GAMIFICATION OF THE REVIEW PROCESS FOR STUDENT TESTING: DOES GAMIFICATION IMPROVE STUDENT ACHIEVEMENT?

by

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Abstract

Advances in technology require the fields of education and training to adapt in order to meet learning and work demands. The academic literature indicates engagement increases learning achievement. Gamified approaches to learning enhance student motivation and engagement, yet empirical evidence to support the implementation into general practice in higher education is needed (de Freitas, 2018; Karpicke, 2012). The current study evaluates the relationship between two types of review of factual content, Kahoot! gamification review and traditional study guide review, with measures of content recall and engagement at the post-secondary level of education. Findings suggest gamification of the review process for student testing can improve student achievement due to increased engagement. The gamified review was more engaging than the traditional study guide review; participants in the 18 to 30 age range scored higher on achievement and engagement; females tended to score slightly higher than males, while major did not significantly affect achievement and engagement scores.

Dedication

This dissertation is dedicated to my son, Dr. Brandan M. Wormsbacher, and my family for encouraging me to pursue my dreams and supporting my journey to accomplish this achievement.

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I would like to thank the individuals who provided academic guidance and support throughout the dissertation. My dissertation chair, committee members, statistician, colleagues, family, friends, and editor.

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CHAPTER 1 INTRODUCTION

Breakthroughs in technology advance the need for the development of skills that will transfer from the learning environment to the work environment. The speed of technological developments places researchers in a diverse number of fields playing catch up in attempts to stay informed. Unfortunately, this fuels research attempts to narrow the focus to individualized niches such as computers, education, medicine, sports, and training. Additionally, the separation of these fields adds to the limited incorporation of research from other fields of study. Current applications of gamification aspects in society include simulations in the medical field for skill acquisition, the use of clickers for understanding in classrooms and conferences, employee selection in business and industry, computer gaming, and for occupation and training purposes in a variety of fields.

Instruction that incorporates game features can enhance engagement in terms of motivation, attention, and knowledge. This is important because review games can be tools for motivated engagement while incorporating the principles of learning for achievement. The fundamental elements of a review process include student engagement and the presence of metacognition. The results of the review process allow students to assess what is known and what still needs to be learned. These insights aid in study, content mastery, and performance using review games in the classroom. An examination of gamification will begin with the historical and theoretical perspectives of the learning process, then offer a review of the current research to explore the effectiveness of gamification for learning, followed by a quantitative experiment to determine if gamification enhances student achievement, conclude with directions for future research.

Background of the Topic

Very few studies adopt a theoretical framework connecting expectations toward gamification to motivate participation, while considering the learning aspect (Caporarello et al., 2017). The studies that do exist focus on simulated training or video games, are based on correlational relationships, and have been conducted with a limited population that lacks diversity (Fotaris et al., 2016). Research in game-based learning is limited to video games (Fotaris et al., 2016; Hwang et al., 2013; Robison, 2014), focuses on visual and attentional tasks (Boot et al., 2008), centers on cognitive training (Anguera, et al., 2013; Baniqued et al., 2013), or concentrates on motivation (Jackson & McNamara, 2013) and perception (Bicen & Kocakoyun, 2018). The literature shows that there is substantive support for the gamification of learning, but it is limited in the area of higher education (Moylan et al., 2015) and randomized controlled studies (Hainey et al., 2016). Research on motivational theories are important factors that have contributed to the promotion of learning and achievement.

The theoretical framework for the gamification of learning enhancement through experience and action is grounded in self-determination theory. Moreover, research in neuroscience found neural evidence to support intrinsic motivation as being generated by inherent processes while extrinsic motivation was generated by external contingencies (Di Domenico & Ryan, 2017; Lee et al., 2012; Lee & Reeve, 2013). The motivation to learn and self-regulation play a key role in the learning process. The use of gamification in education can motivate students to become deeply involved in the learning process. The current state of research suggests that an examination of the theoretical framework connecting learning and motivation when comparing the application of gamification versus traditional methods of study is needed.

Self-determination Theory

The motivational theory of self-determination is employed to understand if the gamification of a review process for testing facilitates achievement and engagement. Self-determination theory (SDT) states that individuals are motivated by autonomy, competence, and relatedness (Ryan & Deci, 2000b). Autonomy is the willingness to do a task (Deci & Ryan, 2000; Reeve & Tseng, 2011). This can be evidenced by allowing choice, and non-controlling instructions which enhance intrinsic motivation. Offering students feedback can facilitate choice and control to promote autonomy. Competence refers to the need for challenge, effectiveness, and proficiency (Deci et al., 1994; Ryan et al., 1991). Therefore, being challenged and receiving positive feedback enhances intrinsic motivation. Relatedness is experienced through connectedness to others and should be present in a distant supportive sense. Relatedness is associated with belonging and fosters autonomous motivation (Ryan & Deci, 2000b). An activity that affords choice, mastery, and connectedness will enhance well-being, self-esteem, and positive affect (Ryan & Deci, 2000b).

The theory of self-determination has connections to Maslow's hierarchy of needs which states that once basic needs are satisfied, individuals are motivated to pursue higher level needs. SDT is a widely researched theory of motivation that addresses intrinsic and extrinsic motivation for acting and factors that facilitate or undermine motivation (Ryan & Deci, 2000a). Extrinsic motivation emanates from outside the individual or task (receive reward or avoid consequences) while intrinsic motivation originates from within an individual or task (interesting and enjoyable). Activities that are appealing, interesting, novel, challenging, or stimulating are integral to intrinsic motivation (Ryan & Deci, 2000b). Satisfaction of the basic psychological

needs of autonomy, competence, and relatedness are universal to all individuals regardless of cultures and ages (Ryan & Deci, 2000a).

Intrinsic motivation is the most valued form of motivation in education due to knowledge outcomes. Advantages of intrinsic motivation include initiative, persistence, cognitive interest, challenge, understanding, change, creativity, enjoyment, opportunity, and higher levels of achievement (Ormrod, 2016). Conversely, intrinsic motivation is undermined when choice, control, or freedom are not present (Deci et al., 2001). Therefore, intrinsic motivation is the foundational perspective for the current study. Satisfying the need for autonomy and competence enhances student motivation in the form of engagement and achievement in the form of performance outcomes in learning. In general, student engagement in learning activities is important to academic success.

Achievement and Engagement

Engagement is related to self-regulation in learning, critical thinking, persistence, and achievement (Reschly & Christenson, 2012). The construct of achievement has been defined in developmental and educational psychology as learning, success, and accomplishment in a subject (Gregory, 2016). The construct of engagement has been defined in developmental and educational psychology as involvement, participation, and commitment to learning activities (Ormrod, 2016). This is important because engagement is a critical issue in learning achievement and academic success at the post-secondary level of education (Reschly & Christenson, 2012) and at the personal level of education (Pintrich, 2004). Research and empirical evidence can help educators create engaging learning environments to promote effective learning processes for academic success.

Statement of the Problem

The current issue in the field of education is a lack of experimental studies yielding concrete data to support teaching and learning methods. Most applications are based on anecdote and processes that have been practiced since ancient treatises were established. Advances in technology necessitate new solutions for learning paradigms. Instructors are faced with the ominous task of actively engaging students in the learning process to ensure sustainable achievement results. The gamification of learning can engage students for effective achievement outcomes. The findings of the present experiment will contribute to the fields of education, training, research, and other professions to improve learning strategies.

Purpose and Rationale

Current technology has caused changes in brain structure and function (Loh & Kanai, 2015). These changes in structure and function of the brain have affected how students learn, which influences how instructors teach. Instructors can benefit student learning by finding methods and techniques to engage students as opposed to traditional lecture method. Multidisciplinary research supports the use of game-based learning for post-secondary students with attention to any limitations that might affect external validity (de Freitas, 2018; Loh & Kanai, 2015). The academic literature indicates engagement increases learning. Game-based approaches enhance student motivation and engagement, yet empirical evidence to support the implementation into general practice in higher education is needed (de Freitas, 2018; Karpicke, 2012). The current study will examine the type of review, Kahoot! gamification group or study guide group, in relationship to learning and engagement.

CHAPTER 2 LITERATURE REVIEW

The theoretical framework that will be used to view gamification as a motivational engagement practice for education and training will be self-determination theory. Self-determination theory (SDT) emphasizes the notion that individuals are motivated by the need for autonomy, competence, and relatedness (Ryan & Deci, 2000b). Autonomy refers to acting by choice and is expressed by allowing students to learn by making choices. Competence refers to individual perception of effectiveness at a given task and is demonstrated through providing the tools to succeed. Relatedness refers to the individual feeling of support from interaction with others and is achieved by removing authoritarian barriers (Filak & Sheldon, 2003).

The satisfaction of meeting these three basic psychological needs promotes intrinsic motivation. Deci et al. (2001) have documented that student learning is facilitated by intrinsic motivation. Intrinsic motivation refers to the inherent drive to do things for the pleasure of doing them (Ryan & Deci, 2000a). Lee and Reeve (2017) further conceptualize intrinsic motivation as challenging and satisfying tasks to produce intrinsic rewards. Educational and work performance improve when intrinsic motivation is present (Ng, 2018; Niemic & Ryan, 2009).

A related construct to self-determination theory is engagement, a central factor of motivation which emphasizes active involvement during a task (Reeve et al., 2004; Jang et al., 2010). Task engagement promotes competence and autonomy, producing positive affect through need-satisfaction (Isen & Reeve, 2005). Turning boring tasks into interesting tasks enhances interest and motivation (Pintrich, 2004). The empirical literature measures intrinsic motivation using self-report or behavioral observation (Isen & Reeve, 2005; Jang et al., 2010). Cetin (2015)

found that self-regulation correlates to motivation. This means that individuals choose to act for the interest and enjoyment of an activity.

Ariani (2019) found that all three psychological needs (autonomy, competence, and relatedness) were positively related to academic engagement. However, the research studies supporting the relationship between engagement and achievement are mixed. Pechenkina et al. (2017) did not find a relationship between student engagement and academic achievement, while other studies found correlational evidence of positive associations between engagement and achievement (Rechley & Christenson, 2012; Lei et al., 2018). Tan Ai Lin et al. (2018) reported gamification of the learning process to be more engaging and to produce higher levels of perceived intrinsic motivation. In addition, Petrovic-Dzerdz (2019) documented strong support for gamification principles to enhance retrieval-based learning for knowledge retention. Taken together, these studies indicate gamified activities promote intrinsic motivation to foster the impetus and self-regulation necessary for meaningful learning.

Review Method

The cross-disciplinary nature, diverse definitions, and varying methodological approaches of research on educational games prompted de Freitas (2018) to explore the literature from the educational science, game science, neuroscience, and information science perspectives to enrich the understanding of games as effective learning tools. The research positively supports games as effective learning tools. Significant improvements are evident in game methods compared to traditional teaching approaches; games enhance motivation through engagement and are associated with changes in behavior. However, few active design studies and rigorously tested approaches exist to support the benefits of gamification for learning (de Freitas, 2018; Dichev & Dicheva, 2017).

Technology poses current challenges to traditional educational practices which necessitate a change in approach. Traditional academic review processes such as study guide reviews are supplementary tools for the study process before testing. However, active techniques for engaging students such as a gamification review have not been conducted in relation to student achievement on tests. Traditional teaching and learning methods (study guide review) will need to be explored further to determine if engaging educational games (Kahoot! gamified review) improves student achievement on tests at the post-secondary level.

Gamification Review

For the purposes of this study, clarification of terminology is necessary. Gamification refers to the use of game design elements in non-game contexts (Caporarello et al., 2017; Deterding et al., 2011; Dichev & Dicheva, 2017). Gamification is one element of game-based learning. Game-based learning is the comprehensive label that includes all the learning techniques using games and game mechanics (Caporarello et al., 2017). Related studies in the field of patient education determined that knowledge achievement and satisfaction scores were different in a statistically more significant extent for game-based learning than lecture-based learning (Adamson et al., 2018). Game characteristics such as goals, rules, challenge, and collaboration are successful for engaging students in the learning process (Garris et al., 2002). Learning outcomes promote game-based learning activities (Boghian et al., 2019), but the literature on gamification is focused on satisfaction and interest.

As a component of game-based learning, gamification has been investigated in relation to motivation. Research on the use of gamification techniques in the classroom demonstrated an impact on motivation, learning, attendance, interest, comprehension, and final grades (Fotaris et al., 2016; Robison, 2014; McPherson, 2014; Woo, 2014; Jackson & McNamara, 2013; Huizenga

et al., 2009). Banfield and Wilkerson (2014) demonstrated that gamification as a teaching pedagogy increased intrinsic motivation. However, studies measuring the motivational effects of gamification are lacking (Dichev & Dicheva, 2017), especially in connection to achievement. The current research supports the further investigation of the potential of gamification techniques to promote engagement and achievement in learning.

Technological advances have resulted in game-based platforms such as Kahoot! which allow for the gamification of learning (Ismail et al., 2019). Castro et al. (2019) found improvement in final assessment scores for the acquisition of course content after incorporating the game-based learning tool Kahoot! Toth et al. (2019) determined students who make incorrect answer choices in Kahoot! during class mark less incorrect answers on exams. This finding is in line with educational research documenting the importance of retrieval in learning.

The type of questions used for review and testing promote different levels of learning. Interestingly, Kahoot! using true or false questions yielded insignificant results, while Kahoot! using multiple choice questions demonstrated a positive effect. Kahoot! now has the capability of fill-in-the-blank format, which lends itself well into retrieval recall. Additionally, studies show that students perceived Kahoot! as motivating engagement to support learning (Licorish et al., 2018; Tan Ai Lin et al., 2018; Yürük, 2019). Deeper engagement in learning activities results in better understanding and persistence in knowledge acquisition.

The gamification of learning makes use of characteristics such as challenge, speed, and competition to increase engagement and provide learning opportunities. However, speed and competition may contrast with regulation of cognitive processes (Pintrich, 2004; Ranieri et al., 2018). Therefore, using Kahoot! in asynchronous mode (one player at a time) will ameliorate

the speed and competition components. An asynchronous format can be used to isolate gamification of the review process for comparison to traditional study guide review processes.

Traditional Review

In a traditional classroom, students passively receive information from the instructor in the form of a lecture. This is sometimes referred to as traditional pedagogy or teacher-centered learning. Students are expected to quietly sit and absorb information. Traditional methods of instruction have taught students to take copious notes during class lectures, highlight textbooks by making notes in the margins, and devise study guides to review before testing. The current direction of education is moving from a traditional lecture based on anecdote, tradition, and doing what has always been done, to a workplace perspective of research that is outcome based.

Self-regulated learning is the process of monitoring, controlling, and regulating one's own (meta)cognition, motivation, and behavior (Ormrod, 2016; Pintrich, 2004). Ariel and Karpicke (2018) demonstrated that repeated retrieval practice improves self-regulated learning behaviors. The authors suggest that instructors utilize direct instruction to inform students to practice retrieval of information three times. However, Ariel and Karpicke (2018) call for an intervention to promote repeated retrieval practice while incorporating the spacing of retrieval attempts. One innovative solution may be to build repeated retrieval into lessons using study guide completion tasks and quizzes prior to testing to build self-regulation skills.

Self-regulated skills can be imparted to students through effective lesson planning and design. Self-regulated learners exercise or have control of learning efforts, gain effectiveness through practice, and procure opportunities for success. Educators that arouse intrinsic motivation and engage students in the learning process help foster study success that promotes academic achievement (Virtanen et al., 2015). Teaching students to be actively engaged in the

acquisition, recall, application, and transfer of knowledge leads to future professional development.

Developing knowledge transfer from an academic environment to the workplace will be successful if students acquire critical thinking and problem-solving skills that result from information mastery as opposed to demonstrating competence for test purposes (Ormrod, 2016). Items used in quizzes should be worded differently than items on final exams (Karpicke & Roediger, 2007). Therefore, in study guides and gamified conditions, items will be worded differently than on the final post-test. The current literature supports the effects of a study guide review or gamified review after lecture to enhance self-regulated learning for post-test content.

Summary of Key Concepts and Constructs

The following is a summary of key concepts and constructs identified in the literature for the type of review, gamification and traditional (Table 1).

Table 1

Review Method: Summary of Key Concepts and Constructs

Concepts / Constructs	Definition	Citation(s)
Intrinsic motivation	The inherent drive to do things for the pleasure of doing them	Ryan & Deci, 2000a
Game-based learning	The comprehensive label that includes all the learning techniques using games and game mechanics	Caporarello et al., 2017
Gamification	The use of game design elements in non-game contexts	Caporarello et al., 2017; Deterding et al., 2011; Dichev & Dicheva, 2017
Kahoot!	A game-based platform that allows for the gamification of learning	Ismail et al., 2019
Self-regulated learning	The process of monitoring, controlling, and regulating	Ormrod, 2016; Pintrich, 2004

one's own (meta)cognition,
motivation, and behavior

An interesting addition to this line of research could include the comparison of a fill-in-the-blank traditional study guide review and a gamified fill in the blank review to determine if enhanced learning and immersion result.

Achievement and Engagement

Psychologists define learning in terms of change in mental representations or associations that result from experience (Ormrod, 2016). Learning determines the way individuals gain knowledge and perform in various situations. Achievement is the appraisal of learning through measures of cognition such as test scores or grades (Gregory, 2016). Educational outcomes such as achievement were found to be significantly related to student engagement (Henrie et al., 2018; Reschly & Christenson, 2012). Reeve and Lee (2018) determined through neuroscientific study that higher levels of perceived autonomy and competence led to increased engagement, which results in learning. Therefore, engaged students should attain higher achievement outcomes. Both theory and research suggest that intrinsic motivation predicts engagement, which in turn predicts academic performance (Pintrich, 2004; Reeve et al., 2004; Ryan & Deci, 2000a).

Educational research on the testing effect concludes that tests lead to retention as compared to not taking a test and undertaking an additional study period. Tests employing the production of information produce better results than cued response tests (Karpicke & Roediger, 2007). Although performance is higher for multiple choice tests than short answer or essay tests in the short-term, the latter produce better retrieval for long-term results. Cordova and Lepper (1996) found that the appropriate use of strategies such as the contextualization (through

personalization and choice) of content improves learning outcomes. These processes have the potential to increase student study effectiveness.

Across four experiments, Soderstrom and Bjork (2014) examined the benefits of testing to potentiate learning by retrieval. The results provided evidence that interim testing improves students' subsequent self-regulated study habits by making them more aware of current knowledge. This helps students make better decisions when regulating study behavior and transfers to both tested and non-tested material. Cognitive engagement and active construction of knowledge assist an individual's control of the learning process (Ormrod, 2016). Engagement has positive long-term outcomes related to persistence in education, increased employment opportunities, and well-being (Reschly & Christenson, 2012). These positive outcomes reach far beyond the educational setting. Advances in neuroscience support self-regulation for strengthening achievement and engagement in education (Blair & Raver, 2014; Di Dominecio & Ryan, 2017).

Achievement

Achievement has been linked to intrinsic motivation for the long-term retention of information (Karpicke, 2012). The long-term retention of information is enhanced by repeatedly and actively retrieving information. Grimaldi and Karpicke (2012) investigated the conditions where learning is enhanced by unsuccessful retrieval events. The findings indicate that learning can be enhanced with additional trials of recall. In this context, making errors can enhance learning and additional study does not benefit the long-term recall of information.

Studies in neuroscience support retrieval as a fast route to memory consolidation (Antony et al., 2017). The neurological perspective notes that the neocortex processes slowly and stores information while the hippocampus learns quickly and encodes the information for storage

transfer. Sleep has been shown to consolidate memory and enhance long-term retention; repeated reactivation of retrieval speeds up consolidation and promotes insight (like sleep and consolidation) from repeated retrieval as opposed to a method of re-study (Antony et al., 2017).

Practicing retrieval has been shown to produce more learning than engaging in other encoding techniques (Karpicke & Smith, 2012). Pastotter et al. (2011) found that retrieval during learning enhances recall of previously learned material, while testing during learning improves recall for future learning. Conversely, neither benefit from re-study or repetitive reading. These studies support the use of retrieval activities during the learning process to enhance recall.

Some studies have found mixed results on learning outcomes (Tan Ai Lin et al., 2018; Turan & Meral, 2018). One concern is that prior knowledge may influence student achievement scores and it is suggested that different types of test questions may measure different types of knowledge (Ranieri et al., 2018). Given this information, future experimental research design will need to account for student prior knowledge. Additionally, Karpicke (2012) challenges future research to identify the effective use of retrieval to enhance meaningful learning.

Engagement

Engagement is a multifaceted term that has been defined in various ways. Historically, academic engagement evolved from occupational contexts and refers to the student devotion of time and energy toward degree attainment (Bae & Han, 2019; Sinval et al., 2018; Woo, 2014). Academic engagement is concerned with the dropout prevention of students currently attending college and university (Reschly & Christenson, 2012). More specific to this study, engagement refers to the active involvement, interest, immersion, and enjoyment during a task (Reeve et al., 2004; SDT, n.d.).

The construct of engagement in more recent studies has been understood in terms of the dimensions of behavior (participation), cognitive (self-regulation), and emotional (belonging) engagement (Bae & Han, 2019; Fuller et al., 2018; Reschly & Christenson, 2012). According to Reschly and Christenson (2012), the constructs of engagement and motivation are distinct and related in that motivation is the intent (internal) and engagement is the action (observable behavior). The relationship between the three dimensions of engagement work together to promote academic success, which encourages student participation and furthering student interest in learning (Lei et al., 2018). Student engagement with learning is essential to various approaches in student learning and academic achievement as measured by test scores or grades (Finn & Zimmer, 2012). Actively engaged learners produce positive achievement outcomes (Finn & Zimmer, 2012) and the multidimensional perspective of engagement supports gamification of the learning process (Reschly & Christenson, 2012).

The literature on the construct of engagement demonstrated strong empirical evidence connected to academic achievement (Lei et al., 2018) and indicates the need to develop interventions that foster motivation (Arashhidi et al., 2016). Immersive and active learning has demonstrated engagement benefits in educational settings. The incorporation of gamification in education is to extract the game elements to help students learn in an interesting and enjoyable way, as if they were playing a game enhancing the engagement factor. Student engagement patterns are associated with greater levels of learning (Lei et al., 2018) and are a key factor in motivational learning. Continued research on the use of interventions to enhance social, behavioral, and emotional performance is needed to assist students with academic performance outcomes (Reschly & Christenson, 2012) and academic instructors in determining the benefit in the use of media and technology to engage students (Finn & Zimmer, 2012).

Summary of Key Concepts and Constructs

The following is a summary of the key concepts and constructs related to the achievement and engagement results from the applied review method (Table 2).

Table 2

Achievement and Engagement: Summary of Key Concepts and Constructs

Concept / Constructs	Definition	Citation
Learning	Change in mental representations or associations that result from experience	Ormrod, 2016
Achievement	The appraisal of learning through measures of cognition such as test scores or grades	Gregory, 2016
Academic Engagement	Student devotion of time and energy toward degree attainment	Bae & Han, 2019; Sinval et al., 2018
Engagement	The active involvement, interest, immersion, and enjoyment during a task	Reeve et al., 2004; SDT, n.d.

Several studies indicate possible connections between age, gender, and major, which support the investigation of these extraneous variables.

Extraneous Variables

Demographic information that may affect study outcomes include age, gender, and major. Research indicates that the use of games in higher education may not generalize to populations over the age of 40 (Gonzalez, 2018). One study indicated significant differences between males and females in engagement and achievement with males scoring higher (Ismail & Mohammed, 2017); another study indicated no gender differences (Vlachopoulos & Makri, 2017). Gonzalez (2018) was unable to determine insights pertaining to gender effects due to the population being

mostly male, while Ranieri et al. (2018) had a predominately female population. Belonging is connected to engagement and persistence which may be influenced by students in science, technology, engineering, and mathematics majors (Wilson et al., 2015). To better generalize research findings, studies need to include students who pursue academic coursework in diverse subjects (Ariani, 2019; Sinval et al., 2018). Collecting information on the age, gender, and major of participants may provide additional insights into the current research.

Bridging the Gap

According to Vlachopoulos and Makri (2017), the field of research in relation to the incorporation of games into higher education pedagogy is vast. The topic of gamification has been difficult to study based on the boundless array of discipline applications (de Freitas, 2019; Dichev & Dicheva, 2017; Ranieri et al., 2018; Tan & Hew, 2016, Tan Ai Lin et al., 2018; Vlachopoulos & Makri, 2017), the lack of a central definition (Detering et al.,2011; Vlachopoulos & Makri, 2017), the absence shared terminology (Vlachopoulos & Makri, 2017), limited generalization of findings (Foster & Warwick, 2018; Gonzalez, 2018; Ke et al., 2015; Ranieri et al., 2018), varying forms of measurement (Fuller et al., 2018; Henrie et al., 2018), and scarcity of research employing an experimental design (Ranieri et al., 2018; Tan & Hew, 2016; Turan & Meral, 2018). Although the research indicates gamification as a means of engaging and motivating learners, the results for achievement have been mixed. Vlachopoulos and Makri (2017) call for affordable solutions to promote the self-regulation of metacognitive skills in higher education. The relationship between engagement and achievement can be further tested in an experimental design to ascertain measurable outcomes for student growth.

Conceptual Hypotheses

Gamification of the review process for testing enhances student achievement and engagement through psychological needs satisfaction (autonomy, competence, and relatedness). The Kahoot! game and the traditional study guide will be used to provide a review of content presented in a brief ten-minute video presentation. It is anticipated that there will be a direct and positive relationship between the review method and the amount of recall. Specifically, recall would be quantitatively measured by looking at the mean number of facts recalled by each group. A negative relationship would not be expected since both methods provide the students with additional exposure to the content. The gamified review is predicted to rate higher in engagement when compared to the traditional study guide review (Henrie et al., 2018; Reschly & Christenson, 2012). Additionally, the age, gender, and major of the participants will be recorded to determine if a relationship with achievement and engagement exists (Ariani, 2019; Gonzalez, 2018; Ismail & Mohammed, 2017; Ranieri et al., 2018; Sinval et al., 2018; Vlachopoulos & Makri, 2017).

CHAPTER 3. METHODOLOGY

The experiment used a quantitative experimental between-subjects design where participants were randomly assigned to one of two levels of the independent variable (Bordens & Abbott, 2014). A power analysis suggested a sample size of $N = 200$ for a medium effect size with a power of .80 and α .05 (Cohen, 1992; Faul et al., 2007; Martinez-Mesa et al., 2014). Frequency data was collected for each of the two groups showing percentages for each question and response option. A pretest/posttest assessed achievement gains. Assumptions for linearity, homogeneity of regression slopes, normality, homoscedasticity, homogeneity of variance and outliers were examined. An analysis of covariance (ANCOVA) was utilized to discern if significant differences exist in the two types of review on achievement scores. The covariate (pretest scores) could influence the dependent variable and were thus controlled for. The ANCOVA is robust to deviations in normality. The Intrinsic Motivation Inventory (IMI) interest-enjoyment subscale, a Likert-type scale, was used to measure engagement. Likert-type ordinal scales can be analyzed using parametric statistics when data assumptions are met (Harpe, 2015; Sullivan & Artino, 2013). A *t*-test is utilized to discern if significant differences exist in the two review groups on engagement scores. An alpha level of .05 or lower determines significance. Descriptive statistics include mean, standard deviation, and variance. Analysis of variance (ANOVA) was used to examine demographic information (age, gender, and major) to determine if there is a relationship with type of review on achievement scores. Age was considered to determine if type of review (Kahoot! gamification or traditional) was related to the age of the participants. Data was then assessed to determine if significant differences are found between male and female participants on the scores. Major (Liberal Arts – Art, English,

Education, History, Political Science, Social Sciences; STEM – Science, Technology, Mathematics; Undecided) was considered as well to determine if type of review (Kahoot! gamification or traditional) is related to the major of the participants. Effect size was examined when interpreting results. An analysis of variance (ANOVA) was used to look at each extraneous variable to determine the contribution of the predictor variable for the review group.

Research Questions and Operational Hypothesis

The aim of this study was to establish the effectiveness of gamification as a method of engagement to enhance achievement in relation to traditional educational methods. The Kahoot! game and the traditional study guide provided a review of content from a video presentation. It was anticipated that there would be a direct and positive relationship between the review method and the amount of recall. Specifically, recall would be quantitatively measured by looking at the mean number of facts recalled by each group. A negative relationship would not be expected since both methods provided the students with additional exposure to the content.

Operational Definitions

The following is a brief review of the operational definitions of variables being measured in this experiment provided in a summary table (Table 3).

Table 3

Summary of Constructs and Demographic Variables Measured in the Present Study

Constructs / Demographics	Definition	Measure	Citation
Achievement	The appraisal of learning through measures of cognition such as test scores or grades	Posttest measure	Gregory, 2016
Engagement	The active involvement, interest, immersion, and enjoyment during a task	Intrinsic Motivation Inventory (IMI)	Reeve et al., 2004; SDT, n.d.

Age	Demographic information will ask for age identification in years	Demographic survey
Gender	Demographic information will ask for male and female identification	Demographic survey
Major	Demographic information will ask for major identification (Liberal Arts – Arts, English, Humanities, Social Sciences, Psychology; STEM – Science, Technology, Engineering, Mathematics; or Undecided)	Demographic survey

The summary table of variables in this experiment is meant to serve as a guide to the next section which will address the research questions and hypothesis of the current experiment.

Research Questions and Hypotheses

What is the relationship between two types of review of factual content, Kahoot! gamification review and traditional study guide review, with measures of achievement and engagement among post-secondary students? Is the effect of review type (Kahoot! gamification or traditional) moderated by age, gender, or major?

Primary Research Question:

What is the relationship between two types of review of factual content, Kahoot! gamification review and traditional study guide review, with measures of achievement and engagement?

RQ1: What is the relationship between two types of review of factual content, Kahoot! gamification review and traditional study guide review, with measures of achievement using pre/posttest gains?

H_1: The type of review (Kahoot! gamification or traditional) is related to improvement in a measure of achievement (after controlling for pretest scores).

Ho_1: The type of review is not related to improvement in a measure of achievement (after controlling for pretest scores).

RQ2: What is the relationship between two types of review of factual content, Kahoot! gamification review and traditional study guide review, with measures of engagement using the Intrinsic Motivation Inventory (IMI)?

H_2: The type of review is related to a greater measure of engagement.
Ho_2: The type of review is not related to a greater measure of engagement.

Age, Gender, and Major

RQ3: Are age and review type (Kahoot! gamification or traditional) related to achievement score outcomes?

$H_0 2$: Age and review type (Kahoot! gamification or traditional) are not related to achievement score outcomes.
$H_a 2$: Age and review type (Kahoot! gamification or traditional) are related to achievement score outcomes.

RQ4: Are gender and review type (Kahoot! gamification or traditional) related to achievement score outcomes?

$H_0 3$: Gender and review type (Kahoot! gamification or traditional) are not related to achievement score outcomes.
$H_a 3$: Gender and review type (Kahoot! gamification or traditional) are related to achievement score outcomes.

RQ5: Are major and review type (Kahoot! gamification or traditional) related to achievement score outcomes?

$H_0 4$: Major and review type (Kahoot! gamification or traditional) are not related to achievement score outcomes.
$H_a 4$: Major and review type (Kahoot! gamification or traditional) are related to achievement score outcomes.

Population and Sampling

The current experiment utilized post-secondary students from a variety of United States colleges and universities. To include a diverse demographic, the population was drawn from a wide geographic area. Actions were taken to reduce bias in the recruitment of volunteers for the study. In addition, respondents were asked about prior experience with games related to studying and academics. Demographic information on age, gender, and major were collected

from the population under investigation to determine the contribution of each to explain variance.

Full-time, part-time, hybrid, online, and on-ground students from various colleges and universities in the United States comprised the setting for participants in this study. Respondents were drawn from institutions of different sizes and levels of regional accreditation. Effort was made to draw students from different undergraduate academic class standings (freshman through senior). Keiser University IRB approval was obtained; students were recruited by an invitational post and email in the LinkedIn social media platform for professional networking and an invitational post in the Psi Chi honor society research participation page. Obtaining participants from all 50 states leads to better generalization of results. The sample size and recruitment will be detailed next.

Sample and Size Recruitment

The required number of participants for the experiment was calculated using the statistical computation software G*Power 3.1. The value for a medium effect size 0.25 and .05 as α error probability was the type of power analysis selected as recommended by Faul et al. (2007) and was used in determining the necessary sample size. The G*Power analysis yielded a sample size of $N = 128$ (see *Figure 1*). The G*Power analysis results are in keeping and more exact than a power analysis based on previous methods which suggested a sample size of $N = 64$ per group for a medium effect size with a power of .80 and α .05 (Cohen, 1992). Increasing the needed sample by 10% to 20% is recommended to account for refusals, missing data, or for adjustments made for confounding variables (Martinez-Mesa et. al., 2014). Therefore, a minimum of $N = 100$ participants for each group or a total of 200 participants for the experiment was needed. As previously stated, the LinkedIn social media platform was used to connect with

college and university students in the United States. Upon IRB approval, an email was sent asking for students interested in participating in the experiment.

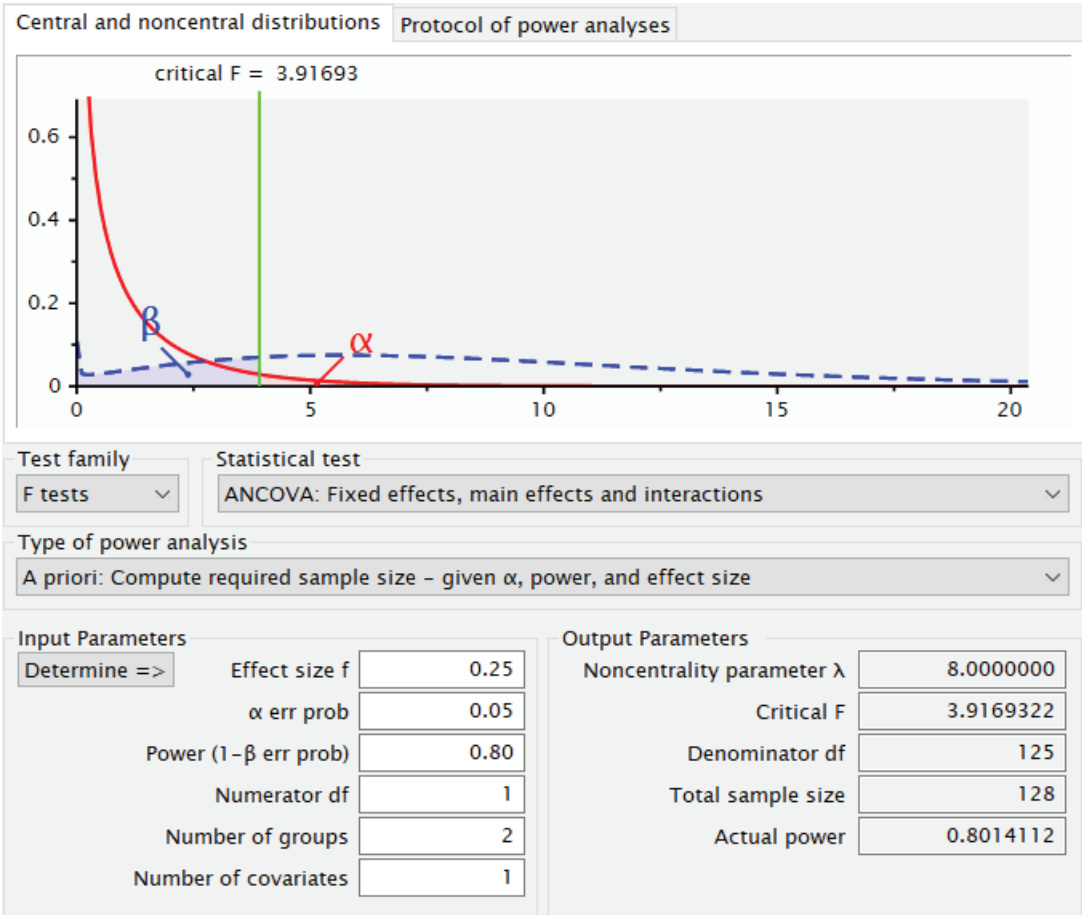

Figure 1. G*Power analysis.

Video Presentation

A video was embedded in the SurveyMonkey platform to conduct a training session, approximately 6 minutes in duration. Care was taken to assure that the subject matter in the video was not common information that students would have prior knowledge of. A medical doctor discussed important concepts for Covid-19/SARS-Covid-2 Hospital Care. Topic coverage included best practices, clinical course, chronic home medication, diagnostic testing, supportive management, and discharge. The pretest/posttest, the Kahoot! gamification review, and the study guide review were based on the video content. The pretest/posttest consisted of

multiple-choice questions, while the Kahoot! gamification and study guide reviews were comprised of fill in the blank questions.

Instruments

The data collection instrument that was used to assess achievement was a 14-question multiple choice pretest and posttest. The pretest and posttest were administered online to participants. The Intrinsic Motivation Inventory (IMI) interest-enjoyment subscale, which is a Likert-type scale, was the data collection instrument used with the aim of measuring participants' engagement. Demographic information was collected after completion of the experiment.

Posttest Scores

A pretest was given to assess the gains on the posttest. The pretest/posttest consisted of 14 multiple choice questions developed by the researcher. A validation study was conducted using a sample of 20 Keiser University graduate student members of Psi Chi honor society to establish psychometric properties prior to conducting the research experiment. All subjects took a pretest before the video presentation. Subjects participated in randomly assigned review groups, either Kahoot! gamification or traditional study guide. All participants took a posttest to assess recall of the content from the video presentation. Following the posttest for learning content, the Intrinsic Motivation Inventory (IMI) Interest-Enjoyment subscale was administered to all subjects.

Intrinsic Motivation Inventory

The Intrinsic Motivation Inventory (IMI) is a self-report instrument developed to determine the levels of intrinsic motivation as the outcome of a set of subscales: Interest-Enjoyment, Perceived Competence, Effort, Value-Usefulness, Pressure-Tension, Relatedness and Perceived Choice (SDT, n.d.). The IMI has been used in various research studies such as sports

activities (McAuley et al., 1989), reading (Grolnick & Ryan, 1987; Ryan et al., 1990), computer activities (Deci et al., 1994), puzzles (Ryan et al., 1983) and education (Filak & Sheldon, 2003). The IMI is a flexible measure that can be varied by subscales and items depending on the characteristics of the tasks being studied (SDT, n.d.). Interest-enjoyment is the most direct self-report measure of intrinsic motivation and the interest-enjoyment subscale was used for this study. This subscale assesses the interest, immersion, and inherent pleasure when doing a specific activity. Interest, immersion, and inherent pleasure are expressed in terms of engagement. Subjects respond to seven questions using a seven-point Likert scale ranging from 1 (not at all true) to 7 (very true) (Ryan et al., 1983; Ryan et al., 1990; SDT, n.d.). Item numbers 3 and 4 are reverse scored (the response is subtracted from 8 and the resulting number is the item score). The subscale scores are calculated by averaging across all items on the subscale. Cronbach's alpha coefficient of .80 was found for the interest-enjoyment subscale and an overall alpha coefficient of .85 for all seven subscales (McAuley et al., 1989). The IMI was correlated against behavioral observation and found to be a valid measure. The goodness-of-fit index and coefficient delta demonstrate the IMI is a capable measure of intrinsic motivation (McAuley et al., 1989). The Intrinsic Motivation Instrument has been used in numerous studies for research from a multidimensional perspective and is a valid, reliable instrument for measuring intrinsic motivation.

Demographic Information

Demographic information was collected from participants upon completion of the experiment. The brief questionnaire asked for participant age (measured in years), gender (males, females, and prefer not to answer), and major (liberal arts – Art, English, Education, History, Political Science, Social Science; STEM - Science, Technology, Engineering, Math;

Undecided; and prefer not to answer). Based on the literature, demographic information that may affect study outcomes include age, gender, and major (Ariani, 2019; Gonzalez, 2018; Ismail & Mohammed, 2017; Ranieri et al., 2018; Sinval et al., 2018; Vlachopoulos & Makri, 2017). Therefore, demographic information determines how age, gender, or major moderates the effects of review type.

Data Collection Analysis

Data collection tools utilized in this experimental study were constructed using the SurveyMonkey online survey tool. Participants were presented with an online page requesting consent. A supplemental analysis of demographic variables (age, gender, and major) was incorporated to determine if effects vary as a result of age, gender, and major (Filak & Sheldon, 2003). Based on the current research, age is related to engagement (Gonzalez, 2018; Timms et al., 2018) and the relationship between engagement and achievement is influenced by gender (Lei et al., 2018). In addition, information on student major was collected. Belonging is strongly linked to engagement, contributes to persistence, and may be influenced by student major (Wilson et al., 2015). A random generator randomly assigns participants to either group A or group B. Kahoot! was used as the group A review game. Kahoot! is an online learning activity that gamifies a classroom or corporate training event, by making learning fun and engaging. Kahoot! (https://getkahoot.com) is a free website where individuals, instructors, and corporate trainers can create games for learning, training, presentations, review, quizzes, surveys, and analytics for formative assessment. Kahoot! can be played asynchronously via the link embedded on the survey platform. A traditional study guide was embedded as the group B review activity. In addition to demographic data, pretest/posttest scores and engagement scores

were collected on the survey platform. Data was extracted from SurveyMonkey by the researcher for analysis using SPSS.

Data Collection Procedures

Upon study approval by the university's Institutional Review Board, participants were recruited using LinkedIn, Psi Chi Honor Society website, and email. Participants for the study are post-secondary college and university students in on-ground, hybrid, and online courses. Both males and females were eligible to participate. There was not an age restriction. The duration of the experiment was approximately 18 minutes. Subjects were asked to click on a link which took them to the experiment. Compensation was offered by a drawing where all participants had a chance to win a $25.00 gift card from Amazon. Subjects indicating willingness to participate signed a consent form where they agreed to participate electronically. Subjects were asked to complete the pretest. The pretest scores were used to assess gains in posttest scores after the video presentation. Subjects watched a brief 6-minute video presentation. Subjects were then randomly assigned to a Kahoot! group (group A) or traditional group (group B) for review. Upon completion of the review, the subjects took the posttest. Subjects completed the Intrinsic Motivation Inventory (IMI) interest-enjoyment subscale. Subjects were asked to complete demographic data pertaining to age, gender, and major. Upon completion of data analysis, as a process of debriefing, participants were invited to review the results on the researcher's LinkedIn page.

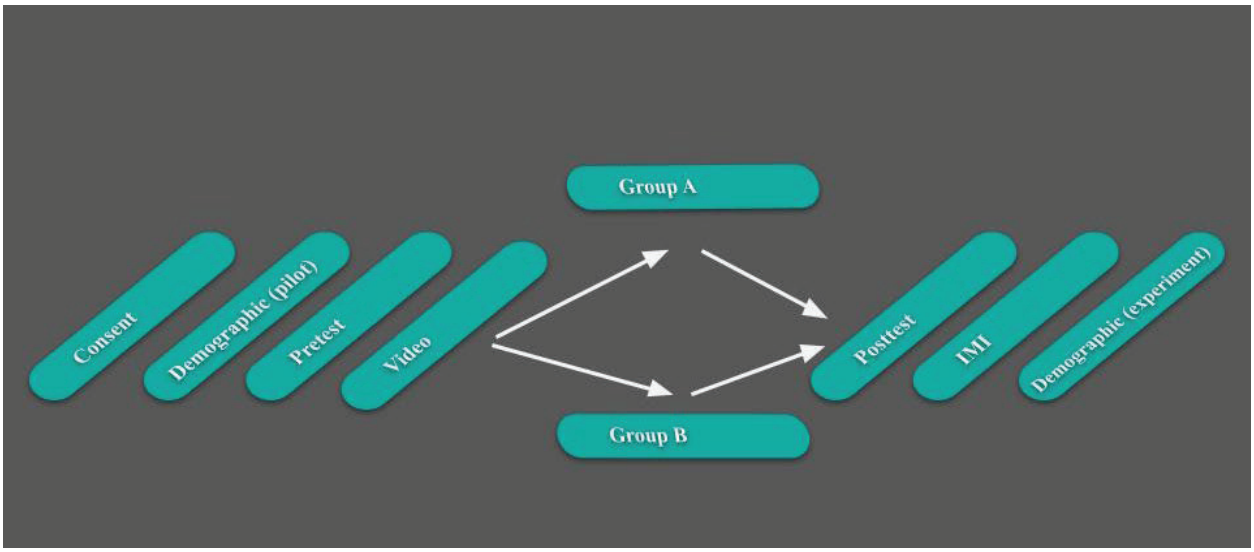

Figure 2. Summary of Data Collection Process

Storage and Protection of Data

The entire experiment is housed and stored on a protected website that only the researcher has access to. The experiment was created using the SurveyMonkey online survey tool. Participants were prompted to click on the link which took them to the consent page. Upon completion of the experiment, participants can view the results as part of the debriefing process. Data will be stored on a secured computer accessible only to the researcher. Confidential information, documents, and data were protected before, during, and after experiment completion.

Data Screening and Cleaning

The process of downloading data from the collection website was conducted by the researcher for input into the statistical package for social sciences (SPSS) for the strict purpose of data analysis. Overall initial screening and cleaning of the data consisted of reviewing the data for correct entry, checking for missing values and determining how to deal with them, checking for outliers and determining how to deal with them, and checking for normality and deciding how to deal with non-normality. Screening data for the IMI focused on determining

patterns of response behavior to detect abnormal response patterns (DeSimone et al., 2015). Abnormal response patterns were evaluated to determine if any bias or limitations existed.

Outliers

Outliers are the result of data entry errors, measurement errors, and genuinely unusual values. Boxplots and scatterplots can be used to detect outliers. Upon determination of outliers, data will be checked for entry errors. If errors were found, correction values could be placed into SPSS and all tests would have been re-run. If outliers are not the result of data entry errors, the next step is to check for measurement errors. If errors in measurement were found, they would need to be removed from the analysis or be replaced with the next largest value. Any data corrections would require tests of assumptions to be re-run. If an outlier is not the result of data entry or measurement, it is a genuinely unusual data point. There are several options for dealing with outliers of this type: keep them by running a non-parametric test; modify them by replacing with a less extreme value; transform the dependent variable; or retain the outlier as is. Removing outliers is an option of last resort. In an effort to preserve the integrity of the data, all decisions concerning outliers are reported in the written results section (Laerd Statistics, 2015).

Statistical Analysis

The types of analysis performed for the experiment were analysis of covariance (ANCOVA), independent-samples *t*-test, and analysis of variance (ANOVA).

Assumptions for Analysis of Covariance

An analysis of covariance (ANCOVA) will be used to compare the means of two types of review (Kahoot! gamification and traditional) and achievement scores. Assumptions relating to the study design for the use of ANCOVA include a continuous dependent variable (posttest achievement score), two categorical independent variables with two or more independent groups

(Kahoot! gamification review and traditional study guide review), continuous covariate (pretest achievement score) and independence of observations. The assumptions that pertain to how the data fit the two-way ANCOVA include linearity, homogeneity of regression slopes, normality, homoscedasticity, homonegativity of variance, and outliers. ANCOVA is robust to deviations from normality. If the data do not meet parametric assumptions, one can proceed by making corrections to data so that it no longer violates assumptions, by using an alternative statistical test, or by proceeding with the analysis when data violates certain assumptions (Laerd Statistics, 2015).

Assumptions for t-test

The type of analysis that was used for engagement was the independent-samples *t*-test. A comparison of the means of two groups or levels of review type (Kahoot! gamified and traditional) and achievement scores. A series of Likert questions that describe a single construct (in this experiment engagement), the data are treated as interval variables. This means interval Likert scale data are appropriate for *t*-test statistics (Harpe, 2015; Sullivan & Artino, 2013). The *t*-test is a parametric test used to compare means and assumes that data are normally distributed. To use an independent *t*-test, several assumptions should be met. The dependent variable is continuous. Engagement is measured on a continuous scale. The independent variable is categorical with two groups. The type of review (Kahoot! gamification or traditional study guide) consists of two categorical, independent groups. The groups consist of different randomly assigned participants. Boxplots were used to detect outliers. The *t*-test is robust to deviations from normality. However, the Shapiro-Wilk test of normality, skewness and kurtosis, and histograms are methods for assessing data approximate normal distribution. When data is not

normally distributed, a non-parametric test such as the Wilcoxon signed-rank test could be used. The Levene's test for homogeneity of variances was conducted (Laerd Statistics, 2015).

Assumptions for Analysis of Variance

Analysis of variance (ANOVA) is used to understand if type of review (Kahoot! gamification or traditional) effects vary in relation to age (measured in years), gender (males and females), or major (liberal arts – Art, English, Education, History, Political Science, Social Science; STEM - Science, Technology, Engineering, Math; Undecided). Data was analyzed for outliers, normality, and homogeneity. An analysis of variance was used to look at each extraneous variable to determine the contribution of the predictor variable for the review group. If data do not meet the assumptions of kurtosis, skewness, homogeneity of variance, and fail to be normally distributed, a non-parametric measure such as the Kruskal-Wallis test could be used.

Table 4

Summary of Research Questions, Variables, Measures, and Proposed Statistical Analysis

Research Question	Independent Variable	Dependent Variable	Moderator	Instrument / Section	Analysis
RQ1-RQ2	Type of Review	Achievement		Posttest	ANCOVA
		Engagement		IMI	*t*-test
RQ3-RQ5	Type of Review	Achievement	Age, Gender, Major	Posttest, Demographic Survey	ANOVA

Assumptions, Limitations, and Ethical Considerations

Data was screened and cleaned for any data entry errors, measurement errors, and for genuinely unusual data points. It was the researcher's assumption that participants would be familiar with the concept of gamification and that respondents would make genuine effort to answer honestly and truthfully. It was also an assumption that the dependent variables would be approximately normally distributed. Lastly, it was assumed that participants would have no

other reason or purpose for participating in the research other than contributing to the research data (Laerd Statistics, 2015). Limitations of the proposed research include obtaining enough participants. Self-report has the potential to cause social desirability effects. Also, inherent in Likert-type surveys, is the degree between extremely characteristic and extremely uncharacteristic may not mean the same for everyone taking the survey. Another concern may be participant familiarity with gamification (Hurizenga et. al., 2009). There are no ethical concerns as subjects were randomly assigned to each type of review, student names were not used, and student identity was protected. The Institutional Review Board approval ensures that each student's privacy is protected and that the study will not cause any harm to participants.

CHAPTER 4. DATA ANALYSIS AND RESULTS

The current study evaluated the relationship between two types of review, Kahoot! gamification review and traditional study guide review, with measures of content recall and engagement at the post-secondary level of education. The research included two phases, a validation study, and a research study. The experiment utilized a pre/posttest design. It was hypothesized that there would be a direct relationship between the review method and the amount of recall, with the gamified review method rating higher in engagement as compared to a traditional study guide review. The experiment used analysis of covariance (ANCOVA), independent samples *t*-test, and analysis of variance (ANOVA) to analyze data results.

Research Questions and Hypotheses

This researcher was interested in the relationship between two types of review of factual content, Kahoot! gamification review and traditional study guide review, with measures of achievement and engagement among post-secondary students. Additionally, is the effect of review type (Kahoot! gamification or traditional) moderated by age, gender, or major?

RQ1: What is the relationship between two types of review of factual content, Kahoot! gamification review and traditional study guide review, with measures of achievement using pre/posttest gains?

H_1: The type of review (Kahoot! gamification or traditional) is related to improvement in a measure of achievement (after controlling for pretest scores).
Ho_1: The type of review is not related to improvement in a measure of achievement (after controlling for pretest scores).

RQ2: What is the relationship between two types of review of factual content, Kahoot! gamification review and traditional study guide review, with measures of engagement using the Intrinsic Motivation Inventory (IMI)?

H_2: The type of review is related to a greater measure of engagement.
Ho_2: The type of review is not related to a greater measure of engagement.

RQ3: Are age and review type (Kahoot! gamification or traditional) related to achievement score outcomes?

$H_0$2: Age and review type (Kahoot! gamification or traditional) are not related to achievement score outcomes.
H_a2: Age and review type (Kahoot! gamification or traditional) are related to achievement score outcomes.

RQ4: Are gender and review type (Kahoot! gamification or traditional) related to achievement score outcomes?

$H_0$3: Gender and review type (Kahoot! gamification or traditional) are not related to achievement score outcomes.
H_a3: Gender and review type (Kahoot! gamification or traditional) are related to achievement score outcomes.

RQ5: Are major and review type (Kahoot! gamification or traditional) related to achievement score outcomes?

$H_0$4: Major and review type (Kahoot! gamification or traditional) are not related to achievement score outcomes.
H_a4: Major and review type (Kahoot! gamification or traditional) are related to achievement score outcomes.

Description of the Sample

The sample population for the experiment was drawn from undergraduate college students on the LinkedIn social media platform, Psi Chi Honorary Society platform, and email. A sample of 243 participants completed the survey, 122 incomplete surveys were eliminated. Nearly half of the respondents ages ranged between 18 and 30 years old (48 %). The number of male respondents was slightly higher than female respondents (60 %). The field of study of respondents was similar in STEM and liberal art subjects (41 %) (see Table 5). The sample population for this experiment was congruent with the population findings of the current literature (Ariani, 2019; Gonzalez, 2018; Ismail & Mohammed, 2017; Ranieri et al., 2018; Sinval et al., 2018; Vlachopoulos & Makri, 2017).

Table 5

Frequencies for Age, Gender, and Major

	Frequency	Percent
Age Groups		
18 to 30	117	48
31 to 44	60	33
45 to 59	46	19
Gender		
Female	93	38
Male	147	60
Prefer not to answer	3	1
Major		
Liberal Arts	101	42
STEM	100	41
Undecided	23	10
Prefer not to answer	17	7

Validation Study

A validation study was performed on a sample of Keiser University graduate Psi Chi honorary society graduate students (N = 20), to ensure instrument psychometric properties, administration technical requirements, and user reactions. The researcher developed the pre/posttest for the dissertation, making the validation study necessary to determine the psychometric properties of the instrument. In addition, the validation study also informed the researcher of any potential issues with the data collection process. For this reason, an additional question was added to the posttest for the validation study asking respondents for their reaction to the experience pertaining to any problems, confusion, or suggestions. The following findings have been discovered through the validation study:

a. Respondents did not have requests for clarification. Therefore, it was accepted that each item on the questionnaire was understandable to the respondents.

b. Respondents suggested that the experiment should require completion of one page before proceeding to the next. Therefore, the SurveyMonkey was adjusted to require page completion before progressing to the next section. Since respondents complete the consent form first, it is understood that withdrawal from the experiment can take place at any time. In addition, the demographic section was moved to the end of the survey to facilitate completion rates.

c. All respondents were randomly assigned to either the Kahoot! gamified review or traditional study guide review. The Kahoot! gamified review mean pretest score was 56 and the mean posttest score was 85, an average gain of 29 points. The traditional study guide review mean pretest score was 59 and mean posttest score was 90, an average gain of 31 points. Data are adjusted mean ± standard deviation unless otherwise stated. The mean achievement score was higher for the traditional study guide group (90.10 ± 9.67) than for the Kahoot! gamification review group (85.20 ± 15.51) (see Table 6). The validation study data was not used in the experimental study data.

Table 6

Validation Study Mean and Standard Deviations for Review Type Conditions

Review Type Conditions	Mean	Std. Deviation
Pre Kahoot!	55.6000	10.84435
Pre Traditional	59.3000	11.82324
Post Kahoot!	82.2000	15.54063
Post Traditional	90.1000	9.66609

Data Collection, Screening, and Cleaning

Before analyzing the data, it is essential to check the data for errors, finding any errors, and correcting any errors in the data file. Upon pre-analysis examination, 81 responses were eliminated as 66 surveys were not completed, 12 did not include demographics, and 3 did not consent to the experiment. The next step in the process was to identify outliers. Reducing the impact of outliers requires changing the score to one unit larger or smaller than the next most extreme score in the distribution to retain in the sample without threatening statistical reliability or (Gravetter & Wallnau, 2017). Additionally, missing information can be problematic. Therefore, identifying missing values and replacing them with estimates computed using mean distribution method as recommended by Peng et al. (2006) will generate an error-free data set. The data set collected contained 41 surveys with missing responses. For the purposes of this study, the responses with missing information were excluded to avoid data errors.

Statistical Analysis and Hypothesis Testing

The sample data collected in the research study was subjected to statistical procedures to evaluate the results in relation to the posed hypothesis. Analysis of the experiment found evidence for gamification as a tool for student achievement and engagement. Statistical evidence will include a clear conclusion or explanation. The subsequent sections will address the reliability of assessments, descriptive statistics and assumptions, and statistical analysis used to test each of the proposed hypotheses, followed by a summary of the findings.

Reliability of Assessments

Cronbach's alpha reliability coefficient is the most utilized statistic for reliability analysis. The acceptable established Cronbach's alpha of a scale should be above 0.70 (Gravetter & Wallnau, 2017). In this study, SPSS output produced a Cronbach's alpha of 0.80

(N = 7). In keeping with the research conducted by McAuley et. al. (1989) on the IMI, it can be concluded that the present study produced similar results.

Descriptive Statistics and Assumptions

Descriptive statistical methods simplify the data and provide organization. The Kahoot! gamified review mean pretest score was 47 and the mean posttest score was 64. The traditional study guide review mean pretest score was 49 and mean posttest score was 66. Both conditions had an average gain of 17 points (see Table 7). Participants that were randomly assigned to the Kahoot! gamified review totaled 128, while the traditional study guide group totaled 115. Data are adjusted mean ± standard deviation unless otherwise stated. Achievement scores were similar for both the Kahoot! gamified review (64 ± 1.81) and the traditional study guide review (64 ± 1.91). These results can be interpreted in one of two ways: The difference is due to chance or the sample data are a true reflection of the difference between the two methods. Inferential statistics were used to interpret the outcome of the difference between the two methods of review.

Table 7

Mean and Standard Deviation for Review Type Conditions

Review Type Conditions	Mean	Std. Deviation
Pre Kahoot!	46.9141	16.85418
Pre Traditional	48.5130	17.64930
Post Kahoot!	63.6563	24.54064
Post Traditional	65.5391	25.85360

Statistical Analysis

An analysis of covariance (ANCOVA) was conducted to determine if there was a statistically significant difference between Kahoot! gamification and traditional study guide review in relation to improvement in a measure of achievement after controlling for pretest scores. Several assumptions must be met to utilize an analysis of covariance. There was a linear relationship between pretest and posttest for each review group, as assessed by visual inspection of a scatterplot (see *Figure 3*). There was homogeneity of regression slopes as the interaction term was not statistically significant, $F(1,239) = .307$, $p = .580$. There was homogeneity of variances, as assessed by Levene's test of homogeneity of variance ($p = .743$). Standardized residuals for the interventions were normally distributed, as assessed by Shapiro-Wilk's test ($p > .05$). Standardized residuals for the overall model were normally distributed, as assessed by Shapiro-Wilk's test ($p > .05$). There was homoscedasticity, as assessed by visual inspection of the standardized residuals plotted against the predicted values. There were no outliers in the data, as assessed by no cases with standardized residuals greater than ±3 standard deviations. Adjusting for pretest scores, there was no statistically significant difference in posttest achievement scored between review groups, $F(1, 240) = .038$, $p = .845$, partial $\eta^2 = .000$.

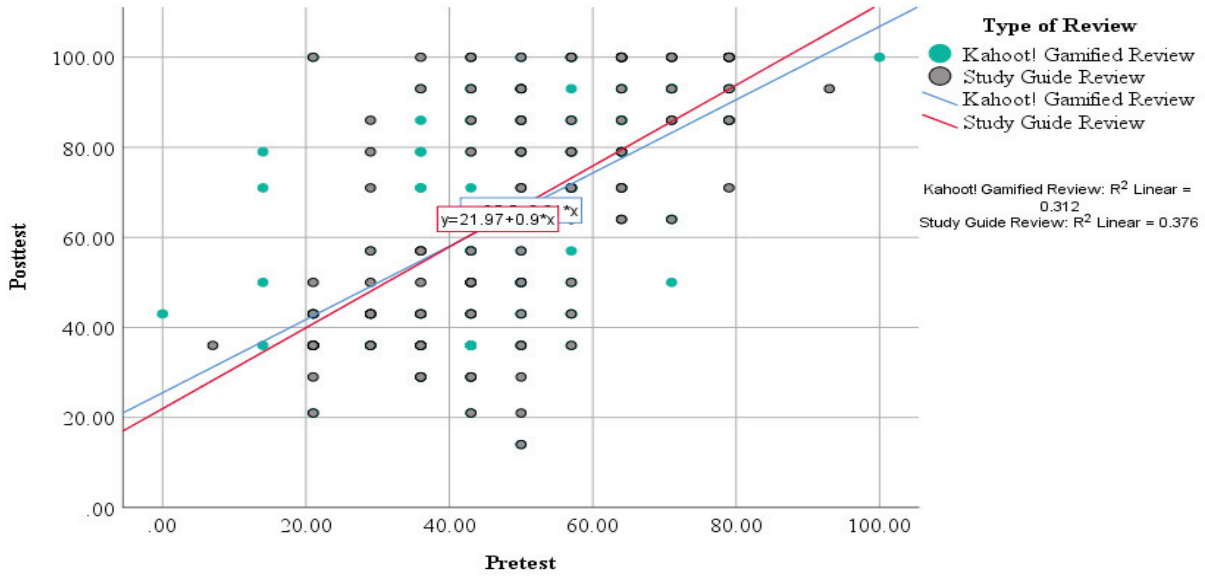

Figure 3. Grouped Scatter for Pretest by Posttest by Type of Review

An independent samples *t*-test was run to determine whether students who participated in a Kahoot! gamification review or a traditional study guide review led to a greater measure of engagement. There were 128 Kahoot! gamified review participants and 115 traditional study guide participants. The average score of engagement for those who participated in the Kahoot! gamification review (4.99 ± 1.13) [mean ± standard deviation] was higher than the engagement score for those who participated in the traditional study guide review (4.73 ± 1.32), with traditional review participants scoring more widely than Kahoot! review participants. Outliers in the data were less than the accepted 3 standard deviations from the mean and therefore retained in the data. The engagement scores for each group were not normally distributed. One explanation may be that sample sizes greater than 50 may flag minor deviations from normality as not statistically significant. The independent samples *t*-test is robust to deviations from normality and the decision was made to continue with the *t*-test. There was homogeneity of variances, as assessed by Levene's test for equality of variances ($p = .335$). The Kahoot! mean engagement score was 0.26 (95% CI, - 0.05 to 0.57) higher than traditional mean engagement

score, $t(241) = 1.638$, $p = .103$, d = .21 (see Table 8). There was not a statistically significant difference between means ($p > .05$), therefore, the alternative hypothesis is rejected, and the null hypothesis fails rejection. Although the results were not shown to be statistically significant, the confidence interval results indicate the difference between Kahoot! gamification review and traditional study guide review on engagement (see *Figure 4*). An exploratory analysis was conducted to determine the relationship between the under 30 and 31 to 44 age groups with measures of engagement using the Intrinsic Motivation Inventory (IMI). There were no outliers in the data, as assessed by inspection of a boxplot. The independent samples *t*-test is robust to deviations from normality and the decision was made to continue with the *t*-test. There was homogeneity of variance as assessed by Levene's test for equality of variances ($p = .794$). The 31 to 44 age group mean engagement score was 0.28 (95% CI, -0.65 to 0.09) higher than the under 30 age group score, $t(195) = -1.484$, $p = ,139$. There was not a statistically significant difference between means ($p > .05$).

Table 8

Mean and Standard Deviation Review Type and Engagement

Review Type	Mean	Std. Deviation
Kahoot! Gamified Review	4.9922	1.13259
Traditional Study Guide Review	4.7342	1.32235

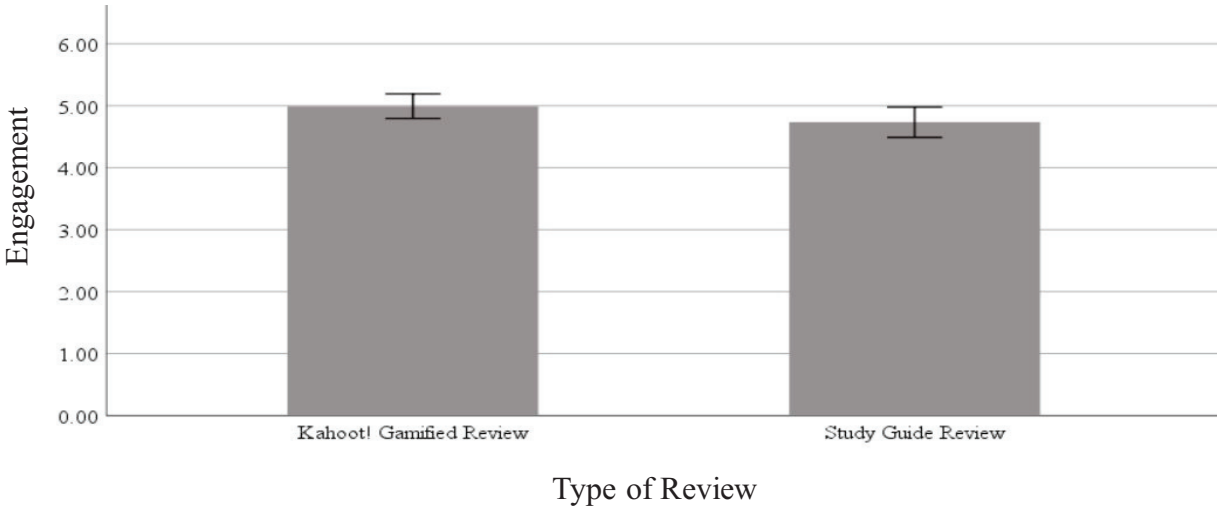

Figure 4. Mean Engagement Score for Type of Review

A two-way analysis of variance (ANOVA) was conducted to determine the impact of age on type of review (Kahoot! gamification or traditional study guide) as measured by the achievement test score. Subjects were divided into three groups according to age (under 30, 31 to 44, 45 and older). Data are mean ± standard error unless otherwise stated. Residual analysis was preformed to test for the assumptions of the two-way ANOVA. Outliers were assessed by inspection of a boxplot. There were no outliers. The data was not normally distributed, as assessed by the Shapiro-Wilk's test ($p < .05$). The ANOVA is robust to deviations from normality and the decision was made to carry on. There was homogeneity of variances, as assessed by Levene's test for equality of variances, $p = .830$. The interaction effect between review type and age for achievement score was not statistically significant, $F(2,237) = 1.100$, $p = .334$, $\eta^2 = .009$. Ignoring age group would be misleading because participants under 30 scored higher on achievement than participants 45 and older. Therefore, an analysis of the main effect and pair wise comparisons were run. The unweighted marginal means achievement for participants under 30, 31-44, and 45 and older were 69.63 ± 2.30, 62.56 ± 2.79, and 53.83 ± 3.72, respectively (see Table 9). There was a statistically significant main effect of age on

achievement score, $F(2,237) = 6.840$, p = .001, $\eta^2 = .055$ (see Table 10). The results are misleading due to the presence of a disordinal interaction (the groups were unbalanced). Participants under the age of 30 were associated with a mean achievement score of 15.79 (95% CI, 5.25 to 26.33) points higher than participants 45 and older, a statistically significant difference, $p = .001$. The was no statistically significant main effect of review type on achievement score, $F(1,237) = 0.017$, $p = .896$, , $\eta^2 = .000$.

Table 9

Mean and Standard Error Age Group and Achievement

Age Group	Mean	Std. Error
Under 30	69.625	2.296
31 – 44	62.557	2.786
45 and older	53.833	3.721

Table 10

Main Effect of Age on Achievement Score

Tests of Between-Subjects Effects

Dependent Variable: Achievement

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	9092.910[a]	5	1818.582	2.997	.012	.059
Intercept	781161.929	1	781161.929	1287.403	.000	.845
Reviewtype	10.354	1	10.354	.017	.896	.000
Agegroups	8300.276	2	4150.138	6.840	.001	.055
Reviewtype * Agegroups	1335.452	2	667.726	1.100	.334	.009
Error	143805.296	237	606.773			
Total	1165323.000	243				

Corrected Total	152898.206	242	

a. R Squared = .059 (Adjusted R Squared = .040)

A two-way analysis of variance (ANOVA) was conducted to determine whether gender was related to type of review (Kahoot! gamification or traditional study guide) as measured by the achievement test score. Participants self-selected either female, male, or prefer not to answer. Data are mean ± standard error unless otherwise stated. Residual analysis was performed to test for the assumptions of the two-way ANOVA. Outliers were assessed by inspection of a boxplot. There were no outliers. The data was not normally distributed, as assessed by the Shapiro-Wilk's test ($p < .05$). The ANOVA is robust to deviations from normality and the decision was made to proceed as planned. There was homogeneity of variances, as assessed by Levene's test for equality of variances, $p = .437$. The interaction effect between review type and gender for achievement score was not statistically significant, $F(1,238) = .037$, $p = .848$, $\eta^2 = .000$. There was a statistically significant main effect of gender on achievement score, $F(2,238) = 5.463$, $p = .005$, $\eta^2 = .044$ (see Table 11). One point of difference between gender is that females scored higher on achievement than males. Therefore, an analysis of the main effect was performed. All pairwise comparisons were run where 95% confidence intervals and p-values are Bonferroni-adjusted. The unweighted marginal means of achievement for females and males was 70.64 ± 2.57 and 60.37 ± 2.06, respectively (Table 12). The results are misleading due to the presence of a disordinal interaction (the groups were unbalanced). Females were associated with a mean achievement score of 10.26 (95% CI, 2.24 to 18.20) points higher than males, a statistically significant difference of $p = .006$ (Table 12). There was no statistically significant main effect of review type on achievement score, $F(1,238) = 0.90$, $p = .764$, , $\eta^2 = .000$. It is interesting to note that the mean and standard deviation pretest

achievement scores were also higher for females than males, 49.84 ± 17.07 and 45.71 ± 16.72, respectively. To further explore gender differences, an analysis was conducted using select cases of female and male, excluding the three cases that preferred not to answer. Outliers were assessed by inspection of a boxplot. There were no outliers. The data was not normally distributed, as assessed by the Shapiro-Wilk's test ($p < .05$). The ANOVA is robust to deviations from normality and the decision was made to proceed as planned. There was homogeneity of variances, as assessed by Levene's test for equality of variances, $p = .723$. The interaction effect between review type and gender for achievement score was not statistically significant, $F(1,236) = .037$, $p = .848$, $\eta^2 = .000$. There was a statistically significant main effect of gender on achievement score, $F(1,236) = 9.677$, $p = .002$, $\eta^2 = .039$. An analysis of the main effect was performed as females scored higher on achievement than males, producing the same results that included the three cases that preferred not to answer.

Table 11

Main Effect of Gender on Achievement Score

Tests of Between-Subjects Effects

Dependent Variable: Achievement

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	6921.040[a]	4	1730.260	2.821	.026	.045
Intercept	196118.651	1	196118.651	319.750	.000	.573
Reviewtype	55.502	1	55.502	.090	.764	.000
Gender	6701.169	2	3350.584	5.463	.005	.044
Reviewtype * Gender	22.560	1	22.560	.037	.848	.000
Error	145977.165	238	613.349			
Total	1165323.000	243				
Corrected Total	152898.206	242				

a. R Squared = .045 (Adjusted R Squared = .029)

Table 12

Mean and Standard Error Gender and Achievement

Gender	Mean	Std. Error
Female	70.638	2.569
Male	60.374	2.056
Prefer not to answer	81.000a	14.299

a. Based on modified population marginal mean

A two-way analysis of variance (ANOVA) was conducted to determine whether students' major was related to type of review (Kahoot! gamification or traditional study guide) as measured by the achievement test score. Participants self-selected major as liberal arts, STEM, undecided, or prefer not to answer. Data are mean ± standard error unless otherwise stated. Residual analysis was preformed to test for the assumptions of the two-way ANOVA. Outliers were assessed by inspection of a boxplot. There were no outliers. The data was not normally distributed, as assessed by the Shapiro-Wilk's test ($p < .05$). The ANOVA is robust to deviations from normality and the decision was made to carry on. There was homogeneity of variances, as assessed by Levene's test for equality of variances, $p = .499$. The interaction effect between review type and major for achievement score was not statistically significant, $F(3,235) = .226$, $p = .878$, $\eta^2 = .003$. There was no statistically significant main effect of major on achievement score, $F(3,235) = .325$, $p = .807$, $\eta^2 = .004$. Students' participating in the review groups were not significantly different with respect to major, $p = .749$. Given that 82% of the participant sample were in STEM or liberal arts majors, the "undecided" and "prefer not to answer" major participants could be a reason for not finding significance. Therefore, an analysis to determine if

there is a difference between STEM and liberal arts majors was conducted. Residual analysis was preformed to test for the assumptions of the two-way ANOVA. Outliers were assessed by inspection of a boxplot. There were no outliers. The data was not normally distributed, as assessed by the Shapiro-Wilk's test ($p < .05$). The ANOVA is robust to deviations from normality and the decision was made to carry on. There was homogeneity of variances, as assessed by Levene's test for equality of variances, $p = .911$. The interaction effect between review type and major (liberal arts and STEM) for achievement score was not statistically significant, $F(1,197) = .550$, $p = .459$, $\eta^2 = .003$. There was no statistically significant main effect of major on achievement score, $F(1,197) = .088$, $p = .768$, $\eta^2 = .000$ (see Table 13).

Table 13

Main Effect of Major on Achievement Score

Tests of Between-Subjects Effects

Dependent Variable: Achievement

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1210.390[a]	7	172.913	.268	.966	.008
Intercept	538138.521	1	538138.521	833.703	.000	.780
Review Type	66.403	1	66.403	.103	.749	.000
Major	629.341	3	209.780	.325	.807	.004
Review Type * Major	437.211	3	145.737	.226	.878	.003
Error	151687.816	235	645.480			
Total	1165323.000	243				
Corrected Total	152898.206	242				

a. R Squared = .008 (Adjusted R Squared = -.022)

Summary of Findings

The results demonstrate two things. First, the mean difference in engagement score between Kahoot! gamification review and traditional study guide review was 0.26, meaning there is a 95% confidence rate that the true mean difference lies somewhere between 0.05 and

0.57. Second, there was a significant main effect for participants under age 30 on achievement scores and a significant main effect for females on achievement scores. Although the differences are small and difficult to observe, this result highlights that the little difference that exists between the type of review (Kahoot! gamification or study guide) and achievement scores are influenced by engagement with scores being higher for participants under 30 and females. These findings are consistent with the research evidence that individuals under 30 have grown up tech savvy and are comfortable with internet-based games and testing (Gonzalez, 2018). This study adds to the research by including students who pursue academic coursework in diverse subjects to better generalize research findings (Ariani, 2019; Sinval et al., 2018).

CHAPTER 5. DISCUSSION

Gamification of the review process for student testing suggests potential for improved student achievement due to increased engagement. The Kahoot! gamified review was more engaging than the traditional study guide review. Participants in the 18 to 30 age range scored higher on achievement and engagement; females tended to score slightly higher than males, while major did not significantly affect achievement and engagement scores. In addition to results and findings, interesting considerations include strengths, limitations, applications, and implications.

Results and Findings

Gamification of the review process is an appropriate tool to promote student achievement and engagement at the post-secondary level of education. The first research question is a comparison of the pretest and posttest for the Kahoot! and traditional review methods. The statistical analysis chosen took into consideration and controlled for the pretest scores. The findings indicate improved performance and are in line with previous studies (Henrie et al, 2017; Reschly & Christenson, 2012). Achievement scores for students who participated in the Kahoot! gamification review did not differ significantly from students that participated in a traditional review. Since both review methods produce improved achievement scores, it remains unclear whether one method is preferable to the other.

The second research question concerns the relationship between the type of review and student engagement. The results confirm that the Kahoot! gamified review was rated higher than the traditional review in engagement. Prior studies show engagement was demonstrated through motivation, participation, and self-regulation (Bae & Han, 2019; Fuller et al., 2018; Reschly &

Christenson, 2012). These findings suggest that gamification can provide a motivating factor to support learning useful in the realm of education. The appeal of gamification and the competition created through gamification could be motivating factors of engagement for learning, well-being, life, and work. Competition and curiosity are natural instincts and using them for learning or training can be a motivating factor well beyond the motivation of reward. Gamification of learning also taps into the social realm through community, collaboration, and competition. Gamification works especially well for learning complicated material (Pintrich, 2004) by making the process fun and attractive. Achievement triggers dopamine release in the brain, increasing engagement in the learning process (Ormrod, 2016).

The last three research questions concern demographics of age, gender, and major. Varying factors such as these may be associated mistakenly. However, previous studies have not been able to distinguish or separate these elements in gamification when it comes to gender, age, or major. Even though the previous studies by Ismail and Mohammed (2017), Timms et al. (2018), Lei et al. (2018), and Gonzalez (2018) were not replicated, findings suggest that age and gender marginally moderate the effect of review type. Prior research indicated that the use of games in higher education may not generalize to populations over the age of 40 (Gonzalez, 2018). The Kahoot! game being mostly technology driven could play a factor in engagement as those under the age of 30 were less engaged than those aged 31 to 44. Perhaps the technology behind Kahoot! was not novel enough to hold the interest of the under 30 students compared to other forms of gamification that could have been used. It could be reasoned that further evaluation should include experiences or interest and more advanced technology. It begs the question about future studies focusing on different types of gamification with regards to specific demographics. Contrary to the finding of Wilson et al. (2015), major does not moderate the

effect of review type. This study adds to the body of literature on the generalizability of major and type of review on achievement scores. Overall, the experimental methodology held true to prior studies using correlational methods, thus extending earlier findings.

Strengths and Limitations

The paucity of studies on gamification do not include an experimental design. The strength of this study is based on the power of random assignment to the two review conditions. In addition to quantitative experimental design, other strengths include the reliability of scales and the number of completed surveys. It is interesting to note that, improved learning outcomes could have been influenced by the review process itself. This may alter or improve aspects of both of the review conditions in the current experiment. One limitation is the use of self-report measures. This may be indicated by the third and fourth questions of the IMI engagement scale as it is a self-report measure. These two questions are worded negatively to increase the reliability of the scales. The response choices indicate respondents answered these two questions similarly to the other five questions. Possible explanations may include (1) students answered the questions without completely reading the question stem or (2) fatigue may have affected responses as the IMI was near the end of the study. Additionally, the current pandemic may have played a role in the collection of data as many students were uncertain of the return to education or taking a year gap, which considerably slowed the data collection process or negatively impacted survey completion rates. Characteristics of the population may affect the external validity, as generalizability to real-life situations of scoring well on a test for a grade differ from scoring on a test in an experimental study. Experimental studies require random assignment and achieving a balanced design that assigns an equal number of participants to each group is sometimes difficult to achieve. Unbalanced designs can negatively affect the violation

of assumptions on the validity of a test, which may have been a factor in the analysis of the data. The researcher was curious if respondents had prior experience with games related to studying and academics and included this question in the demographic section at the end of the experiment. Interestingly, 128 of the 243 respondents reported having prior experience with games related to studying and academics. Additionally, the 128 participants acknowledging experience were under the age of 30. A related limitation would include inquiry as to the appeal of gamification and comfort with technology.

Implications for Application of Results

The implications of these findings or what they could mean in the work environment are promising as a method for engagement. The applicability of these results would be useful in the workplace for individual and group training and development. Gamification can increase productivity in learning and work environments, actively engage students and employees, add to technology applications in college and on the job, increase well-being and health awareness, extend marketing applications, and enhance student and candidate experiences. The current pandemic has necessitated organizations to move toward working remotely and to adapt to new procedures for onboarding, training, and employee development. These processes can be facilitated through the use and incorporation of gamification. Educators and employers may consider gamification as a new user interface in what will be deemed the "new normal" going forward.

Implications for Future Research

The areas of future research based on the findings include a continued need for experimental studies in the field of higher education. User experience will also be a measure for optimization as companies plan to embark further into digital technology for hiring and training.

Future research may choose to identify speed of retention and if a digital multi-technology approach would be not only assisting in employee productivity but also speed up the length of training, saving human and financial capital. This becomes important when one considers that most companies view training as an expense rather than an investment (Devarakonda, 2019) and devote more than 3% of expenditures (Wentworth, 2016) toward training and team evolvement.

Summary and Conclusion

Gamification is a unique approach to improve engagement with a subject matter. This can be facilitated to almost any genre or sector for employee training and development. Upon comparison of the findings, the underlying facts suggest that females and younger populations are more likely to benefit from the gamification of presented material. The results are compelling when one considers the current workforce is concentrating more on diversity and inclusion. As companies look toward Millennials and Generation Z to replace the aging of higher-level positions, appealing to new ways of engaging these workers is paramount. Gamification is more useful than ever in a workplace that is taking up a work-from-home mentality as multi-media can bridge the gap to increase engagement. Further research needs to be considered on a more advanced method of gamification such as through improved incorporation of storytelling, audio interaction, video interaction and rewards (e.g., points or health bars) as seen in traditional video games. The incoming workforce was educated in a way that their previous peers were not. Considering many classes are offered online, gaming is very prevalent and social interaction during an activity or experience has become a motivating factor for socialization. The new workforce is accustomed to learning new things in a way that is different than attending a lecture and reading the information from a book. A highly improved user interface and user experience will become more paramount than ever for successful

companies to train their most important asset, their employees. Thus, it can be considered that gamification is going to be the future for successful business and organizational results moving forward.

REFERENCES

Adamson, M. A., Chen, H., Kackley, R., & Micheal, A. (2018). For the love of the game: Game-versus lecture-based learning with generation Z patients. *Journal of Psychosocial Nursing and Mental Health Services*, *56*(2), 29-36.

Alrashidi, O., Phan, H. P., & Ngu, B. H. (2016). Academic engagement: An overview of its definitions, dimensions, and major conceptualizations. *International Education Studies, 9*(12), 41-52. Retrieved from https://search.proquest.com/docview/1969015655?accountid=35796

Anguera, J. A., Boccanfuso, J., Rintoul, J. L., Al-Hashimi, O., Faraji, F., Janowich, J . . . Gazzaley, A. (2013). Video game training enhances cognitive control in older adults. *Nature, 501*(7465), 97-101. doi: 10.1038/nature12486

Antony, J. W., Ferreira, C. S., Norman, K. A., & Wimber, M. (2017). Retrieval as a fast route to memory consolidation. *Trends in Cognitive Science, 21*(8), 573-576. doi: 10.1016/j.tics.2017.05.001

Ariani, D. W. (2019). Basic psychological needs as predictors of burnout and engagement. *Journal of Psychological & Educational Research*, *27*(2), 51-74.

Ariel, R. & Karpicke, J. D. (2018). Improving self-regulated learning with a retrieval practice intervention. *Journal of Experimental Psychology: Applied*, *24*(1), 43. doi: 10.1037/xap0000133

Bae, Y., & Han, S. (2019). Academic engagement and learning outcomes of the student experience in the research university: Construct validation of the instrument. *Educational Sciences: Theory & Practice, 19*(3), 49-64. http://dx.doi.org/10.12738/estp.2019.3.004

Banfield, J. & Wilkerson, B. (2014). Increasing student intrinsic motivation and self-efficacy through gamification pedagogy. *Contemporary Issues in Education Research, 7*(4), 291-298.

Baniqued, P. L., Lee, H., Voss, M. W., Basak, C., Cosman, J. D., DeSouza, S., . . . Kramer, A. (2013). Selling points: What cognitive abilities are tapped by casual video games? *Acta Psychologica,142*(1), 74-86. doi: 10.1016/j.actpsy.2012.11.009

Bicen, H. & Kocakoyun, S. (2018). Perceptions of students for gamification approach: Kahoot as a case study. *International Journal of Emerging Technologies in Learning, 13*(2), 72-93. https://doi.org/10.3991/ijet.v13i02.7467

Blair, C., & Raver, C. C. (2014). Closing the achievement gap through modification of neurocognitive and neuroendocrine function: Results from a cluster randomized control trial of an innovative approach to the education of children in kindergarten. *PLoSOne,*

9(11). e112393. doi: 10.1371/journal.pone.0112393

Boghian, I., Cojocariu, V. M., Popescu, C. V., & Mâţă, L. (2019). Game-based learning. Using board games in adult education. *Journal of Educational Sciences and Psychology*, *9*(1).

Boot, W. R., Kramer, A. F., Simons, D. J., Fabiani, M., & Gratton, G. (2008). The effects of video game playing on attention, memory, and executive control. *Acta Psychologica, 129,* 387-398.

Bordens, K. S. & Abbott, B. B. (2014). *Research design and methods: A process approach* (9th ed.). New York: McGraw-Hill Education.

Caporarello, L., Magni, M., & Pennarola, F. (2017). Learning and gamification: A possible relationship? *EAI Endorsed Transactions on e-Learning*, *4*(16). doi: 10.4108/eai.19-12-2017.153488

Castro, M. J., Lopez, M., Cao, M. J., Fernandez-Castro, M., Garcia, S., Frutos, M., & Jimenez, J. M. (2019). Impact of educational games on academic outcomes of students in the degree in nursing. *PloS one*, *14*(7). doi: 10.1371/journal.pone.0220388

Cetin, B. (2015). Academic motivation and self-regulated learning in predicting academic achievement in college. *Journal of International Education Research, 11*(2), 95-106.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*(1), 155-159.

Cordova, D. I. & Lepper, M. R. (1996). Intrinsic motivation and the process of learning: Beneficial effects of contextualization, personalization, and choice. *Journal of Educational Psychology, 88*(4), 715-730.

de Freitas, S. (2018). Are games effective learning tools? A review of educational games. *Educational Technology & Society, 21*(2), 74-84.

Deci, E. L., Eghrari, H., Patrick, B. C., & Leone, D. (1994). Facilitating internalization: The self-determination theory perspective. *Journal of Personality, 62*, 119-142.

Deci, E. L., Koestner, R. & Ryan, R. M. (2001). Extrinsic rewards and intrinsic motivation in education: Reconsidered once again. *Review of Educational Research, 71*(1), 1-27.

Deci, E. L. & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11*(4), 227-268.

DeSimone, J. A., Harms, P. D., & DeSimone, A. J. (2015). Best practice recommendations for data screening. *Journal of Organizational Behavior, 36*(2), 171-181. doi: 10.1002/job.1962

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011, September). From game design

elements to gamefulness: Defining "gamification". In *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments*, 9-15.

Devarakonda, S. (2019). Calculating the economic viability of corporate trainings (traditional & eLearning) using benefit-cost ratio (BCR) and return on investment (ROI). *International Journal of Advanced Corporate Learning, 12*(1), 41-57.

Di Domenico, S. I., & Ryan, R. M. (2017). The emerging neuroscience of intrinsic motivation: A new frontier in self-determination research. *Frontiers in Human Neuroscience*, *11*(145), 1-14. doi: 10.3389/fnhum.2017.00145

Dichev C. & Dicheva, D. (2017). Gamifying education: What is known, what is believed and what remains uncertain: A critical review. *International Journal of Educational Technology in Higher Education, 14*(9), 2-36. doi: 10.1186/s41239-017-0042-5

Faul, F., Erdfelder, E., Lang, A., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral. and biomedical sciences. *Behavior Research Methods, 39*(2), 175-191.

Filak, V. F. & Sheldon, K. M. (2003). Student psychological need satisfaction and college teacher-course evaluations. *Educational Psychology, 23*(3), 235- 247. doi: 10.1080/0144310320000600 84

Finn, J. D., & Zimmer, K.S. (2012). Student engagement: What is it? Why does it matter? In S.L. Christenson, A. L. Reschly, & Wylie, C. (Eds). *Handbook of Research on Student Engagement*, (pp. 97-131). New York, NY: Springer. doi:10.1007/978-1-464-2018-7-1

Fotaris, P., Mastoras, T., Leinfellner, R., & Rosunally, Y. (2016). Climbing up the leaderboard: An empirical study of applying gamification techniques to a computer programming class. *The Electronic Journal of e-Learning, 14*(2), 94-110.

Foster, T., & Warwick, S. (2018). Nostalgia, gamification and staff development–moving staff training away from didactic delivery. *Research in Learning Technology*, *26*. http://dx.doi.org/10.25304/rlt.v26.2021

Fuller, K. A., Karunaratne, N. S., Naidu, S., Exintaris, B., Short, J. L., Wolcott, M. D., … White, P. J. (2018). Development of a self-report instrument for measuring in-class student engagement reveals that pretending to engage is a significant unrecognized problem. *PloS one*, *13*(10), e0205828. doi: 10.1371/journal.pone.0205828

Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. *Simulation Gaming, 33*, 441-466. doi: 10.1177/1046878102238607

Gonzalez, A. (2018). Turning a traditional teaching setting into a feedback-rich environment. *International Journal of Educational Technology in Higher Education, 15*(1), 32-53. doi: 10.1186/s41239-018-0114-1

Gravetter, F. J. & Wallenau, L. B. (2017). *Statistics for behavioral sciences* (10th ed.). Boston, M.A.: Cengage Learning.

Gregory, R. J. (2016). *Psychological testing: History, principles, and applications* (7th ed.). Boston, MA: Pearson.

Gramaldi, P. J. & Karpicke, J. D. (2012). When and why do retrieval attempts enhance subsequent encoding? *Memory Cognition, 40*(4), 505-513. doi: 10.3758/s13421-011-0174-0

Grolnick, W. S. & Ryan, R. M. (1987). Autonomy in children's learning: An experimental and individual difference investigation. *Journal of Personality and Social Psychology, 52*(5), 890-898.

Hainey, T., Boyle, E., Connolly, T., & Wilson, A. (2016). A systematic literature review of games-based learning empirical evidence in primary education. *Computers & Education, 102*, 202-223.

Harpe, S. E. (2015). How to analyze Linkert and other rating scale data. *Currents in Pharmacy Teaching and Learning, 7*(6), 836-850. doi: 10.1016/j.cptl.2015.08.01

Henrie, C. R., Bodily, R., Larsen, R., & Graham, C. R. (2018). Exploring the potential of LMS log data as a proxy measure of student engagement. *Journal of Computing in Higher Education*, *30*(2), 344-362. doi: 10.1007/s12528-017-9161-1

Huizenga, J., Admiraal, W., Akkerman, S., & ten Dam, G. (2009). Mobile game-based learning in secondary education: engagement, motivation, and learning in a mobile city game. *Journal of Computer Assisted Learning, 25*, 322-344.

Hwang, G., Sung, H., Hung, C., Yang, L., & Huang, I. (2013). A knowledge engineering approach to developing educational computer games for improving students' differentiating knowledge. *British Journal of Educational Technology, 44*(2), 183-196. doi: 10.1111/j.1467-8535.2012.01285.x

Isen, A. M., & Reeve, J. (2005). The influence of positive affect on intrinsic and extrinsic motivation: Facilitating enjoyment of play, responsible work behavior, and self-control. *Motivation and emotion*, *29*(4), 295-323. doi: 10.1007/s11031-006-9019-8

Ismail, M. A. A., Ahmad, A., Mohammad, J. A. M., Fakri, N. M. R. M., Nor, M. Z. M., & Pa, M. N. M. (2019). Using Kahoot! as a formative assessment tool in medical education: a phenomenological study. *BMC Medical Education*, *19*(1), 230-238. https://doi.org/10.1186/s12909-019-1658-z

Ismail, M. A. A., & Mohammad, J. A. M. (2017). Kahoot: A promising tool for formative assessment in medical education. *Education in Medicine Journal*, *9*(2), 19-26. https://doi.org/10.21315/eimj2017.9.2.2

Jackson, G. T. & McNamara, D. S., (2013). Motivation and performance in a game-based intelligent tutoring system. *Journal of Educational Psychology, 105*(4), 1036-1049.

Jang, H., Reeve, J., & Deci, E. L. (2010). Engaging students in learning activities: It is not autonomy support or structure by autonomy support and structure. *Journal of Educational Psychology, 102*(3), 588-600. doi: 10.1037/a0019682

Karpicke, J. D. (2012). Retrieval-based learning: Active retrieval supports meaningful learning. *Current Directions in Psychological Science, 21*, 157-163. doi: 10.1077/0963721412443552

Karpicke, J. D. & Roediger, H. L. III (2007). Repeated retrieval during learning is the key to long-term retention. Journal of Memory and Language, 57, 151-162. http://dx.doi.org/10.1016/j.jml.2006.09.004

Ke, F., Xie, K., & Xie, Y. (2015). Game-based learning engagement: A theory-and data-driven exploration. *British Journal of Educational Technology*, *47*(6), 1183-1201. doi: 10.1111/bjet.12314

Laerd Statistics (2015). One-sample t-test using SPSS statistics. *Statistical tutorials and software guides*. Retrieved from https://statistics.laerd.com/

Lee, W. & Reeve, J. (2013). Self-determined, but not non-self-determined, motivation predicts activations in the anterior insular cortex: An fMRI study of personal agency. *Social Cognitive & Affective Neuroscience*, *8*(5), 538-545. Doi: 10.1093/scan/nss029

Lee, W. & Reeve, J. (2017). Identifying the neural substrates of intrinsic motivation during task performance. *Cognitive, Affective, & Behavioral Neuroscience*, *17*(5), 939-953. doi: 10/3758/s13415-017-0524-x

Lee, W., Reeve, J., Xue, Y., & Xiong, J. (2012). Neural differences between intrinsic reasons for doing versus extrinsic reasons for doing: An fMRI study. *Neuroscience Research*, *73*(1), 68-72. doi: 10.1016/j.neures.2012.02.010

Lei, H., Cui, Y., & Zhou, W. (2018). Relationships between student engagement and academic achievement: A meta-analysis. *Social Behavior and Personality, 46*(3), 517-528. https//doi.org/10.2224/sbp.7074

Licorish, S. A., Owen, H. E., Daniel, B., & George, J. L. (2018). Students' perception of Kahoot!'s influence on teaching and learning. *Research and Practice in Technology Enhanced Learning, 13*(1), 9–31.

Loh, K. K. & Kanai, R. (2015). How has the internet reshaped human cognition? *The Neuroscientist, 22*(5), 506-520. doi: 10.1177/1073858415595005

Martínez-Mesa, J., González-Chica, D. A., Bastos, J. L., Bonamigo, R. R., & Duquia, R. P. (2014). Sample size: How many participants do I need in my research? *Anais brasileiros de dermatologia*, *89*(4), 609-615. doi: 10.1590/abd1806-4841.20143705

McAuley, E., Duncan, T., & Tammen, V. V. (1989). Psychometric properties of the Intrinsic Motivation Inventory in a competitive sport setting: A confirmatory factor analysis. *Research Quarterly for Exercise and Sport, 60*, 48-58.

McPherson, S. H. (2014). Unders and overs: Using a dice game to illustrate basic probability concepts. *Teaching Statistics Trust, 37*(1), 18-22.

Moylan, R. M., Burgess, A. W., Figley, C., & Bernstein, M. (2015). Motivating game-based learning efforts in higher education. *International Journal of Distance Education Technologies, 13*(2), 54-72.

Ng, B. (2018). The neuroscience of growth mindset and intrinsic motivation. *Brain Sciences*, *8*(2), 20-39. doi: 10.3390/brainsci8020020

Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, competence, and relatedness in the classroom: Applying self-determination theory to educational practice. *Theory and research in Education*, *7*(2), 133-144. doi: 10.1177/1477878509104318

Ormrod, J. E. (2016). *Human Learning* (7th ed.). Upper Saddle River, NJ: Pearson/Merrill Prentice Hall.

Pastötter, B., Schicker, S., Niedernhuber, J., & Bäuml, K. H. T. (2011). Retrieval during learning facilitates subsequent memory encoding. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *37*(2), 287-297.

Pechenkina, E., Laurence, D., Oates, G., Eldridge, D., & Hunter, D. (2017). Using a gamified mobile app to increase student engagement, retention and academic achievement. *International Journal of Educational Technology in Higher Education, 14*, 1-12. doi: 10.1186/s41239-017-0069-7

Peng, C. Y. J., Harwell, M., Liou, S. M., & Ehman, L. H. (2006). Advances in missing data methods and implications for educational research. M.S. Sawilowsky (Ed.), Real data analysis (pp. 31-78). Greenwich, CT: Information Age Publishing, Inc.

Petrovic-Dzerdz, M. (2019). Gamifying online tests to promote retrieval-based learning. *International Review of Research in Open and Distributed Learning, 20*(2). http://dx.doi.org/10.19173/irrodl.v20i2.3812

Pintrich, P. R. (2004). A conceptual framework for assessing motivation and self-regulated

learning in college students. *Educational Psychology Review, 16*(4), 385-407. doi: 10.1007/s10648-004-0006-x

Ranieri, M., Raffaghelli, J. E., & Bruni, I. (2018). Game-based student response system: Revisiting its potentials and criticalities in large-size classes. *Active Learning in Higher Education*, 1-14. doi: 10.1177/1469787418812667.

Reeve, J., Jang, H., Carrell, D., Jeon, S., & Barch, J. (2004). Enhancing students' engagement by increasing teachers' autonomy support. *Motivation and Emotion*, *28*(2), 147-169.

Reeve, J. & Lee, W. (2019). A neuroscientific perspective on basic psychological needs. *Journal of Personality*, *87*(1), 102-114. doi: 10.1111/jopy.12390

Reeve, J. & Tseng, C. M. (2011). Cortisol reactivity to a teacher's motivating style: The biology of being controlled versus supporting autonomy. *Motivation and Emotion*, *35*(1), 63-74. doi: 10.1007/s11031-011-9204-2

Reschly, A. L. & Christenson, S. L. (2012). Jingle, jangle and conceptual haziness: Evolution and future directions of the engagement construct. In S.L. Christenson, A. L. Reschly, & Wylie, C. (Eds). *Handbook of Research on Student Engagement*, (pp. 3-20). New York, NY: Springer. doi:10.1007/978-1-464-2018-7-1

Robison, C. C. (2014). It's a game! Evaluation of a classroom game to enhance learning in an introductory counseling course. *Innovative Teaching, 3*(10), 1-14.

Ryan, R. M., Connell, J. P., & Plant, R. W. (1990). Emotions in non-directed text learning. *Learning and Individual Differences, 2*, 1-17.

Ryan, R. M. & Deci, E. L. (2000a). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology, 25*(1), 54-67. doi: 10.1006/ceps.1999.1020

Ryan, R. M. & Deci, E. L. (2000b). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*(1), 68-78. doi: 10.1037//0003-066X.55.1.68

Ryan, R. M., Koestner, R., & Deci, E. L. (1991). Varied forms of persistence: When free choice behavior is not intrinsically motivated. *Motivation Emotion, 15*, 185-205.

Ryan, R. M., Mims, V., & Koestner, R. (1983). Relation of reward contingency and interpersonal context to intrinsic motivation: A review and test using cognitive evaluation theory. *Journal of Personality and Social Psychology, 45*(4), 736-750.

Self-Determination Theory. (n.d). *Intrinsic Motivation Inventory*. Retrieved from https://selfdeterminationtheory.org/intrinsic-motivation-inventory/

Sinval, J., Casanova, J. R., Marôco, J., & Almeida, L. S. (2018). University student engagement inventory (USEI): Psychometric properties. *Current Psychology,* 1-13. http://dx.doi.org/10.1007/s12144-018-0082-6

Soderstrom, N. C., & Bjork, R. A. (2014). Testing facilitates the regulation of subsequent study time. *Journal of Memory and Language, 73*, 99–115. doi: 10.1016/j.jml.2014.03.003

Sullivan, G. M. & Artino, A. R. Jr. (2013). Analyzing and interpreting data from Linkert-type scales. *Journal of Graduate Medical Education, 5*(4), 541-542. doi: 10.4300/JGME-5-4-18

Tan Ai Lin, D., Ganapathy, M., & Kaur, M. (2018). Kahoot! It: Gamification in Higher Education. *Journal of Social Sciences & Humanities*, *26*(1). 565-582.

Tan, M., & Hew, K. F. (2016). Incorporating meaningful gamification in a blended learning research methods class: Examining student learning, engagement, and affective outcomes. *Australasian Journal of Educational Technology*, *32*(5). https://doi.org/10.14742/ajet.2232

Timms, C., Fishman, T., Godineau, A., Granger, J., & Sibanda, T. (2018). Psychological engagement of university students: Learning communities and family relationships. *Journal of Applied Research in Higher Education, 10*(3), 243-255. doi: 10.1108/JARHE-09-2017-0107

Tóth, Á., Lógó, P., & Lógó, E. (2019). The effect of the Kahoot quiz on the student's results in the exam. *Social and Management Sciences, 27*(2), 173-179. http://dx.doi.org/10.3311/PPso.12464

Turan, Z., & Meral, E. (2018). Game-based versus non-game-based: The impact of student response systems on students' achievements, engagements, and test anxieties. *Informatics in Education, 17*(1), 105-116. Retrieved from https://search.proquest.com/docview/2101587844?accountid=35796

Virtanen, P., Nevgi, A., & Niemi, H. (2015). Self-regulation in higher education: Students' motivational, regulational and learning strategies, and their relationships to study success. *Studies for the Learning Society, 3*(1-2), 20-34. http://dx.doi.org/10.2478/sls-2013-0004

Vlachopoulos, D. & Makri, A. (2017). The effect of games and simulations on higher education: A systematic literature review. *International Journal Education Technology Higher Education, 14*(22). https://doi.org/10.1186/s41239-017-0062-1

Wentworth, D. (2016). *Training budget benchmarks and optimizations for 2017*. Brandon Hall Group.

Wilson, D., Jones, D., Bocell, F., Crawford, J., Kim, M. J., Veilleux, N., Floyd-Smith, T., Bates,

R, & Plett, M. (2015). Belonging and academic engagement among undergraduate STEM students: A multi-institutional study. *Research in Higher Education, 56*(7), 750-776. doi: 10.1007/s11162-015-9367-x

Woo, J. (2014). Digital game-based learning supports student motivation, cognitive success, and performance outcomes. *Educational Technology & Society, 17*(3), 291-307.

Yürük, N. (2019). Edutainment: Using Kahoot! As A Review Activity in Foreign Language Classrooms. *Journal of Educational Technology and Online Learning*, *2*(2), 89-101. doi: 10.31681/jetol.557518