measured in two ways. H2 was analyzed using a survey (appendix F) that contained a combination of questions from the National Survey of Student Engagement (NSSE Home, n.d.) and Community College Survey of Student Engagement (CCSSE - About the CCSSE Survey, n.d.). The validity, reliability, and quality of indicators of both survey instruments are well documented with supporting studies found on each respective website (McClenney, Marti, & Adkins, n.d.; Miller, Sarraf, Dumford, & Rocconi, n.d.)

H3 was analyzed using behavioral activity data within the course management system. In particular: quantity of page views (content pages, gradebook), total number of posts on the course discussion board, and number of discussion posts beyond the required three per prompt. These behavioral data have been shown to be correlated to student success (Beer et al., 2010; Macfadyen & Dawson, 2010; Vogt, 2017). This data was analyzed using two-sample t-tests comparing mean difference.

3.4.3 Content Knowledge

A pretest was given before students began module 2 and the posttest was given upon completion of module 2. Both groups completed the same pretest and posttest. Pre/Post test scores were analyzed using a paired sample t-test to compare the mean differences of scores between each group.

3.5 Procedure

To answer the research questions, two online college algebra sections were utilized. Before the experiment began, all students were briefed about the study and provided with the Institutional Review Board approved waiver of documented informed consent. Participants who chose to participate then completed a demographics survey. Once students entered the first content module they completed a pretest assessing knowledge of the learning outcomes. All students then spent a three week period accessing learning activities which consisted of watching instructional videos, reading examples related to specific topics, and completing discussion prompts encouraging peer-to-peer engagement. The only difference between the control and experimental groups is the experimental group received the treatment of badges. Upon completion of the learning activities all students completed the posttest which was identical to the pretest. Lastly, students completed the student engagement survey as well as the Intrinsic Motivation Inventory.

Participants experienced two modules delivered via the learning management system. The first module was titled *Welcome Module*, hereinafter called module 1, and contained material that was not part of the standard curriculum for a college algebra course. This module contained introductory and review content with the following assessments: a syllabus quiz, a skill review activity related to content from prior math classes, and a discussion prompt. The second module was titled *Modeling Functions*, hereinafter called module 2, and was the first content module that addressed course learning outcomes. Module 2 contained the following: a pretest, three discussion prompts, learning activities with a related homework assignment, a chapter review, and the posttest. Both groups had the same experience except that the experimental group received digital badges with embedded feedback.

CHAPTER 4: RESULTS

This chapter contains an analysis of data collected in an effort to answer each of the hypotheses.

4.1 Student Characteristics

The experiment consisted of 22 students in the experimental group and 23 in the control group. The average age of all 45 participants was 23.8 years with 19 males and 26 females. Other demographics from the survey are listed in Table 1.

Table 1 Participant Demographics

Education	Frequency	Work Hours	Frequency
First Year	22	0	4
Years 2-4	22	1-5	1
4 Years or More	1	6-10	7
		11-15	10
		>15	23

4.2 Badges Earned

Badges were incremental; participants had the opportunity to earn a one, two, or three star badge for each of the six named badges. Provided in Table 2 is the name of each badge, the order in which they were earned, the criteria necessary to earn each badge along with the trigger for each

level. The Badgr system used the term ‘criteria’ to denote what must be done by the student in order to receive the badge. Hamari and Eranti (Hamari & Eranti, 2011) discuss completion logic and dissect the concept in to four distinct components. In brief, the components and their meaning are:

1) *Pre-requirements for the game setting*. Pre-requirements outline necessary conditions within the game state prior to a trigger being activated. Examples include the selection of correct game mode, difficulty, or player role. In this study the only pre-requirement was that the student must have been in the course completing work.
2) *Conditional requirements for the game state*. Conditional requirements specify how, when, where, in what time frame, and for which players the trigger takes place. In this study the conditional requirement is the specific assignment the student is completing/submitting.
3) *Triggering action or event*. The triggering action defines the change required to the game state in order to unlock the badge. The trigger answers this question: What does a player have to do (e.g., correctly diagnose a patient) or what system-invoked event must take place (e.g., the round has ended due to time running out)? In this study, the trigger is the condition necessary to achieve each level of the incremental badge (called the criteria in Badgr).

Furthermore, the conditional requirement for three badges were assignments that allowed unlimited attempts before the due date (symbolized as UA in Table 2). The conditional requirement for the Function Master badge was completing the module posttest, which allowed only one attempt. Two badges had a conditional requirement associated with a graded assignment but the triggers were for voluntary behavior (symbolized V in Table 2). For example, participants

who completed more than the minimum required discussion posts earned the Most Valuable Team Player badge.

Table 2 - List of Badge Names and Criteria

Badge Number (Order Earned)	Badge Name	Condition to Earn Badge (Trigger for Level 1, Level 2, Level 3)
# 1	Syllabus Star	Syllabus Quiz – UA (80%, 90%, 100%)
# 2	Skill Builder	Skill Review Assignment – UA (80%, 90%, 100%)
# 3	Function Master	Complete Module Posttest – 1 Attempt (Score ≥ 80%, ≥ 90%, ≥ 100%)
# 4	So Extra	Complete Practice Test – UA, V (Score ≥ 80%, ≥ 90%, ≥ 100%)
# 5	Early Bird	Finish A Homework Assignment At Least One Day Before Due Date – V (One Assignment, Two, Three)
# 6	MVTP Most Valuable Team Player	Extra Discussion Posts – V (< 4 Extra, 4-5 Extra, > 5)

Out of the 22 participants in the experimental group, there were varying badge levels obtained. Table 3 presents the number of students who earned each level for all six of the named badges. For simplicity of the frequency counts, if a student earned a level three badge they were not counted as earning a level 1 or 2; this type of frequency count eliminates repeated counts for the same participant. For example, only 18 of the 22 participants earned the Early Bird badge (badge 5 as shown in Table 1)

Table 3 - Frequency of Highest Level Earned in Experimental Group

Badge Number / Level	1	2	3	4	5	6
1	0	1	4	1	1	3
2	0	3	7	2	3	3
3	22	18	7	19	14	16
Total	22	22	18	22	18	22

Table 4 - Frequency of Highest Level Potentially Earned in Control Group

Badge Number / Level	1	2	3	4	5	6
1	0	2	4	0	2	11
2	0	5	6	2	8	3
3	23	16	5	19	6	0
Total	23	23	15	22	16	14

Lastly, the average level of badges was calculated for each group. A significant difference was observed for the Early Bird badge (badge 5 in Table 2) and the Most Valuable Team Player (badge 6). Recall that the trigger for badge five was the optional behavior of early submission of assignments. The trigger for badge six was also optional behavior, using excess discussion posts.

Using an independent samples t-test to compare means, there is a significant difference between groups for badge 5, $t(34) = 2.17$, $p = 0.0385 < .05$, $d = 0.75$. Similarly, there is a significant difference for badge six, $t(36) = 7.11$, $p < .001$, $d = 2.29$.

4.3 Perceived Motivation – Hypothesis 1

The Intrinsic Motivation Inventory (selfdeterminationtheory.org, nd.; Ryan, 1982) is a subjective measure used to determine participants' intrinsic motivation (see appendix D). Hypothesis 1 investigated the difference between the experimental and control groups. Using a Likert scale of 1 (not at all) to 5 (always), an independent samples t-test for difference of means was utilized and found no significant difference in perceived motivation between the two groups, $t(43) = 1.02$, $p = .31$.

Table 5 – Independent Samples t-test for Hypothesis 1

	n	Minimum	Maximum	Mean	Std. Deviation
Control	23	1	5	2.34	2.71
Experimental	22	1	5	1.20	1.36

4.4 Engagement – Hypotheses 2 and 3

Hypothesis 2 was measured using a combination of questions from the National Survey of Student Engagement (NSSE Home, n.d.) and Community College Survey of Student Engagement (CCSSE - About the CCSSE Survey, n.d.). The scores on the Likert scale were averaged and an independent samples t-test was used to compare means between the experimental and control

groups. There was no significant difference in perceived engagement between the two groups, $t(43) = .04$, $p = .96$.

Table 6 – Independent Samples t-test for Hypothesis 2

	n	Minimum	Maximum	Mean	Std. Deviation
Control	23	1	5	2.92	1.06
Experimental	22	1	5	2.91	1.05

Hypothesis 3 investigated engagement using behavioral data within the course management system. Hypotheses 3a was tested using overall page views. The learning management system was unable to report page views per student, only total page views per day was reported within each class. No significant difference was found using an independent samples t-test, $t(43) = .25$, $p = .79$.

Table 7 - Independent Samples t-test Hypothesis 3a

	n	Minimum	Maximum	Mean	Std. Deviation
Control	23	182	1827	772	203
Experimental	22	208	2149	787	189

Hypotheses 3b used the total number of discussion posts to investigate engagement. The minimum required was three per prompt. There were 3 prompts, thus a minimum of nine posts were required. The mean number of posts was compared between the experimental and control group and the results were tested using an independent samples t-test. Participants in the

experimental group created a significantly higher number of discussion posts than participants in the control group, $t(43) = 5.64$, $p < .001$, $d = 1.84$. For further detail, the median and 20% trimmed mean was calculated for each group. Notice that the median and trimmed mean were very close to the total mean for each group. This indicates that the total mean is not skewed by any outliers.

Table 8 - Independent Samples t-test for Hypothesis 3b

	n	Minimum	Maximum	Mean	Median	20% Trimmed Mean	Standard Deviation
Control	23	5	13	9.2	9	9.2	2.04
Experimental	22	4	32	17.2	18	17.4	5.85

Hypotheses 3c investigated engagement through the number of discussion posts completed in excess of the minimum required number. Recall the minimum number of required posts was nine. Therefore, for a student who completed 13 posts, the excess calculation for that student was four. Also, for a student who posted below the minimum requirement, their excess was calculated as zero since they did not complete any excess posts. An independent samples t-test was used to compare means between the groups. Participants in the experimental group created a significantly higher number of discussion posts in excess of the required minimum, $t(43) = 5.66$, $p < .001$, $d = 2.20$. For further detail, the median and 20% trimmed mean was calculated for each group. Notice that the median and trimmed mean were very close to the total mean for each group. This indicates that the total mean is not skewed by any outliers. Lastly, the average overage for each student was

calculated for the three discussion prompts. For example, if a student had 2, 3, and 5 excess posts in each of the three discussion prompts, then the average excess posts for that student was 3.3. Finding the average of each student average shows that the control and experimental group had an average per student of 0.7 and 3.1 respectively.

Table 9 - Independent Samples t-test for Hypothesis 3c

	n	Minimum	Maximum	Mean	Median	20% Trimmed Mean	Std. Deviation
Control	23	0	4	1.4	1	1.2	1.38
Experimental	22	0	23	9.2	9	9.0	4.86

4.5 Content Knowledge – Hypothesis 4

Hypothesis 4 investigated the effects of feedback delivered via digital badges on learning gains. A dependent samples t-test, with paired data from pretest to posttest, was used to compare the mean change between both groups. The mean delta (change of scores) was assumed to be zero. The test showed a significant improvement, $t(21) = -7.37$, $p < .001$, $d = 1.25$, and $t(21) = -6.17$, $p < .001$, $d = 1.54$ for both the experimental and control group respectively.

Table 10 - Independent Samples t-test for Pretest and Posttest Means Within Groups

	n	Min Pretest	Max Pretest	Min Posttest	Max Posttest	Mean	Std. Deviation
Control	23	32.13	72.11	48.74	98.99	1.39	1.38
Experimental	22	24.49	92.51	37.63	99.24	9.16	4.86

The second analysis tested the mean paired difference (delta) of scores between groups. The delta was calculated for each student (in each group), then the mean delta of each group was compared using an independent t-test and found no difference in mean delta, $t(21) = .28$, $p = .39$.

Table 11 - Independent Samples t-test for Delta Between Groups

	n	Minimum	Maximum	Mean	Std. Deviation
Control	23	3.26	50.11	23.85	15.85
Experimental	22	16.78	61.94	25.29	20.08

CHAPTER 5: DISCUSSION

There has been a call for more research to help parse out the elements of gamification that can be effective, especially considering the use of digital technology and its incorporation as a learning tool in all modes of classroom delivery (Hanus & Fox, 2015). This study examined the teaching effectiveness of feedback delivered via digital badges in an online course. The dependent variables investigated were learning gains, perceived motivation, and engagement. The only significant improvements in the badged condition were found with peer-to-peer engagement. No significant differences were found with perceived engagement, perceived motivation, or learning gains. Many educators are hopeful to find positive results from gamification. So, the question is: what can be learned from this study and how can it be used to shape future research on digital badges?

5.1 Learning Gains

In regards to learning gains, participants in both the experimental and control group had significant improvement from pretest to posttest, showing that learning did take place within each group. The mean delta between the experimental and control groups were not significantly different. Considering these results, it seems apparent that digital badges had little to no effect on learning gains. It is possible that improvement from pretest to posttest within each group was influenced by student effort to complete the required course material.

In regards to effort, it has been shown to have a positive influence on academic success (Carbonaro & Gamoran, 2002; Farkas, Grobe, Sheehan, & Shuan, 1990; Natriello & McDill, 1986). This dissertation did not investigate any possible relationship that might exist between effort and digital badges. Even though the number of page views was used to measure

engagement, effort cannot be measured solely by the number of page views. Carbonaro (2002) posits that effort must be divided into three categories: rule oriented (class attendance, behavior), procedural (complete work and submit on time), and intellectual (desire to do more than get answers correct, desire to perform above ability). All three categories should be considered in order to gain a full picture of effort. Future research should investigate whether the use of digital badges has an effect on effort.

It is not possible to determine whether the significant improvement from pretest to posttest within each group was due to badge criteria related to required assignments or for voluntary behavior. One reason that required assignments was used as criteria for a badge was to ensure students received the embedded feedback. If the majority of badges were earned through triggers based on voluntary behavior then the learner might have missed influential formative feedback. Also, providing frequent feedback on low-stakes assignments was intended to give a perception that feedback was more formative and less controlling. This perception may reduce negative influences on effort and self-regulation (Nicol & Macfarlane-Dick, 2006; Ryan, 1982). However, delivering badges for required assignments, regardless of graded value, may have been ineffective if participants still perceived them as being controlling. Future studies could consider two separate experimental groups, one using triggers for required assignments while another group receives badges for only voluntary behavior.

5.2 Motivation

This study examined perceived motivation using the interest/enjoyment subscale of the Intrinsic Motivation Inventory and did not find a significant difference between the experimental and control groups. The effects of badges on perceived motivation may have been nominal since

the course was required for graduation. In essence, students already possessed motivation as they began the course and thus extrinsic motivators were not effective (Deci et al., 2001). The lack of any significant results on the IMI aligns with some prior research related to the effects of rewards and extrinsic motivators. Deci et al. (2001) observed that rewards can have a negative effect on a person who already possesses interest in an activity. It could be possible that students perceived a badge as a reward rendering the effects on motivation minimal. Similarly, the use of incremental badges in this study might be perceived negatively, forcing the learner to follow a trail of bread crumbs and reducing their sense of autonomy (Blair, 2012).

Other studies have shown that rewards can be used to gradually improve performance (Cameron et al., 2001) and help maintain or improve effort of persistence (Bellotti et al., 2013). Since effort and performance can change over time, then perhaps motivation is also temporal. In an educational setting, this temporal change could be caused by success or failure on graded assignments. When a learner experiences a failure event they may also experience a decrease in motivation. Recent research has studied the concept of grit, a student's perseverance of effort and consistency of interest over time (Duckworth, Peterson, Matthews, & Kelly, 2007). Since grit considers a temporal aspect of effort and interest, future studies might find value in investigating a possible relationship between badges and grit.

Another variable that may influence how badges effect motivation is the individual ability of a learner (Abramovich, Schunn & Higashi, 2013). The results gathered from the IMI were measured using scores from all students in aggregate. Also, the treatment occurred during the first 3 weeks of the course, which did not allow for stratifying students based on prior ability. Instead, the influence of badges on perceived motivation may have been more evident if participants were stratified based on individual levels of ability before treatment occurred. One way to measure

ability would involve using data from previous completed courses with similar learning outcomes. A second way to measure ability before the badge treatment occurs could be accomplished by delivering badges in the middle or near the end of the class. This would allow a stratification based on student ability using results from the first content module. Lastly, a third possible method to gauge ability comes from traditional student success data, such as GPA. Using all three measures for ability could help control for variability to look for possible influences of badges within high or low performing students.

Prior knowledge is another variable that may alter how badges affect motivation. Interestingly, prior knowledge of specific content can have a negative effect on motivation and effort (Wood & Lynch, 2002). Some learners can feel a sense of complacency due to a high level of prior knowledge, thus experiencing a decrease in motivation. In this case, badges may have little influence on learners who have a high level of prior knowledge. Similar to stratifying participants based on general academic ability, future research should further consider the potential effects of prior knowledge of specific content (or lack thereof).

5.3 Engagement

In this study, survey results were used to assess perceived engagement, and behavioral data was used to analyze observed student engagement. In regards to behavior within the course, engagement with course learning material was not significantly different. In order to measure this behavioral activity, daily total page views of all students were extracted from the course learning management system. The mean of daily page views was calculated for both groups and compared. This one measurement was useful; however, it could be greatly affected by an outliner. For example, if one student viewed five times as many pages as other students, then this outlier could

greatly skew the mean of the collective group. In order to control for this possibility, an additional measure could involve page views per log-in session for each individual student. Unfortunately, this data was not obtainable for this course management system. Also, there may be other analytics tools that can provide different metrics in regards to student traffic in the course management system.

A possible limitation on engagement with learning material may be due to the inability of the Badgr system to utilize triggers for all desired conditions. The system can execute simple triggers for criteria such as assignment scores or submission. However, Badgr was unable to automatically deliver badges for behaviors such as excess discussion posts. Also, it was not able to distinguish between submission assignments before the due date or on the due date. Due to this limitation some badges were delivered manually. If a student initially found interest in earning badges, a few delays in delivery may have discouraged the participant and caused a decrease in motivation to earn future badges. The effects of feedback, whether immediate or delayed, should be further considered as timing may have varying results (Blair, 2011). However, it may just be the case that digital badges have no influence on student interaction with required learning activities. If success in a required course is the primary reason for engagement, then few interventions may have any effect on significantly increasing student desire to earn badges on assignments that are mandatory graded activities.

Promising results were observed with peer-to-peer interaction which may indicate a positive relationship between badges and peer engagement. The experimental group had a significantly higher number of overall discussion posts as well as posts in excess of the minimum requirement. These two results are promising in regards to learner behavior and the desire to

engage with their peers. This is favorable behavior because student engagement in learning communities is believed to have a positive effect on performance gains .

One possible result from increased engagement could be related to group cohesiveness. Cohesiveness is the extent to which group members are attracted to other members (Campion, Medsker, & Higgs, 1993). The motivation for members to remain a part of the group depends upon the level of cohesiveness (Goodman, Ravlin, & Schminke, 1987). The discussion requirement in this experiment is cooperative in nature since classmates participate in online conversations. Lott and Lott (1965) posit that cooperative learning can foster cohesiveness because it increases contact among group members. Since badges seem to have increased engagement in this study, then badges may encourage group cohesiveness, bonding students together as they strive for success. Group cohesiveness is known to generate mutual concern (Slavin, 1980) increase self-esteem (Ames & Felker, 1979), and predict student learning in online distance education (Williams, Duray, & Reddy, 2006). The results due to increased engagement should encourage future research to investigate any possible correlation between digital badges, collaboration, and cohesiveness.

5.4 Design Applications

In this study, the completion logic for three of the badges was based on a trigger related to optional behavior. One of the badges had a graded assignment as a conditional requirement but the trigger was based on optional behavior: posting excess discussions. As noted in the results discussion, there was a significant increase in the average number of excessive discussion posts in the experimental group. Also, the level of badges earned for excess discussion posts was significantly different between the groups if the control had received the badge treatment. Since

the badges were incremental, levels one through three, this means the average level earned was significantly higher in the experimental group. The conclusion is that badges had a positive effect on peer-to-peer engagement. One possible reason this worked is because the trigger was based on optional behavior. Another reason is due to the natural desire humans have for group identification.

Looking at optional behavior, there are some recent studies that discuss results from the use of this trigger in badge design applications. In prior studies some students report they felt strong negative emotions when graded activities were used as triggers for earning a badge (Haaranen, Ihantola, Hakulinen, & Korhonen, 2014). Another study noted that completion logic for badges associated with optional behavior had a positive influence on lecture attendance and engagement. These results suggest that utilizing a trigger based on optional behavior may be effective in changing behavior and is one factor that should be considered in further badge design studies.

To further explore triggers based on optional behavior, consider a content module in a physics course with conservation of energy as a learning outcome. The instructor wishes to design an activity that involves the psychological construct of curiosity. A badge design that encourages play and exploration is effective in developing curiosity. This desire is based on the fact that learning can be achieved through play (Rodriguez, 2006; Ruckenstein, 1991). Thus, the instructor uses an existing simulation (PhET Interactive Simulations, n.d.) that allows players to explore the relationship between kinetic energy, potential energy, and thermal energy (see Figure 3). This interactive simulation provides a playful experience within a system involving motion.

The learner begins by choosing where to place the skateboarder. Upon release of the rider, a bar graph dynamically changes, illustrating the concept of conservation of energy: energy is never lost, it only changes form.

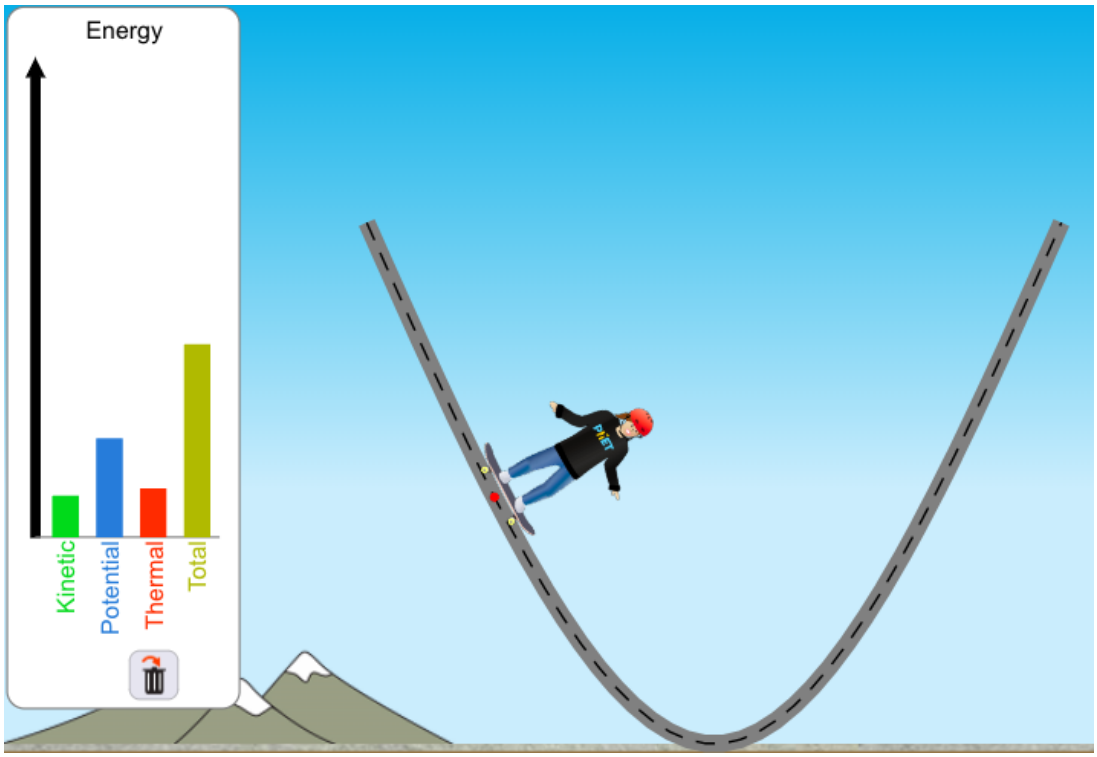


Figure 3 - Conservation of Energy Simulation (PhET Ineractive Simulations, n.d.)

The conditional requirement for earning a badge would involve completing an optional worksheet that scaffolds the learning experience, leading the player to explore through a guided activity. The levels of the incremental badges could utilize triggers related to the number of questions the player can answer on the scaffolded worksheet. An example of an optional trigger may involve correctly answering a question related to the principal of conservation of energy. Each level of the incremental badge could require a slightly more difficult question from the prior question (see table 12). A possible question could say “Notice as the rider continues motion after being released,

she begins to slow down and motion eventually stops. Why does thermal energy increase until the rider stops?"

Table 12 - Triggers for Physics Simulation

Badge Level	Trigger
1	Why is kinetic energy zero at the point of release?
2	Why is potential energy zero at the bottom of the ramp?
3	Why does thermal energy increase until the rider stops?

The second reason badges may have a positive effect on peer-to-peer engagement is due to the psychological construct of relatedness within a social interaction. In this case, badges can facilitate group identification: the desire for learners to have a shared experience in collaborative work (Antin & Churchill, 2011). Humans have an innate desire and psychological need to relate and connect meaningfully with others. An advantage to encouraging collaboration is that social interaction can influence motivation (Das & Lavoie, 2014). This can be especially helpful in a formal learning environment. In this study, badges increased peer-to-peer engagement on a discussion board, thus acting as a catalyst for group identification. Thus, it seems that the use of badge triggers to encourage peer-to-peer engagement may stimulate the cognitive behavior of social interaction. If this is true, badges should be designed for activities related to cooperative work.

An example of this design feature can be illustrated utilizing a team building exercise. Consider a learning activity that involves a team of six people working together to solve a crime

mystery. Each team member is given their own copy of an information sheet about the crime and subsequent evidence. First, a narrative story is provided to introduce the setting and the crime that occurred. At the end of the narrative, a detective's report is given with information about the collected evidence. Each of the sheets distributed to the six group members contains slightly different details. For example, one sheet may contain information that none of the other sheets disclosed. Also, two sheets may have the same information but with slightly different details: both sheets state that hair was found at the crime scene but only one provides the color. A few of the goals of this activity are to develop goal setting, communication skills, problem solving, flexible thinking, and conflict resolution, all within a team environment (Macon, 2014). The directions may have the following structure:

1) Individually read the following narrative and detective's report with the details about each suspect. Enough information has been provided to solve the crime.
2) Discuss the details with your group. Use this information to deduce which suspect took the cash from the cash box.
3) You can assume that there are no other suspects that need to be considered – one of the suspects listed is the thief.

One of the outcomes of this activity is goal setting - encourage group members to work together in order to achieve a common goal. Recall that the mystery cannot be solved by one person sine their individual information sheet does not have enough information in isolation. Since differing details in each sheet are initially difficult to discover, this activity provides a challenging scenario for the group to solve collaboratively. Properly designed goals that are attainable but challenging can be highly motivating (Abramovich et al., 2013; Cameron & Pierce, 1994). A

second outcome of this activity is to develop effective communication within a group. Once the crime is solved through collaboration, participants should feel a sense of satisfaction. The satisfication that comes from effectively reaching a group decision is mediated through the psychological concept of relatedness through social interaction.

Furhtermore, if multiple groups are solving the mystery, triggers could be based on the construct of competition. Badges can facilitate the correlation between competition in games and conceptualizations of self-efficacy (Vorderer, Hartmann, & Klimmt, 2003). In summary, utilizing a badge design related to a collaborative assignment can simultaneously connect to psychological constructs such as group identification, relatedness, social interaction, and self-efficacy. Some possible triggers for badging in this particular group activity can be seen in Table 13.

Table 13 - Triggers for Team Building Activity

Badge Level	Trigger
1	Submit a correct solution
2	Submit a well-written correct solution supported with the evidence used
3	Be the first group to submit a well-written and correct solution

The two examples discussed above illustrate recommended components of badge design to enact behavioral change in a gamified learning environment. Badges can affect learners on multiple levels as they foster specific interactions within a learning environment. As posited by McDaniel and Fanfarelli (McDaniel & Fanfarelli, 2016), “functions that shape the user experience of badging are further mediated by cognitive, social, and affective forces” (pg. 77).

CHAPTER 6: CONCLUSIONS

This dissertation has examined the effects of delivering feedback via digital badges in a learning environment. The results were not effective on a majority of the variables tested: perceived motivation, perceived engagement, and learning gains. Some possible limitations were discussed and suggestions made for future research such as: analyze the results on different populations like traditional and non-traditional students, investigate different effects on the possession of prior knowledge, consider a possible relationship between badges and grit (student effort) after a failure event, compare activities that are graded and optional as well as for voluntary behavior with graded and optional work.

Even though there were positive results for engagement between participants, it is still unclear which badge design is correlated to this behavior. A few of the badges in this study were rewarded for voluntary behavior, while others were earned for required work. The increase in peer-to-peer engagement may have occurred solely from badges earned for voluntary behavior due to a minimization of perceived control. It is possible that the increase came from the badges earned for completing required content, encouraging students to persist. It is also likely that both designs for delivery worked in unison. Finally, the positive results could potentially have been influenced by the design of the trophy room.

The increase in peer-to-peer engagement may fall more in line with results from social psychological research. Badges are typically used to target feelings of motivation, desire, curiosity, and interest. Further research should continue to investigate how badges affect psychological functions that shape the experience of the learner. Badges can also be used to affect group

identification, or the desire for learners to have a shared experience in collaborative work (Antin & Churchill, 2011).

The manner in which humans interact with badges are complex. Psychological and emotional factors can have varying effects depending on the learner and the environment. In a learning, further factors can involve pedagogical design as well as delivery sytems. Designers need to consider all of these factors as they develop badges with the abililty to influence positive behavioral changes. Finally, much of the research on badges has not been conducted under the principle of replication. This has created a growing body of results based on varied badge designs and a wide range of implementation. As the field continues to advance, it is important for some standardization to occur in conjunction with replication. This will help provide more empirical results, to build a stronger foundation, and advance the application of digital badges.

APPENDIX A: DEMOGRAPHS SURVEY

Demographics Survey

Participant # _____ Age _____ Major _____ Date _____ Gender ___

1. What is the highest level of education you have (circle best response)?

   First year in college Completed less than 4 years of college

   Other (please explain) _____

2. In how many online classes have you enrolled in your college career (completed or not)?

   This is my first 1-2 3-5 More than 5

3. Did any of your prior online classes ever use badges as a reward for completing tasks?

   Yes No

4. Have you taken any other mode of class (face to face, reduced seat time, etc…) that has used badges?

   Yes No

5. Have you ever played a game that rewards badges?

   Yes No

   If Yes, which game(s)? _____

6. How many other classes are you enrolled this semester?

   This is my only class 1-2 3-4 5-6 7-8 More than 8

7. How many hours do you work during a week?

0 1-5 6-10 11-15 16-20 More than 20

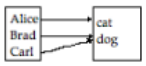
8. How many hours of sleep do you typically get each night?

   Less than 6 7-9 10-12 Other: _____

APPENDIX B: PRE/POSTTEST

Question 1 — 1 pts

Determine whether the relation represents a function. If it is a function, state the domain and range.



- Is a function.
  Domain: {Alice, Brad, Carl}
  Range: {cat, dog}
- Is a function.
  Domain: {cat, dog}
  Range: {Alice, Brad, Carl}
- Not a function

Question 2 — 1 pts

Determine whether the relation represents a function. If it is a function, state the domain and range.

A set of ordered pairs: {(11, -3), (2, -2), (2, 0), (6, 2), (18, 4)}

- Is a function
  Domain: {11, 6, 2, 18}
  Range: {-3, -2, 0, 2, 4}
- Is a function
  Domain: {-3, -2, 0, 2, 4}
  Range: {11, 6, 2, 18}
- Not a function

Question 3 — 1 pts

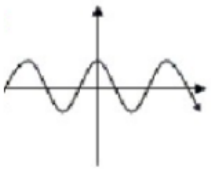
Determine whether the equation defines y as a function of x.

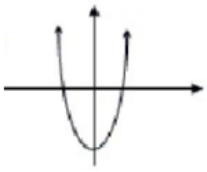
$x - 4y = 3$

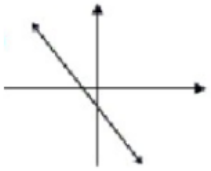
- Is a function
- Is not a function

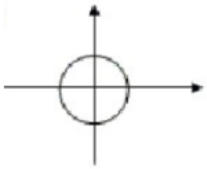
Question 4 1 pts

Which one of the following graphs does NOT represent a function?









Question 5 1 pts

Find the value for the function.

Find $f(-9)$ when $f(x) = |x| - 6$

- -3
- 3
- -15
- 15

Question 6 1 pts

Find the value for the function.

Find f(2) when $f(x) = \sqrt{x^2 + 3x}$

- $2\sqrt{3}$
- $\sqrt{10}$
- $\sqrt{13}$
- $\sqrt{7}$

Question 7 1 pts

If $f(x) = 4x - 5$ for what value(s) of x does $f(x) = 0$?

- $\frac{5}{4}$
- -4 and 5
- 4 and -5
- -5

Question 8 1 pts

Find the domain for the function $f(x) = \sqrt{10 - x}$

- $x \geq \sqrt{10}$
- $x \geq 10$
- $x \leq \sqrt{10}$
- $x \leq 10$

Question 9 1 pts

Find the domain of the function $f(x) = \frac{3x}{x-5}$

- $\{x|x \neq 5\}$
- $\{x|x \neq -5\}$
- $\{x|x \neq 0\}$
- Domain is All Real Numbers

Question 10 1 pts

If a rock falls from a height of 70 meters on Earth, the height H (in meters) after x seconds is approximately $H(x) = 70 - 4.9x^2$

What is the height of the rock when x = 1.8 seconds? Round to the nearest hundredth.

- 54.45
- 54.12
- 85.88
- 61.18

Question 11 1 pts

If $f(x) = 6x - 3$ and $g(x) = 8x - 4$

Find $f(x) - g(x)$

- $-2x + 1$
- $-2x - 7$
- $14x - 7$
- $2x - 1$

Question 12 1 pts

If $f(x) = x^2 - 6$ and $f(x) = 2x - 2$

Find $f(4) + g(4)$

- 0
- 40
- 4
- 16

Question 13 1 pts

The function $f(t) = -0.13t^2 + 0.53t + 30.1$ models the U.S. population in millions, ages 65 and older, where t represents years after 1990. The function $g(t) = 0.51t^2 + 12.36t + 105.2$ models the total yearly cost of Medicare in billions of dollars.

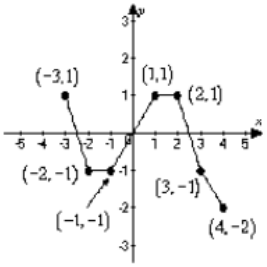
a) What does the function $\frac{g(t)}{f(t)}$ represent?

b) Calculate $\frac{g(5)}{f(5)}$

- a) Cost per person in thousands of dollars
  b) $0.20 thousand
- a) Cost per person in thousands of dollars
  b) $12.64 thousand
- a) Cost per person in thousands of dollars
  b) $0.16 thousand
- a) Cost per person in thousands of dollars
  b) $6.09 thousand

Question 14 — 1 pts

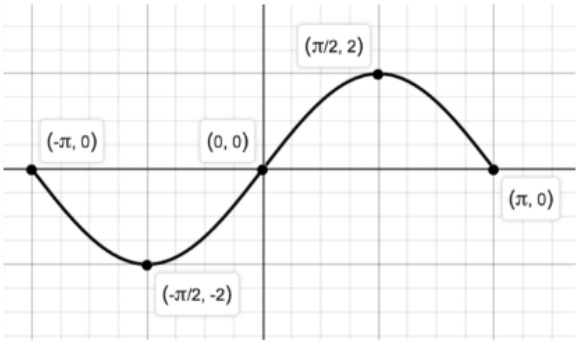
Use the graph to find the intervals where the function is increasing, decreasing, or constant.



- Decreasing on (-3, -2) and (2, 4); increasing on (-1, 1)
- Decreasing on (-3, -2) and (2, 4); increasing on (-1, 1); constant on (-2, -1) and (1, 2)
- Increasing on (-3, -2) and (2, 4); decreasing on (-1, 1); constant on (-2, -1) and (1, 2)
- Decreasing on (-3, -1) and (1, 4); increasing on (-2, 1)

Question 15 — 1 pts

Use the graph below to find the domain, range, and the x and y intercepts



- Domain: $-\pi \le x \le \pi$
  Range: $-1 \le y \le 1$
  Intercepts: $(-\pi, 0)$, $(0, 0)$, $(\pi, 0)$
- Domain: all real numbers
  Range: $-1 \le y \le 1$
  Intercepts: $(-\pi, 0)$, $(0, 0)$, $(\pi, 0)$
- Domain: $-1 \le x \le 1$
  Range: $-\pi \le y \le \pi$
  Intercepts: $(-\pi, 0)$, $(0, 0)$, $(\pi, 0)$

Question 16 1 pts

Find the function value $f(1)$ for the given piecewise function

$$f(x) = \begin{cases} -x+3\ , & if\ x < 2 \\ 2x-3\ , & if\ x \geq 2 \end{cases}$$

- 2
- - 1
- 1
- -2

Question 17 1 pts

Consider the graph of the function $f(x) = \sqrt{x}$

Find the function that is finally graphed after the following transformations are applied:
The graph is reflected about the x-axis, then shifted down 9 units, and finally shifted left 3 units.

- $y = \sqrt{-x+3} + 9$
- $y = -\sqrt{x+3} - 9$
- $y = -\sqrt{x-3} - 9$
- $y = \sqrt{-x-3} - 9$

Question 18 1 pts

Consider a graph of a function $y = f(x)$ that has the point (3,2). Which one of the following points would lie on the graph of $y = f(x+2) + 1$?

- (5,3)
- (1,3)
- (5,1)
- (4,4)

Question 19 1 pts

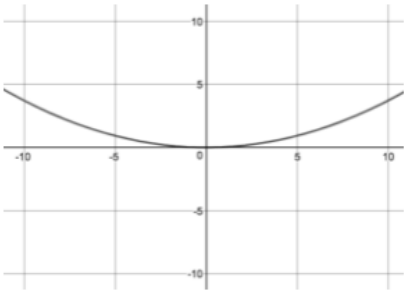
A rectangular sign is being designed so that the length of its base is 20 feet less than the height h. Express the area of the sign as a function of the height h.

- $A = h^2 - 20h$
- $A = 20h - h^2$
- $A = 20h^2 + h$
- $A = h^2 + 20h$

Question 20 1 pts

Suppose a cold front is passing through the United States at noon with a shape described by the function $y = \frac{1}{27}x^2$ where each unit represents 100 miles. Missouri is located at the origin and the positive y-axis points north.

Suppose the front moves south 340 miles and west 120 miles and maintains its shape. Give the equation for the new front.



- $y = \frac{1}{27}(x - 1.2)^2 + 4.3$
- $y = \frac{1}{27}(x + 1.2)^2 + 4.3$
- $y = \frac{1}{27}(x - 1.2)^2 - 4.3$
- $y = \frac{1}{27}(x + 1.2)^2 - 4.3$

Question 21 — 1 pts

Look at the graph given to answer each question.

a) The value of $f(-50) =$ ____

b) What value of x makes $f(x) = -30$? x = ____

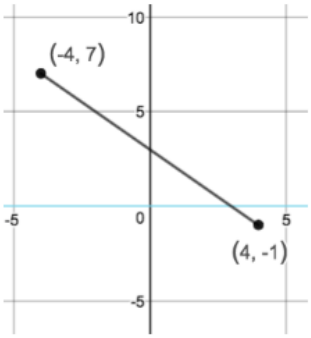
c) The horizontal line y = 10 intersects the graph ____ time(s).

d) The vertical line x = 30 intersects the graph ____ time(s).

e) The y-intercept is y = ____

Question 22 — 1 pts

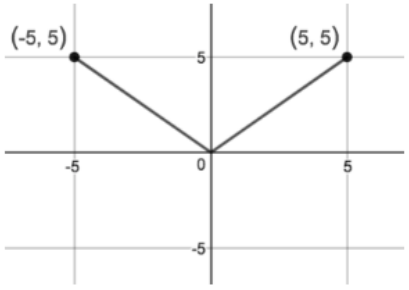
Given the graph of a function $f(x)$ find the domain and range.



- Domain is $-4 \leq x \leq 4$
  Range is $-1 \leq y \leq 7$
- Domain is $-1 \leq x \leq 7$
  Range is $-4 \leq y \leq 4$
- Domain is $-1 \leq x \leq 7$
  Range is $4 \leq y \leq 1$
- Domain is $-4 \leq x \leq 1$
  Range is $-4 \leq y \leq 7$

Question 23 1 pts

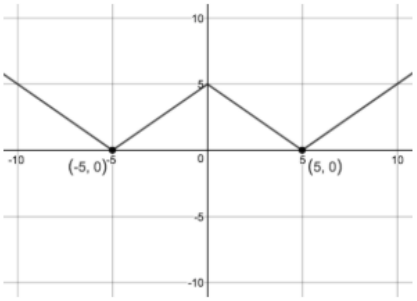
Determine if the graph of the function is even, odd, or neither.



- even
- odd
- neither

Question 24 1 pts

Find where the graph of f has a local maximum and local minimum.



- f has a local maximum at x = 5; f has a local minimum at x = 0
- f has a local maximum at x = -5 and 5; f has a local minimum at x = 0
- f has a local maximum at x = 0; f has a local minimum at x = -5 and 5
- f has no local maximum or minimum

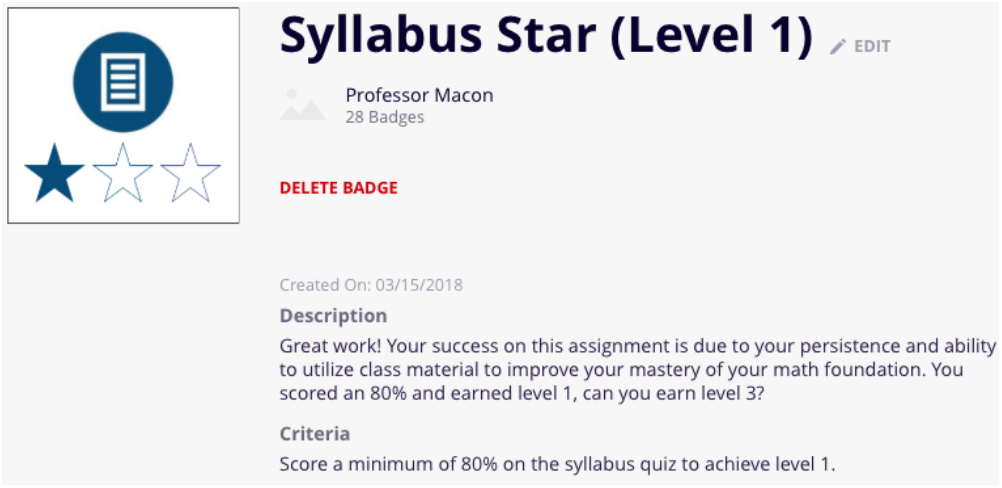
Question 25 1 pts

Find the x and y intercepts for the graph of the equation $x^2 + y - 4 = 0$

- (-4,0), (4,0), (0,4)
- (-2,0), (2,0), (4,4)
- (0, -2), (0,2), (4,0)
- (-2,0), (2,0), (0,4)

APPENDIX C: BADGE DESIGN

The appendix contains screen shots of all the badges used with the imbedded feedback. Three badges were used for required material. Three badges were used for material not required. The badges used for required material were Syllabus Star, Skill Builder, and Function Master. The three badges used for non-required material were So Extra, Early Bird, and Most Valuable Team Player.



Syllabus Star (Level 3) EDIT

Professor Macon
28 Badges

DELETE BADGE

Created On: 08/16/2018

Description

Great work! Your success on this assignment is due to your persistence and ability to utilize class material to improve your mastery of your math foundation. You scored a 1000% and earned level 3! Well done!

Criteria

Score a perfect 100% on the syllabus quiz to earn level 3.

Skill Builder (Level 1) EDIT

Professor Macon
28 Badges

DELETE BADGE

Created On: 09/17/2018

Description

Congratulations! Your progress on the skill review assignment is due to your determination to prepare for the course work. You scored a 80% and earned level 1, can you get level 3?

Criteria

Score 80% on skill review assignment

Skill Builder (Level 2) EDIT

Professor Macon
28 Badges

DELETE BADGE

Created On: 09/17/2018

Description

Well done! Your progress on the skill review assignment is due to your determination to build a good foundation for the course work. You scored a 90% and earned level 2, can you get level 3?

Criteria

Score 90% on skill review assignment

Skill Builder (Level 3) EDIT

Professor Macon
28 Badges

DELETE BADGE

Created On: 09/17/2018

Description

Congratulations! Your progress on the skill review assignment is due to your determination to prepare for the course work. You scored a 100% and earned level 3. Excellent work!

Criteria

Score 100% on the skill review assigment

Function Master (Level 1) EDIT

Professor Macon
28 Badges

DELETE BADGE

Created On: 09/17/2018

Description

Congratulations! Your progress on Chapter 3 Module is due to your hard work to learn about functions for success in this course. You scored a 80% and earned level 1, can you get level 3?

Criteria

Score 80% on Chapter 3 Review Test

Function Master (Level 2) EDIT

Professor Macon
28 Badges

DELETE BADGE

Created On: 09/17/2018

Description

Congratulations! Your progress on Chapter 3 Module is due to your hard work to learn about functions for success in this course. You scored a 90% and earned level 2, can you get level 3?

Criteria

Earn 90% on Chapter 3 Review Test

Function Master (Level 3) EDIT

Professor Macon
28 Badges

DELETE BADGE

Created On: 09/17/2018

Description

Congratulations! Your progress on Chapter 3 Module is due to your hard work to learn about functions for success in this course. You scored a 100% and earned level 3. Excellent work!

Criteria

Score 100% on Chapter 3 Review Test

So Extra (Level 1) EDIT

Professor Macon
28 Badges

DELETE BADGE

Created On: 09/26/2018

Description

{student name} you are so extra! Not in a bad way. Even though the practice test was not required, you did the extra work anyway! Another behavior of successful students in a math course: practice, practice, practice! Keep doing extra work and it will pay off!

Criteria

Complete the practice test one time.

So Extra (Level 2) EDIT

Professor Macon
28 Badges

DELETE BADGE

Created On: 09/26/2018

Description

{student name} you are so extra! Not in a bad way. Even though the practice test was not required, you did the extra work anyway! Another behavior of successful students in a math course: practice, practice, practice! Keep doing extra work and it will pay off!

Criteria

Complete the Practice Test, more than one time, with a perfect score of 90% or higher

So Extra (Level 3) EDIT

Professor Macon
28 Badges

DELETE BADGE

Created On: 09/24/2018

Description

{student name} you are so extra! Not in a bad way. Even though the practice test was not required, you did the extra work anyway! Another behavior of successful students in a math course: practice, practice, practice! Keep doing extra work and it will pay off!

Criteria

Complete the Practice Test, more than one time, with a perfect score (which is not required for a grade)

Early Bird (Level 1) EDIT

Professor Macon
28 Badges

DELETE BADGE

Created On: 09/22/2018

Description

Well done {student name}! Starting and finishing assignments early is an excellent habit that successful students have because it helps better handle unforeseen issues that can make you turn things in late! Keep up the hard work.

Criteria

Submit one homework assignment before the day of the due date.

Early Bird (Level 2) EDIT

Professor Macon
28 Badges

DELETE BADGE

Created On: 09/22/2018

Description

Well done {student name}! You have done a great job finishing before the due date. By starting early you have plenty of time to plan for unforseen challenges. This is a great habit that many successful student possess. Don't stop now!

Criteria

Submit two homework assignments before the day of the due date.

Early Bird (Level 3) EDIT

Professor Macon
28 Badges

DELETE BADGE

Created On: 09/22/2018

Description

Well done {student name}! You have done a great job finishing many of your assignments early. This behavior will help you succeed in any course because it helps you better handle unforeseen issues that can make you late! Keep up the hard work.

Criteria

Submit three or more homework assignments before the day of the due date.

MVTP (Level 1) EDIT

Professor Macon
28 Badges

DELETE BADGE

Created On: 09/22/2018

Description

Congratulations {student name} ! You are a Most Valuable Team Player. Your extra work on the discussion board, interacting with classmates, and answering questions, has helped build an engaging learning community that helps develop communication skills and team building.

Criteria

Engage with peers beyond the discussion post requirements. You answered a question for one of your classmates.

MVTP (Level 2) EDIT

Professor Macon
28 Badges

DELETE BADGE

Created On: 09/22/2018

Description

Congratulations {student name} ! You are a Most Valuable Team Player. Your extra work on the discussion board, interacting with classmates, and answering questions, has helped build an engaging learning community that helps develop communication skills and team building.

Criteria

Engage with peers beyond the discussion post requirements. You answered a question for two of your classmates.

MVTP (Level 3) EDIT

Professor Macon
28 Badges

DELETE BADGE

Created On: 09/22/2018

Description

Congratulations {student name} ! You are a Most Valuable Team Player. Your extra work on the discussion board, interacting with classmates, and answering questions, has helped build an engaging learning community that helps develop communication skills and team building.

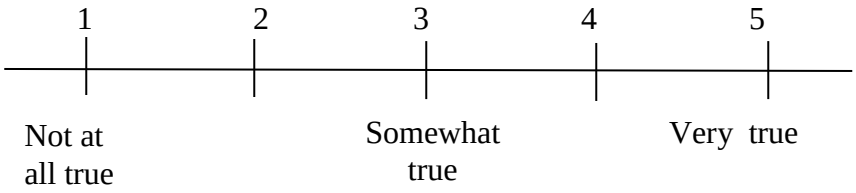
Criteria

Engage with peers above and beyond the requirements. You answered a question for 3 or more of your classmates.

APPENDIX D: INTRINSIC MOTIVATION INVENTORY

Intrinsic Motivation Inventory

For each of the statements below, please indicate how true it is for you, using the following rating scale:



1. I enjoyed doing this chapter very much. _____
2. I think I am pretty good at this chapter. _____
3. I put a lot of effort into this. _____
4. This chapter was fun to do. _____
5. I did not feel nervous at all while doing this chapter. _____
6. I didn't try very hard to do well at this chapter. _____
7. I think I did pretty well at this chapter, compared to other students. _____
8. I felt very tense while doing this chapter. _____
9. After working at this chapter for a while, I felt pretty competent. _____
10. I thought this was a boring chapter. _____
11. I was very relaxed while doing this chapter. _____
12. This chapter did not hold my attention at all. _____
13. I tried very hard on this chapter. _____
14. I would describe this chapter as very interesting. _____
15. I am satisfied with my performance at this chapter. _____

16. I was anxious while working on this chapter. _____

17. I thought this chapter was quite enjoyable. _____

18. It was important to me to do well at this chapter. _____

19. I was pretty skilled at this chapter. _____

20. This was a chapter that I couldn't do very well. _____

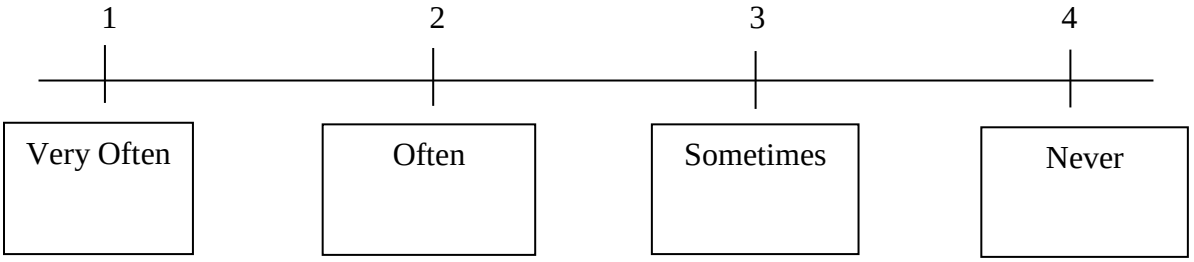
21. I didn't put much energy into this chapter. _____

22. I felt pressured while doing this chapter. _____

23. While I was doing this chapter, I was thinking about how much I enjoyed it. _____

APPENDIX E: ENGAGEMENT SURVEY

Student Engagement Survey



Please rate the following statements based on your behavior in this class.

1. _____ I asked questions and/or contributed to course discussions
2. _____ I asked another student for help with homework
3. _____ I helped another student with homework
4. _____ I prepared for an exam by working with other students
5. _____ I visited a tutor center or accessed online tutoring
6. _____ I connected my learning to a society problem or issue
7. _____ I communicated with my professor one-on-one about course material (visited office, via email, on phone)
8. _____ I talked to my professor about topics other than coursework
9. _____ I talked to fellow students about topics other than coursework
10. _____ Discussed ideas from class with others outside of class (family members, friends, co-workers, etc.)
11. _____ I worked harder than I thought I would have to in order to do well on an assignment

12. _____ I discussed my academic performance with either my instructor, classmates, family, friends, or co-workers)

13. _____ Watched a video to learn about course content

APPENDIX F: IRB APPROVAL

University of Central Florida Institutional Review Board Office of Research & Commercialization

12201 Research Parkway, Suite 501

Orlando, Florida 32826-3246

Telephone: 407-823-2901 or 407-882-2276

www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1**

FWA00000351, IRB00001138

To: **Brian Macon**

Date: **August 29, 2018**

Dear Researcher:

On 08/29/2018 the IRB approved the following modifications until 08/28/2019 inclusive:

Type of Review:	IRB Addendum and Modification Request Form Expedited Review
Modification Type:	Revision of study timeline from Fall 2018 to Spring 2019
Project Title:	Gamification: Feedback and Digital Badges
Investigator:	Brian Macon
IRB Number:	SBE-18-14285
Funding Agency:	
Grant Title:	
Research ID:	N/A

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30 days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

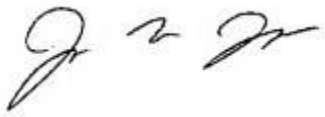
If continuing review approval is not granted before the expiration date of 08/28/2019,

approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

All data, including signed consent forms if applicable, must be retained and secured per protocol for a minimum of five years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained and secured per protocol. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

This letter is signed by:



Signature applied by Racine Jacques on 08/29/2018 02:36:16 PM ED

Designated Reviewer

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