Application of Gamification in a College STEM Introductory Course: A Case Study

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Abstract

Between 2000 and 2016, the STEM industry reportedly added jobs at the rate of 28% while all jobs were growing at only 6%. However, 48% of bachelor's degree students and 69% of associate's degree students in STEM majors left their program of study between 2003 and 2009. The high attrition rate is often attributed to low student engagement, boredom, alienation, lack of diversity in student population, and faculty attitudes. This exploratory case study demonstrates thick descriptions of student experiences in an Introduction to Computing course with a special focus on gameful design of short-term and long-term course activities. The findings of this case study described an application of gamification to increase engagement. The participants of the case study include 501 students enrolled in 4 semesters and 15 courses. Through the process of qualitative content analysis, 1002 course review comments and 182 comments from a third-party source were categorized and processed into emerging themes and patterns. The lecture themes identified in qualitative content analysis were intellectual engagement, emotional engagement, behavioral engagement, physical engagement, and social engagement. The course-long themes to promote participation were attendance, management of anxiety, assignment completion, timely feedback, mastery of the material, and course completion. The implications of the case study included a demonstration of a working gamification system for high enrollment and mandated curriculum courses. The first research question: "How does gamification encourage engagement during lectures?" addresses student willingness to use their personal devices in active learning with the Kahoot peer-response system, the reciprocal nature of engagement between instructors and students, and the importance of games as an

instructional metaphor. The second research question: “How does gamification encourage participation in the activities during the entire length of the course?” focuses on the role of instructional design in a candidate course for gamification, a variety of tools necessary to promote course-long engagement, a bridge in the affective domain from disinterest to emotional investment, and the application of the Anna Karenina principle for adoption of gamification.

Table of Contents

Chapter 1: Introduction

Effective teaching has been a field of diligent study for a significant period of time (Bloom, 1984). Teaching and learning methods, along with human motivational theories, have broad application. Beyond the field of education, they apply to many areas of business with some examples in continuous employee development or leadership mentorship. However, the views on the most effective ways of teaching and on the role of technology in teaching differ. In ancient times, Socrates believed that the technology of writing was going to ruin learning and education (Kohan, 2013). As evidence-based approaches were perfected, one-on-one tutoring was found to improve student grades by two standard deviations (Bloom, 1984), and yet the search for teaching techniques in group environments that equal the success of one-on-one tutoring continues. Active learning and peer-instruction were found to increase academic performance toward student outcomes by 0.47 standard deviation in a meta-analysis of 166 studies (Ruiz-Primo, Briggs, Iverson, Talbot, & Shepard, 2011). Another meta-analysis of 225 studies reported that students are 150% more likely to fail in courses dominated by traditional lectures over courses with active learning strategies (Freeman et al., 2014).

Traditional lectures are sometimes defined as “teaching by telling” (Bonwell & Eison, 1991) or “exposition-centered” (Freeman et al., 2014). Active learning is connected with constructivist course design, inquiry-based teaching, collaborative activities, and technology-enabled activities (Ruiz-Primo et al., 2011). Further, a connection is made between experience in introductory courses and a negative impact in student engagement, attendance, and participation (Fredricks, Blumenfeld, & Paris, 2004).

Effective teaching is important from business perspectives of academic institutions. High enrollment in introductory courses makes up an important part of revenue stream for schools.

The introductory courses support organizations financially and also represent the pool of candidates for advanced programs of study. Therefore, creating engagement in introductory courses and promoting retention is a high-priority objective. Since gamification is applied by many commercial organizations to engage large numbers of customers, attempts are made early on to apply gamification to academic activities.

Background

A theory often applied to gamification is the self-determination theory by Richard Ryan and Edward Deci (2000). For sixteen years, the self-determination theory has been applied to a variety of fields to modify behavior, instill new habits, and promote intrinsic motivation. This case study, which covers the emerging field of gamification as well as education, and business, also utilizes self-determination theory. The focus of the case study explores the application of gamification in college introductory STEM courses.

The basic elements of self-determination theory (autonomy, relatedness, and competence) were applied to the business field in order to promote employee well-being, performance, and employment tenure (Williams et al., 2014). In the field of education, the self-determination theory was applied to mitigate academic dishonesty by addressing student needs of autonomy (Kanat-Maymon, Benjamin, Stavsky, Shoshani, & Roth, 2015). In music education, the theory was used to increase student motivation and improve learning environment (Evans, 2015). In physical education, the application of self-determination theory showed evidence of increasing performance in physical activities and improved the attitude toward exercise later in adulthood (Weiyun & Hypnar, 2015). In broader educational studies, self-determination theory element of autonomy seems to be negatively affected by deadlines (Amabile, DeJong, & Lepper, 1976), surveillance (Enzle & Anderson, 1993), testing (Grolnick & Ryan, 1987), and controlling language (Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004).

A modern application of the self-determination theory is in gamification. Commercial businesses have been utilizing reward-point systems and other gamification strategies for some time now (Saran, 2015). Improvement was found in marketing on mobile devices with gamification (Hofacker, de Ruyter, Lurie, Manchanda, & Donaldson, 2016). The University of Michigan applied gamification to college courses by developing a custom Learning Management System, which is driven by individual paths of learning and game points instead of grades (Aguilar, Fishman, & Holman, 2013). The University received a 1.8-million-dollar grant to continue the project.

While many studies report benefits of gamification in education and other fields (Dicheva, Dichev, Agre, & Angelova, 2015), Gartner warned in 2012 that 80% of gamification projects would fail in the next two years due to poor understanding of effective design in gamification (Gartner, 2012). The successful studies in education focus on problem-solving skills, exploration, and discovery as project outcomes (Lee & Hammer, 2011; Kapp, 2012; Sitzmann, 2011). Studies that report negative impacts of gamification cite decreases in motivation, empowerment, and satisfaction due to ongoing comparisons between students in leaderboards (Hanus & Fox, 2015). Faiella and Ricciardi (2016) suggest that more work needs to be done to experimentally establish the learning benefits of gamification in education.

In the business field, the term *zombification* was coined to express mechanical following of gamification rules to reach extrinsic rewards (Conway, 2014). Further, *exploitationware* is another negative term associated with gamification to underline the tangible employer benefits resulting from employee gamification activities in contrast with intangible, and often valueless, rewards given to employees (Bogost, 2011). Laboring without proper compensation was given yet another name by Kuchlich (2005) in the expression *playbour*.

While the above negative expressions about gamification stress the need for ethical consideration, they demonstrate the effectiveness of the principle and the need for informed design. Gamification has a noticeable effect on people and requires further investigation. There is a need to maximize the positive effects of gamification and minimize the negative impact.

Statement of the Problem

Science, Technology, Engineering, and Mathematics (STEM) is an important academic area for the United States in order to effectively compete in the global markets, economy, and innovation (Chen & Soldner, 2013). Reportedly, students have left behind their studies in STEM and switched to other majors. Some of the reasons are based on student engagement and point out student boredom, alienation, low achievement, and high dropout rates (Fredricks et al., 2004). A 30% failure rate was found in relation to female students and minorities in introductory, so-called STEM gatekeeper courses (Vasquez, Fuentes, & Kypuros, 2015).

There exists a negative sentiment among some higher education faculty that scientists cannot be made, they are born that way, or that students need to be weeded out in gatekeeping courses (Gasiewski, Eagan, Garcia, Hurtado, & Chang, 2012). A study of 2,873 students in 15 schools covering 73 introductory courses underlines the importance of supportive faculty role in student success. Gasiewski et al. demonstrates that engagement increases with the adoption of a new teaching role, which replaces the gatekeeping professor with the role of an engaged professor. Other studies confirm the reciprocal nature of engagement, which means that both the students and the professors must promote a positive attitude (Skinner & Belmont, 1993). While teachers can be monitored through classroom visitations and other evaluation protocols in order to increase engagement (Early, Rogge, & Deci, 2015), the engagement of students cannot be forced the same way.

When considering gamification in classroom activities, researchers report a dearth of studies about the immersion in game environments associated with storification (Hamari et al., 2016). Researchers call for more qualitative studies in this area to understand the nature of engagement in games (Consalvo & Dutton, 2006; Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012). The complexity of the phenomenon and continually changing audience in the classroom lends itself to a qualitative study.

Purpose of the Study

The purpose of this qualitative case study is to explore and describe the gamification of a STEM introductory college course, Introduction to Computing, at Grand Valley State University. STEM attrition in academia, as well as the shortage of STEM workforce on national scale, makes attracting and retaining students a significant business problem for STEM academic departments and for the industries relying on STEM workforce. Exploring the technology implemented in this gamification study and providing a model of gamification demonstrates a business solution for academic or enterprise learning. The study includes 501 students who contributed data in form of course evaluations, journals, public review posts, as well as activity data available in a digital gamification system, peer-instruction system, and various cloud-based assignment systems. Gamification was applied to the course through custom software and gameful instructional design.

Research Questions

- Q1. How does gamification encourage engagement during lectures?

- Q2. How does gamification encourage participation in the activities during the entire length of the course?

Nature of the Study

This qualitative case study explores the application of gamification in a higher education environment. The research questions are in the "how" format, which provides the students the opportunity to supply observations and report on the field notes of the phenomenon. Yin (2009) suggests that a case study is appropriate when the researcher has little control over events and when a contemporary phenomenon is considered in a real-life context.

The "how" questions are supported by the exploratory nature of the case study. The gamification strategies included in the case study were an experiment in the class. Surveys submitted to participants in the form of end-of-semester evaluations allowed for documenting the experiences of participants. While the design of the gamified course was controlled by the researcher, the behaviors of participants cannot be controlled, and the incoming student populations are never the same.

Gamification in education with advanced technology is a relatively new development. Building complex systems on top of active learning and peer instruction is part of a new generation of teaching and learning innovation. The application of these methods allows a phenomenon to occur in student motivation and it requires our attention and study.

Significance of the Study

This case study provides evidence of successful application of gamification to an introductory college course. The success is measured by qualitative data provided by the participants of the study. This includes an increase in affinity toward the subject matter, expressions of motivational levels, and subjective opinions connected with participation in the course.

The significance of the study is emphasized in the impact of higher attendance in lectures, completion of assignments, and exploration of the subject matter to mitigate the problems mentioned in the Statement of the Problem section. The resolution of high-failure rates in introductory courses, low achievement, student boredom, student alienation, along with high dropout rates will have a significant impact in STEM academic programs producing graduates to handle industry needs.

If the study was not conducted, the impact of the software developed for the study or the application of motivational theories could not be qualified in an academic environment. Since the study presents a case for little modification of curriculum, the application of gamification can be broadly generalized to other subject matter areas and other populations.

Definition of Key Terms

Autonomy. An element of the self-determination theory, which implies free choice, taking initiative to originate actions and engagement (Vandercammen, Hofmans, & Theuns, 2014)

Extrinsic motivation. Emotional state leading to actions caused by external factors, which are separable from outcomes of the activity (Olafsen, Halvari, Forest, & Deci, 2015; Yoo, Han, & Huang, 2012).

Gamification. The use of game mechanics and dynamics in nongame contexts (Deterding, 2012)

Gameful design. Gamification is an instance of gameful design. It means applying game design patterns in practice (Deterding, 2012) with special attention to intrinsic motivation (Lee & Doh, 2012).

Intrinsic motivation. Emotional state leading to actions caused by satisfaction derived from the activity itself instead of external factors (Olafsen et al., 2015; Yoo et al., 2012)

Flow. A concept introduced by Professor Csikszentmihalyi from the University of Chicago meaning energized focus in an activity, full immersion, and enjoyment (Hamari et al., 2016).

Fiero. An expression of winning or final accomplishment, typically expressed with raised hands and exclamation with etymology in an Italian word meaning pride or happiness (McGonigal, 2011).

Includification. Integration of accessibility of digital material and increasing the inclusiveness and diversity of gamer population (Barlet & Spohn, 2012).

Storification. Usage of non-narrative elements, such as video, to create structure of narrative story (Morneau, Van Herreweghe, Little, & Lefebvre, 2012).

Quantification. Collection of data and its visualization in order to provide feedback and modify behavior (Whitson, 2013).

Summary

The research of effective teaching provides clear lessons that tutoring and active learning show significant improvements over more traditional approaches (Bloom, 1984; Ruiz-Primo, Briggs, Iverson, Talbot, & Shepard, 2011; Freeman et al., 2014). Benefits of such approaches can be linked to motivational theories such as the self-determination theory, which features autonomy, relatedness, and competence as key requirements in motivating students (Ryan & Deci, 2000). Recently gamification, which draws from the self-determination theory, has been applied to commercial environments in the form of loyalty reward systems or employee experience tracking (Saran, 2015; Hofacker, de Ruyter, Lurie, Manchanda, & Donaldson, 2016). Academic institutions, which are facing enrollment, retention, and graduation challenges, also experiment with gamification systems to increase student motivation (Aguilar, Fishman, & Holman, 2013).

The purpose of this qualitative case study is to explore and describe the gamification of a STEM introductory college course, Introduction to Computing, at Grand Valley State University. The study will include 501 students who contributed data in form of course evaluations, public review posts, as well as activity data available in a digital gamification system, peer-instruction system, and various cloud-based assignment systems. The case study approach allows for answering "how" questions to investigate the application of gamification on student engagement and participation in STEM learning (Yin, 2014).

Chapter 2: Literature Review

This literature review has explored the scientific fields of psychology, education, business, and the emerging field of gamification. The databases used in the archival research include Eric Database, ProQuest, SAGE Online Journals, EBSCO Host, Google Scholar, and Mendeley Network. The majority of searches and referenced material belong to scholarly peer-reviewed journals. When appropriate, scholarly books and relevant Internet websites were also included. The referenced sources were produced in recent years since 2011, with the exception of the theory of motivation section of this literature review. Theory of motivation is a well-established science, and in order to provide the original references on theories older sources are provided. In some instances, sources older than five years provided the necessary historical perspective on the scholarly development of the body of knowledge.

Documentation

The purpose of this case study is to explore the application of gamification in a college STEM course called Introduction to Computing. Gamification was applied to the course through custom software and gameful instructional design. The literature review first considered various theories of human motivation in order to establish a foundation of knowledge in psychology of what motivates people in general. Next, the review moved to explore gamification and considered how gamification built on various theories of motivation in diverse fields like business and sports. The focus then moved into the field of education. Initially, the body of knowledge pertaining to the motivation of college students was explored. Finally, the review considered the most recent information available about existing experiments and findings in gamification of higher education. The chapter concludes with a summary, including the underlying call of researchers for examples of practical application of gamification in education, which is the goal of this case study.

Theory of Motivation

Motivational theories can be categorized into two broad disciplines: content theories and process theories. Content theories focus on goals and needs that motivate people (Damij, Levnajić, Rejec Skrt, & Suklan, 2015). They attempt to answer the question of what motivates people. Process theories explain how individuals choose behaviors to meet their needs by answering the question of how motivation occurs (Huczynski & Buchanan, 2013; Mollit, 2016).

Content theories.

Acquired needs theory focuses on three elements, which are motivating to individuals: achievement, affiliation, and power (Tsounis, Sarafis, & Bamidis, 2014). Achievement refers to frequent recognition of efforts and accomplishments. Affiliation may favor approval of other people over personal achievement. Finally, power is the ability to control people or circumstances with less desire for approval as it is present with affiliation (Moorer, 2014).

Activation theory suggests that people perform activities because a proper level of mental arousal was generated (Scott, 1966). In order to motivate, the arousal needs to be within a balance between overstimulation and boredom (McClelland & Liberman, 1949). Activation can be generated by novelty, variation, uncertainty, and various other forms of stimulation.

Attribution theory indicates that humans have a need to explain the world around them to connect or attribute a cause to events (Roesch & Amirkham, 1997). This often provides a greater sense of control over one's life. Upon learning of someone else's mistake, we tend to follow internal attribution by assigning blame for the error to personality traits. However, our own mistakes are often resolved through external attribution, which are situational factors (Harvey, Madison, Martinko, Crook, & Crook, 2014). We tend not to assign the blame to ourselves. This theory helps researchers to understand the motivation of people in resolving conflicts and searching for actionable findings. Roesch and Amirkham studied athletes and found that those who were more experienced avoided self-serving external attribution and focused on more realistic reasons for their failures (Roesch & Amirkham, 1997). This made them more likely to succeed and avoid motivation based on external factors such as the concept of an unfair world.

The drive reduction theory explains that needs of humans create stimuli, which prod us to action (Hull, 1943). In turn, actions are expected to satisfy relevant needs and reduce the internal drive. When the actions do not satisfy needs or when enacting the drive is somehow frustrated, this leads to negative emotions, which are naturally avoided by human beings. Such feelings then lead to change in behavior in order to reduce drives and satisfy needs (Damij, Levnajić, Rejec Skrt, & Suklan, 2015). Primary drives are associated with survival and procreation, while secondary drives relate to social and identity factors.

Endowed progress effect theory is based on the work of Nunes and Dreze (2006). They had set up a study in a car wash, where a loyalty card tracked visits. The first group was given a 10-stamp card, with the first two stamps already punched out. The second group was given a card with eight stamps, with none of them completed. Both groups needed eight visits to receive a free car wash. Nunes and Dreze (2006) found that the first group redeemed the free car wash at the rate of 34%, while the second did so at 19%. The first group visited the business more often, and the time between car washes shortened as the free wash opportunity approached (Schroeder & Fishbach, 2015). Therefore, as people see and are recognized for the progress they make, they are more likely to pursue and achieve their goal.

The existence, relatedness, and growth (ERG) theory builds on Maslow's Hierarchy of Needs (Alderfer, 1972). Clayton Alderfer simplified the approach by disconnecting the elements from depending on each other, making the needs no longer a hierarchy. Instead, he proposed that the needs are on a continuous spectrum (Tsounis, Sarafis, & Bamidis, 2014). The existence need covered Maslow's physiological and safety needs, it stood for safety and security, which produce feelings of comfort for humans.

The next major need, relatedness, meant that people seek out relationships and care about social settings. This identified by Maslow's love, belonging, and esteem needs (Schroeder & Fishbach, 2015). The third need, growth, meant that humans pursue achievement and fulfillment in their activities; they want to feel whole through contributing to their environment and their own well-being. This parallels with Maslow's self-actualization and transcendence (Alderfer, 1972; Tsounis, Sarafis, & Bamidis, 2014).

Process theories.

Valence-instrumentality-expectancy theory, or VIE theory, establishes that people attempt to predict the future and create expectations according to the events' perceived likelihood (Vroom, 1964). When events are reasonably likely and attractive to people, they may evaluate how well they can contribute to the expected outcome. If the people feel they can influence the likely outcome of an event, they would be motivated to act to make that future event come true (Damij, Levnajić, Rejec Skrt, & Suklan, 2015). Valence means the value of the outcome to the person. Instrumentality means that the person has a clear path to the outcome—that completing certain actions will lead to accomplishing the goal (McClelland & Liberman, 1949). Expectancy stands for the belief, based on perceived capability, that the person can complete the necessary activities (Vroom, 1964).

The goal-setting theory indicates that people prefer to work on goals; they are motivated to do so if they are involved in the goal setting process (Locke & Latham, 2015). Such goals need to be clear with understandable steps for completion (Latham, Brcic, & Steinhauer, 2017). They also need to be challenging to be stimulating. Finally, the person needs to feel that the goal is achievable, that they are not likely to fail (Tsounis, Sarafis, & Bamidis, 2014). This theory also touches on our need for feedback. We become encouraged and motivated when we receive feedback on our progress toward goals (Schroeder, & Fishbach, 2015). Feedback can be self-talk or comments from other people. Negative feedback in self-talk can be just as demotivating as external feedback.

Affect perseverance claims that emotional preference initiates a motivational process; however, after the original reasons for the emotion are invalidated, the emotional preference continues (Sherman & Kim, 2002). The motivation is generated by an emotional reaction to thoughts, but it remains associated with the emotions even after the rational foundation for the thoughts disappear (McQuilkin, 2014). The motivation produced can then be redirected to another activity, which is not related to the original thoughts.

Escape theory claims that some of the activities people feel motivated to complete provide them with a distraction—or escape—from reality of their own lives, or displeasure in some way with their own character (Schoenleber & Berenbaum, 2012). Some of the escape mechanisms can be relatively harmless, such as sports or hobbies, but some may be hazardous or fatal. Overindulgence in drugs or extreme sports can represent a high-risk escape activity (Damij, Levnajić, Rejec Skrt, & Suklan, 2015). Schoenleber & Berenbaum (2012), authors of the theory, initially focused on dysfunctions connected with body esteem and resulting activities including irrational thoughts, binge drinking, among others.

Festinger's theory on cognitive dissonance suggests that an uncomfortable feeling of tension between two conflicting ideas or thoughts can be motivating (Festinger, 1957). The mental dissonance may increase with the importance of the subject to the individual, with the level of conflict among the ideas, or the inability to resolve or explain the conflict. Cognitive dissonance leads to change of behavior—or justification of existing behavior—based on resolution of the mental conflict (McQuilkin, 2014; Schroeder & Fishbach, 2015). Festinger (1957) studied a cult, where members upon arriving at an unfulfilled prophecy could not accept that the cult theology was incorrect. Instead, they resolved the cognitive dissonance by an alternate explanation of events around them.

Another theory is the overjustification effect. Greene, Sternberg, and Lepper (1976) conducted an experiment by playing mathematical games with children. Initially, the children seemed to enjoy the games. After some time, rewards were given away to the children for achieving success in the games. When the rewards were taken away, the children stopped playing the games. This phenomenon was called overjustification effect (Levy, DeLeon, Martinez, Fernandez, Gage, Sigurdsson, & Frank-Crawford, 2016). The researchers explained that the children had reasoned that they were playing in the first place for the rewards, even when the games were intrinsically rewarding at the beginning.

The investment model is a theory developed by Rusbult (Uysal, 2016). Rusbult submits that people are motivated to stay in relationships based on commitment. This commitment depends on the balance of a relationship's costs and rewards, as well as its comparison with potential other relationships. A large component of this equation is the investment already made in the current relationship in terms of financial, temporal, and emotional cost (Edwards, Gidycz,

& Murphy, 2015). This means that when people are asked to invest heavily in a process, they are more likely to be motivated to stick with it.

Reactance theory states that people are motivated to do things when they are told not to (Pennebaker & Sanders, 1976). When a behavior is prohibited, people experience an uncomfortable feeling, or reactance. In order to practice or test their freedom to choose, people are likely to perform the action, which in turn releases the feeling of reactance (Brehm, 1966). Pennebaker and Sanders experimented with signs on college campus bathrooms. The first sign instructed students not to write on walls, while the other one requested politely not to do so. The bathrooms with the controlling language and order style expression resulted in significantly more graffiti on the walls as opposed to the bathrooms marked with the request style sign (Pennebaker & Sanders, 1976).

The side-bet theory claims that our future choices are based on a number of choices we already made (Aranya & Jacobson, 1975). Side bets are smaller, dependent decisions, which are expected to become successful if the main commitment activity succeeds. If the main activity fails, the side bets are believed to be doomed. Therefore, the smaller bets contribute to the commitment to the main bet (Lam & Rahma, 2014). Aranya and Jacobson (1975) studied computer systems analysts and their commitment to the company and the job. They found that age, salary, number of children, and marital status played a large role in commitment to employment. Older individuals with longer tenure and higher salaries made many decisions and bets around family and marriage, which were dependent on the employment, which increased their commitment.

The self-determination theory states that people sense either an external locus of causality or an internal perceived locus of causality (Ryan & Deci, 2000). The theory provides three domains that satisfy universal psychological needs: autonomy, relatedness, and competence. Today the theory is used in such diverse industries as education, management, gambling, and video gaming in order to create habits, create behaviors, and motivate to action (Hofacker, de Ruyter, Lurie, Manchanda, & Donaldson, 2016; Aguilar, Fishman, & Holman, 2013; Kanat-Maymon, Benjamin, Stavsky, Shoshani, & Roth, 2015; Williams et al., 2014; Evans, 2015; Weiyun & Hypnar, 2015; Rodriguez, Neighbors, Rinker, & Tackett, 2015; Langan, Lonsdale, Blake, Toner, 2015).

Ryan and Deci (2000) break down the self-determination theory into six domains: cognitive evaluation, organismic integration, causality orientation, a set of basic psychological needs, goal contents, and relationships motivation. Cognitive evaluation means motivation in people that causes them to act in life without external encouragement (Ryan, 1982). An example could be a child that plays and explores without receiving external punishment or reward.

The second element of the self-determination theory is the organismic integration (Deci & Ryan, 2014). This means that people, in addition to the above intrinsic motivation, are also motivated by extrinsic factors (Wierts, Burns, Santin, Mack, Blanchard, & Wilson, 2015). They often internalize such social elements as values, goals, or belief systems, and as they adopt them, they are motivated by them. A spectrum of external motivators includes external regulation, introjection, and identification (Ryan & Deci, 2000; Damij, Levnajić, Rejec Skrt, & Suklan, 2015).

The third part of the self-determination theory is causality orientation (Ryan & Deci, 2000). Within this concept people act on ideas because they want to orient themselves toward the environment. The orientations may include valuing that which is occurring. There may be gains or approval available, or there may be anxiety concerning competence. These orientations are called autonomy, control, and amotivated orientation (Deci & Ryan, 2014).

The fourth element of the self-determination theory is the set of basic psychological needs (Ryan & Deci, 2000). In order to nurture psychological health and optimal functioning, people must satisfy their psychological needs. Three important needs are identified: autonomy, competence, and relatedness (Wierts, Burns, Santin, Mack, Blanchard, & Wilson, 2015). Ryan and Deci (2000) argue that such needs are cross-developmental and cross-cultural, but that they require validation and refinements.

The fifth element of the theory is goal contents (Ryan & Deci, 2000). Goals can be both extrinsic and intrinsic. Both types of goals can motivate. Extrinsic goals are associated with lower wellness and include financial success, popularity, and appearance (Gunnell, Crocker, Mack, Wilson, & Zumbo, 2014). Intrinsic goals such as close relationships, personal growth, and community lead to greater well-being (Deci & Ryan, 2014).

The sixth and final element in self-determination theory includes relationships motivation (Edwards, Gidycz, & Murphy, 2015). People not only benefit from high-quality relationships, but according to Ryan and Deci (2000), they also require them to satisfy the need for relatedness. In relationships involving romantic partners, best friends, or those belonging to a group, people satisfy their psychological needs (Wierts, Burns, Santin, Mack, Blanchard, & Wilson, 2015). High-quality relationships are further defined where members of the relationship support all three needs discussed in other elements of the self-determination theory (Damij, Levnajić, Rejec Skrt, & Suklan, 2015). When partners support each other's autonomy, competence, and relatedness, such relationships become high quality relationships (Ryan & Deci, 2000).

Challenges in STEM Education and Industry

STEM means Science, Technology, Engineering, and Mathematics. These fields are central in creating fast-growing occupations (National Research Council, 2012). Between 1950 and 2009, the annual growth in STEM was 5.9% with the general workforce growth of 1.2% (National Science Foundation, 2012). The 2016 U.S. News/Raytheon STEM Index reported a 28% growth since 2000 in STEM jobs compared to 6% in all fields (Neuhauser & Cook, 2016). However, at the academic level some reports showed that only 33% of U.S. students in the fourth grade and 26% of students in eighth grade met the learning objectives in mathematics (National Research Council, 2011). Therefore, some researchers conclude that the current state of secondary and post-secondary educational institutions may have a negative impact on the U.S. economy. In 2012, the President's Council of Advisors on Science and Technology made it a national priority in the United States to produce more graduates in STEM, who could attend to the nation's needs in technology industries. Focus was put on retention of students in STEM fields. This was cited as a low-cost solution to employment gap of STEM educated professionals (Erdogan & Stuessy, 2015).

According to the U.S. Department of Education (Chen & Soldner, 2013), the National Science Board warned in 2010 that historical leadership of the U.S. in scientific and technological innovation was being challenged. The retention of STEM talent was characterized as fierce competition. At the same time, the performance of U.S. elementary and secondary students in math and science lagged behind many nations (Provasnik et al., 2012). This pattern included the rates of U.S. undergraduates choosing STEM majors. The National Science Board report (2012) also indicated that the United States had one of the lowest ratios of STEM major versus other major bachelor degrees in the world. Some reports indicated that well-qualified students, with some estimated potential to be leaders in STEM industries, purposely abstained from careers in STEM (Chen & Soldner, 2013).

The U.S. government undertook a number of campaigns to boost the nation's capacity to produce STEM professionals. The 2009 "Educate to Innovate" campaign (The White House, 2016) aimed at increasing participation and performance of students in STEM majors. Other important reports urged the increase of the number of graduates as well as their diversity (National Research Council, 2012). The U.S. Department of Commerce urges that STEM jobs would grow at 17% in the decade between 2008 and 2018, while other employment may grow at 10% (Langdon, McKittrick, Beede, Khan, & Doms, 2011). The President's Council of Advisors on Science and Technology (PCAST, 2012) had tasked higher education to produce more STEM graduates in the current decade if the United States was to stay competitive in global, dynamic economy. The Council called for 1 million more professionals in STEM over the currently projected number.

Reported problems in STEM college introductory courses went beyond academic performance. Student attendance in higher education lectures had become an ongoing problem, despite the use of modern teaching methods (Kelly, 2012). Problems such as low achievement, student boredom, and alienation, along with high dropout rates were linked to engagement (Fredricks, Blumenfeld, & Paris, 2004; Swap & Walter, 2015). Especially in the STEM fields, those problems are escalated by high attrition rates (Chen & Soldner, 2013). One White House report shows that students leave STEM for many reasons including experiencing an uninviting atmosphere, participating in weed-out classes, and discovering that courses demonstrated no relevancy (Lander & Gates, 2010). Student engagement was shown to be linked statistically to the rate of student graduation (Price & Tovar, 2014).

As far back as 1997, STEM fields were considered by peer-reviewed research as unwelcoming and even chilly (Christe, 2013). Some difficulties were attributed to the subject matter itself, but the viewpoint of professors in STEM also carried criticism. Students reported feeling humiliated and insulted by professors. Some learners described an absence of positive relationships with faculty members. Faculty was reported as being insensitive to student learning and personal needs, which together promoted an antagonistic long-term relationship.

While faculty focused on producing high-quality graduates, they also contributed to a high level of attrition in STEM fields in academically weaker students (Christe, 2013). Faculty sometimes viewed student withdrawal from STEM majors as a sign of successful instruction. The STEM introductory courses were viewed as a gatekeeping process to spare unfit students from the rigors of scientific work. This approach contributed to fewer graduating students—students who perhaps were not yet ready for STEM, but may have had qualities and skills that needed to be still developed (Yeager & Dweck, 2012).

Other components of the negative faculty viewpoint, which focused on existing student talent and led to fewer STEM graduates, were beliefs that students dropped out despite quality of the instruction, actions of educators, or actions of schools (Micari & Pazos, 2012). Educators further believed that working hard in solitary was the recipe for academic success. Therefore, faculty often focused on student talent as a primary force to be successful in STEM, while dismissing the power of positive mentoring relationships and building up skills in weaker students. This would echo the concept of a fixed mind-set in research of Yeager and Dweck. Fixed mind-set leads to more frequent failures than a growth mind-set approach (Yeager & Dweck, 2012).

Despite faculty views on academic success being dependent primarily on predisposition of students, a number of studies underlined a different story. Reports provided analytical evidence showing that low-performing students or underprepared students made up an equal part of the STEM exiting group as the high-performing students (Marra, Rodgers, Shen, & Bogue, 2012; Wagner, Christe, & Fernandez, 2012). Micari and Pazos (2012) suggested that despite scientific evidence, faculty underestimate or overlook their own involvement and importance of student-faculty relationships. On the other hand, in some studies, faculty members outside of the student major influenced the persistence of students in staying within their initially selected major (Pascerella & Terenzini, 2015).

Studies found that student background plays some role in a decision to drop STEM as a major of study. Women, underrepresented minorities, first-generation students, low-income students, and those with weaker academic backgrounds left STEM fields at higher rates (Chen & Soldner, 2013; Stinebrickner & Stinebrickner, 2011). The report also identified attitudinal factors as motivation and self-beliefs in the capacity to learn the subjects as increasing the risk of attrition (Chen & Soldner, 2013). In a study based on a calculus course, women were found to be 1.5 times more likely to leave the STEM major compared to male students (Ellis, Fosdick, & Rasmussen, 2016). The reason investigated was lack of confidence in possessing the necessary mathematical skills.

Another set of reasons for student attrition included negative experiences in gatekeeper courses. Eagan, Herrera, Garibay, Hurtado, and Chang (2011) reported that large class sizes, lack of direct contact with instructors, language barriers associated with international faculty, faculty valuing research over teaching, and passive learning techniques contributed to such negative experiences in STEM. In addition, poor experience, especially for women and underrepresented minorities, may be caused by the perceptions of the culture at the institution (Chang, Eagan, Lin, & Hurtado, 2011; Espinosa, 2011). Feelings of isolation in STEM may be caused by too few role models and mentors from the same minority group, as well as too few peers pursuing the study. Perceived discrimination in the STEM industry on the base of gender, race, and ethnicity (Joseph, 2016) were also a factor in minority students selecting and staying in the field.

The November 2013 statistical analysis report produced by the U.S. Department of Education covering a large data set puts STEM attrition in the context of other fields of study (Chen & Soldner, 2013). The report concluded that 28% of students initially chose a STEM major in four-year schools. Out of that number, 48% of bachelor's degree candidates left the STEM major within the first two years and 69% of associate's degree candidates.

However, comparing this attrition rate with other fields of study indicated similarities. For example, other majors like history or English showed similar results. Consequently, the urgency of STEM attrition and degree completion was not related to higher attrition in comparison to other academic fields. It was caused by the workforce needs in the United States and professional career opportunities for students.

The need for effective STEM education is present not just in the United States, but on a global scale. A recent international study found that only 5% of the population in 33 developed countries possesses high computer-related skills and only 30% can tackle medium-complexity tasks (OECD, 2016). In a study covering 215,942 participants aged 16 to 65, the Organisation for Economic Cooperation and Development conducted a job-related computer skill test. The tasks varied from simple, as in reply to all in an email, to advanced, scheduling a meeting room in specialized software based on multiple emails with requirements. The resulting four levels of technology proficiency grouped results into a spectrum of no computer skills to strong skills. The researchers warned that given the findings, governments should reconsider policies of digital economy, especially as it applies to e-government and online access to public services.

The American Society of Training and Development took a poll of 1,179 organizations and found that 79% of respondents reported a skills gap (Bridgeland, Milano, Rosenblum, & Civic, 2011). The skills gap reflected a difference in an organization's existing capacity and the capacity to achieve business goals. The obstacle was the availability of prospective employees who possessed skills and abilities to fill critical jobs. Without meeting its goals, the organization was unable to grow or compete in the marketplace. A report called "Across the Great Divide. Perspectives of CEOs and College Presidents on America's Higher Education and Skills Gap" (Bridgeland, Milano, Rosenblum, & Civic, 2011) indicated that a significant majority of leaders in various fields of business have called for more postsecondary degree completion in order to address the problem of skills gap with a belief that this will have a strong positive impact on the U.S. economy.

Even basic technology skills gained in introductory courses have some market value. A research sponsored by Microsoft, based on data from the U.S. Bureau of Labor Statistics, analyzed 14.6 million job postings in 2013 identified 20 most commonly required job skills. These skills were then projected on 60 position types with above-average growth potential and above average salary potential in future period of 2013-2020, possibly representing 11.5 million jobs. The findings show that Microsoft Office was the only software package in the top 20 skills and reported as number 3 on the list. It was also cited as a required skill more than five times as often as other, non-Microsoft software (Anderson & Gantz, 2013).

Burning Glass Technologies analyzed 25 million job postings in 2014 and 2015 (Burning Glass Technologies, 2015). Some of the most requested skills reported included writing, communication, and organizational skills across all job categories. Microsoft Office skills ranked in top 10 marketable job skills.

In addition to benefits in the U.S economy, studies have documented the impact of college credentials on the financial well-being of students. Even postsecondary certificate holders were reported to earn 20% more than high school graduates who did not have any postsecondary education (Carnevale, Rose, & Hanson, 2012). Other studies estimated that a bachelor's degree over a lifetime of the graduate may be worth as much as $2.8 million dollars (Carnevale, Role, & Cheah, 2011). An associate degree graduate earned on average 30% more than a high school graduate. Further, a survey by Business Roundtable reported that 75% of U.S. employers required new employees to have an Associate degree (Business Roundtable, 2012). Other employment projections indicated that by 2018, 63% of new jobs will require some college education (Carnevale et al., 2011).

Playing Games, Gamification, and Motivation

Deterding (2012) defines gamification as the use of game design elements in nongame contexts. Some of the most commonly used elements are points, achievements, levels, and leaderboards. Gamification has been applied in many fields, especially in business, and contributed to increase in use of services and changing of behavior (Cunningham & Zichermann, 2011). Extrinsic motivation demonstrated through badges and levels with points are implemented in parallel with intrinsic motivation based on autonomy, relatedness, and competence. While gamification of business activities is relatively a new concept, games are well established in human civilization as a tool for entertainment, education, and even survival

(McGonigal, 2011). Some of the well-established areas in modern times that have been using gamification for a considerable amount of time include marketing and education through the use of loyalty point cards, membership rewards, scholastic levels, degrees, and academic grades (Nelson, 2012).

The new emergence of game thinking in other industries can be associated with the availability and low cost of technology, personal data tracking, and prevalence of the game medium (Deterding, 2012). Some of the alternative definitions for gamification suggest that it is game thinking in practice (Werbach & Hunter, 2012). Gamification can be also defined as designing products, services, or systems as a video game designer would, to take advantage of human psychology. The definition of the term gamification is not yet agreed upon, and many researchers provide their contributions (Eickhoff, Harris, De Vries, & Srinivasan, 2012; Manna, Saha, & Geetha, 2012; McNeill, Charles, Burke, Crosbie, & McDonough, 2012; O'Mara, 2012; Rouse, 2013; Terlutter & Capella, 2013).

Vassileva (2012) suggests that gamification taps into a spectrum of motivation theories ranging from needs based, through social based, to rewards based. Needs-based theories include Maslow's hierarchy of needs, need-achievement theory, goal-setting theory, and self-efficacy theory. Social-based group includes social comparison and personal-investment theory. Rewards-based theories include expectancy-value theory and Skinner's reinforcement theory. Therefore, gamification fuses intrinsic and extrinsic motivation into an immersive experience (Ryan & Deci, 2000; Muntean, 2011; Richter, Raban, & Rafaeli, 2015). While extrinsic motivators, like money, can decrease motivation but increase performance, researchers call intrinsic motivation unreliable even if it can lead to higher satisfaction (Cunningham &

Zichermann, 2011). Therefore, a balance between extrinsic and intrinsic motivation is the goal of well-designed and well-implemented gamification.

A key piece of research in immersive experience and finding fulfillment in activities is found from the University of Chicago on the feeling of Flow (Csikszentmihalyi, 1991). Csikszentmihalyi pioneered the idea that in any activity a person will encounter tasks that are too easy and too difficult. Some may become boring; others may create anxiety (Damij, Levnajić, Rejec Skrt, & Suklan, 2015). The flow is a level of engagement, or level of positive emotions generated, when a person completes tasks that are challenging, while those tasks may lead to increased competency in a skill. Being aware of the reasons for anxiety and for boredom may help people to find more enjoyment and fulfillment in their work or life (Schroeder & Fishbach, 2015). Csikszentmihalyi (1991) applied this theory to many types of work and many levels of mastery. In a classroom, each student may have a different angle of learning to produce flow. This is why standardized curriculum is so challenging to apply to the entire class (Akutsu, Gordon, & Noguchi, 2014). Instead, students should be given a fair number of optional activities, which vary in difficulty. Pursuing those activities can help students to explore the subject matter and help to generate flow in them.

An important study for gamification was published by the American Psychological Association in 2014. The study reviews the emotional, cognitive, and social impact of playing video games (Granic, Lobel, & Engels, 2014). The study concludes that playing video games has benefits and a large potential for teaching new forms of thought and behavior. The research question was aimed at potential benefits of a wide variety of games, including violent shooter games, and whether playing these games may boost learning, health, and social skills. The purpose of the research was to provide a balance to already existing research in this area. The negative impact of gaming permeated the majority of research available to Granic et al.

The significance of this study is in the considerable contrast to the negative understanding of games in existing research. Games have been linked with addiction, aggression, and depression (Ferguson & Olson, 2013; Lemola et al., 2011). Such research sometimes was reactionary to tragic events such as the Sandy Hook Elementary School shooting (Obama & Biden, 2013), where $10 million was allocated by the government to investigate the negative effects of playing violent games. The significance of this research to gamification is in mitigating the negative perceptions of games not simply for entertainment but for other constructive use.

Granic et al. (2014) notes that while games had been studied historically, more recently video games provide a new platform for connecting people across geographical distances, social structures, socioeconomic standings, generation gaps, and even language barriers. Adaptive functions and benefits of play are well documented in developmental psychology by respected scholars as Vegotsky, Piaget, Erikson, Gottman and others. Therefore, the potential of technology-aided games is unique in history.

Industries based on games make up a large part of global economy. While a quarter of Americans view casino gambling as unfavorable, global gross profits in 2015 totaled $317 billion dollars, with $71 billion contributed by the U.S. market (Statista, 2016). Internet casino market in 2013 was worth $2.2 billion dollars; in 2015 it grew to $3.4 billion dollars. U.S sports markets in 2014 contributed $60 billion to the U.S economy. In 2014, 40% of top television shows were sports or contest shows (Ledford & Lawler, 2015).

Video games are a popular medium in entertainment today with $23.5 billion dollars spent on games in 2015 (Entertainment Software Association, 2016). The average age of a male gamer is 35 years old, compared with 30 years old in 2013 (Entertainment Software Association, 2013). Females make up about 41% of the sampled gamer population with the average age of 44 (Entertainment Software Association, 2016). On average, gamers have been playing games for 13 years. Gamers choose to play video games at the expense of other activities: 49% play fewer board games, 37% watch less television, 37% go fewer times to the movies. Forty-two percent of gamers feel that video games help them spend time with family. Seventy-five percent of gamers believe playing video games provides mental stimulation or education.

The following are the top five reasons why parents play games with their kids:

1. It's fun for the entire family: 88%
2. Because they're asked to: 76%
3. It's a good opportunity to socialize with their child: 76%
4. It's a good opportunity to monitor game content: 59%
5. They enjoy playing video games as much as their child does: 57%

Business processes designed through gamification, while tapping into psychology of motivation, can be addictive to the participants (Ledford & Lawler, 2015). Game motifs such as competition, challenge and strategy, levels of difficulty, timely feedback and scoring, practice without risk, and rewards contribute to considerable excitement and ongoing reinforcement (Cunningham & Zichermann, 2011; Nelson, 2012). This, in turn, can lead to persistent effort by the participant at the expense of other real-world activities.

The main difference between games and gamification is that in gamification the activities do not turn into a fully fledged game as a product (Deterding, 2012). Gamification reaches beyond the goal of entertainment by selective incorporation of elements into a gamefully designed system, which continues to pursue goals of the nongame environment. The system engages and motivates participants to reach the goals of the system designers (McGonigal, 2011). Recommended best practices in gameful design include game mechanics that provide feedback and reinforcement, pattern recognition, collecting, organizing, surprise and unexpected delight, gifting, flirtation and romance, recognition for achievement, leading others, fame and getting attention, playing the hero, gaining status, and nurturing and growing (Cunningham & Zichermann, 2011).

Hamari (2015) conducted a two-year experiment in an ecommerce environment to find out if electronic badges would increase user engagement, service profitability, and business goal commitment. The first part of the experiment measured user engagement without gamification tools for a year, and the second part measured the same system with gamification elements added in (Deterding, 2012; Hamari, Shernoff, Rowe, Coller, Asbell-Clarke, & Edwards, 2016). The first part included 1,410 users and the second 1,579. The results of the study suggest that users who participated in the operations of the online system with electronic badges were significantly more likely to act in the system and reach the business goals (Hamari, 2015).

The experiment was implemented in Sharetribe online system, which is an ecommerce system that allows for building user communities and trading services. The electronic badges encouraged participation and reaching business goals (Hamari, 2015). As a study limitation, the authors acknowledge that the activity of the non-gamified population in the first year of the experiment may have been limited by system adoption, networking, and other startup limitations. Once gamification, in the form of badges, was applied, the measurements and system activity also included some users from the non-gamified population (Hamari, Shernoff, Rowe, Coller, Asbell-Clarke, & Edwards, 2016). However, measurements were made on users who created accounts after the gamification was applied. Users who created accounts after gamification was applied were more likely to actively use the service, comment on listings, list goods for trade, post trade proposals, and complete transactions (Hamari, 2015).

Related concepts to gamification are *storification* and *includification*. Storification stands for using non-narrative elements, such as video, to create structure of a narrative story via video editing software (Morneau, Van Herreweghe, Little, & Lefebvre, 2012). Another application of storification is by weaving a storyline through semirelated or analogue concepts in the real world. Quantification relates to data collection and visualization in order to provide feedback and modify behavior (Whitson, 2013). In Gaming the Quantified Self, Whitson stipulates that quantification is a surveillance apparatus used in gamification in order to make gameful or everyday activities more fulfilling and fun. Includification means the integration of accessibility of digital material and increasing the inclusiveness and diversity of the gamer population (Barlet & Spohn, 2012).

The gaming industry has very specific concerns related to applying accessible options in software (Barlet & Spohn, 2012). The fear that accessibility features have the potential of breaking the functionality of achievements, enabling repletion bots, increase the cost of new game features, affecting technical certification requirements for gaming platforms are frequent considerations for game software companies. Universal Design principles are important; however, Barlet and Spohn admit that aiming at 100% of accessibility in the game industry, as is universally designed, is not realistic. They provide game developers with practical guidelines for player mobility, vision, hearing, cognitive, and other challenges.

Motivation in Higher Education

Motivation can be defined as a process to instigate and maintain a goal-directed activity (Vansteenkiste, Lens, & Deci, 2006). Student learning has been historically linked to motivation of either an intrinsic or extrinsic nature (D'Lima, Winsler, & Kitsantas, 2014). Intrinsic motivation was understood to be undertaken in pursuit of inherent interest or enjoyment. Intrinsically motivated individuals were not driven by physiological needs. Instead, their reward was the activity itself. In the case of learning, intrinsic motivation involved recognizing the rewards and experiencing them during the activity (Early, Rogge, & Deci, 2014).

Extrinsic motivation was defined as pursuing objectives to attain outcomes separate from the activity itself. Extrinsically motivated behavior followed the means-end structure, which is necessary for many outcomes that are separate from the activity and carry consequences (Vansteenkiste et al., 2006). Therefore, extrinsic motivation is required for some activities, which are necessary but do not immediately carry rewards. Extrinsic components in an educational environment can be positive such as in good grades, praise, or employment, or negative such as in low grades, limited goals, or affected scholarship or position (D'Lima et al., 2014).

Researchers further qualified the types of motivation in academic environments as the difference between autonomous motivation and controlled motivation (Vansteenkiste et al., 2006). Autonomous motivation covered activities governed by choice, which included intrinsic motivation and well-internalized extrinsic motivation (Ryan & Deci, 2000). Intrinsic motivation indicates a proactive, growth-oriented attitude (Edwards, Gidycz, & Murphy, 2015). The internal need and desire for the sense of competence is often an intrinsic motivator for learning (Damij, Levnajić, Rejec Skrt, & Suklan, 2015).

Controlled motivation was generated under pressure or coercion and demonstrated poorly internalized extrinsic motivation (Edwards, Gidycz, & Murphy, 2015). Classroom climate, as the interpersonal environment, was found to either support autonomous or controlled motivation (Early et al., 2014). The phenomenon of causality pleasure was found to be an intrinsic motivator. Such pleasure, resulting from the student initiating an activity and succeeding at it, was found to energize behavior in pursuit of competence and personal causation (Deci & Ryan, 2014).

The quality of student motivation was also linked to the content of the goals that students value (D'Lima et al., 2014). Such goals as growth, relationships, and community were linked to intrinsic motivation and student well-being. On the other hand, extrinsic goals of wealth, fame, and image related negatively to student well-being and adjustment. Intrinsic goals affect achievement, persistence, and student learning.

Vansteenkiste et al. (2006) write about autonomy-supportive learning contexts and controlling contexts. Autonomy-supportive contexts feature instructors who empathize with the perspective of the learners. They also allow choice and self-initiation, provide meaningful rational for limiting choices, and provide timely feedback (Schroeder & Fishbach, 2015). Controlling learning contexts pressure students to think, act, or feel. They feature salient reward contingencies, overly controlling language ("have to," "should"), deadlines, guilt-inducing strategies, shaming, and the use of conditional regard (Vansteenkiste et al., 2006). Autonomy-supportive learning environments were linked to benefits in academic competence, school achievement, and higher well-being (Ryan & Deci, 2000).

Some studies compared cognition in student learning to motivation. In relation to cognition, the studies found that motivation was more likely to undergo an adjustment; therefore, it was most often selected as a tool for increasing student academic performance (Täht, Must, Peets, & Kattel, 2014). Teacher-student interpersonal relationships can affect motivation and across cultures develop positive academic motivation (Maulana, Opdenakker, & Bosker, 2014).

Student success and motivation depend on need-supportive teacher-student interactions (Stroet, Opdenakker, & Minnaert, 2013). Such interactions follow the intrinsic motivation principles of the self-determination theory in the area of relatedness as the teacher-student interactions are encapsulated within teacher-student relationships. When student needs are supported, student motivation is positively influenced. Positive influence of motivation then leads to engagement, which results in increased quality of student participation in learning activities (Opdenakker & Minnaert, 2011).

College level students are also influenced negatively by external agents. More specifically, parents, who might have been a positive influence in earlier developmental stages, and supported the motivational needs of younger children, sometimes do not adjust according to the student developmental level (Kriegbaum, Villarreal, Wu, & Heckhausen, 2016). In such situations, assistance in the problem-solving process was found to inhibit goal attainment when it was discharged in a directive or controlling way instead of in an autonomous approach (Gorin, Powers, Koestner, Wing, & Raynor, 2014). Motivational process was found to be key when college students faced difficulties in dealing with important problems like graduating from college, handling work or extracurricular distractions, or the setbacks of receiving a low course grade (Hamm et al., 2013). However, some parenting styles that included permissiveness or parental lack of involvement with college level students showed some evidence of student amotivation in academic pursuits (Alt, 2014).

Cultural components affect student motivation. Motivation in college level courses is a concern to researchers not just in the United States, but also abroad (Aubrey & Coombe, 2011). Students in United Arab Emirates were found to encounter motivation and engagement as main obstacles to success. Else-Quest, Mineo, and Higgins (2013) found that student motivation was strongly associated with achievement in math and science and related to gender, culture, and ethnicity. African American males were found to be less motivated than females. Researchers identified community attitudes, where "acting black" did not go along with high academic achievement. Cultural background continues to play a role in student motivation in subjects such as science (Emdin, 2011; Emdin & Lee, 2012).

A study of 537 Chinese undergraduate students considered the benefits of intrinsic motivation. Some findings indicated that intrinsic academic motivation had a positive impact on self-reported depression and stress (Yunhui, Wei, & Jiang, 2016). Academic intrinsic motivation was linked with general well-being in students and resulted from inherently rewarding experiences such as studying for a course without the need for extrinsic reward.

Undergraduate students may have additional complexity with motivation in their academic study (Yunhui et al., 2016). As they struggle for an autonomous personal life and undergo anxiety in preparation for their professional careers, they undergo challenging psychological and psychosocial changes. Depression and stress may be part of the experience of the undergraduate student (Pintrich & De Groot, 1990). Involvement in arguments with others affects the self-determination element of relatedness and impacts intrinsic motivation (Reeve, 2012). Some associate conflict-based interactions with greater suicide risk (Hirsch & Barton, 2011).

Motivation in learning can be linked to engagement in three major areas: behavioral engagement, emotional engagement, and cognitive engagement (Fredricks et al., 2004). Behavioral engagement focuses on attendance and participation. A student may have good work ethics or diligence, which will cause them to complete all assignments in a class, even when the student is not engaged in the class and finds the class boring. However, completing extra-credit activities, especially activities that are not graded at all, demonstrates behavioral engagement. This is linked with achieving positive academic outcomes and preventing students from dropping out of school or their program of study (Finn, 1989).

Emotional engagement describes the reactions of students in the classroom or outside of the classroom to the teacher, other students, and the organization in the context of the class (Fredricks et al., 2004). Positive emotional engagement is further linked with creating ties to the institution and building the willingness of students to work (Finn, 1989). This engagement type can be measured by conducting surveys of students throughout the class and of the faculty. This engagement can be noticed by observers in the class and it can also be self-reported.

Cognitive engagement means the level of investment in learning that students demonstrate (Fredricks et al., 2004). It includes thoughtfulness and purposefulness in assigned tasks. It means exerting the necessary effort to comprehend complex ideas or master difficult skills. Skinner and Belmont (1993, p. 572) offer another view on the above three aspects of student engagement by focusing on engagement versus disaffection.

Skinner and Belmont suggest that engagement means intensity and emotional quality of student involvement in initiating and carrying out learning activities. When engaged, students select tasks on the border of their competencies, and such work is accompanied by a positive emotional tone (Csikszentmihalyi, 1991; Eickhoff, Harris, De Vries, & Srinivasan, 2012; Hamari et al., 2016). When given the opportunity, engaged students exert intense effort and concentration, along with enthusiasm, optimism, curiosity, and interest (Skinner & Belmont, 1993) toward their chosen task.

On the other hand, student disaffection means they are passive, they do not try hard, and they give up easily in the face of challenges. Such students tend to be bored, depressed, anxious, or even angry about their presence in the classroom. Sometimes they seem withdrawn from learning or rebellious toward teachers and classmates (Skinner & Belmont, 1993).

Motivation to learn along with the ability to learn can be also linked with important biological factors (Landers et al., 2015; Skinner & Belmont, 1993). Students must be physically and emotionally ready to learn. The brain needs to be able to process the information delivered in active or passing learning environments; otherwise, motivation will suffer. The correlation of successful learning has been linked to sleep patterns, hydration, proper nutrition, and exercise (Doyle & Zakrajsek, 2013). Perhaps the emotional readiness for learning is a strong foundation toward the gamification in the higher education concept.

Gamification in Higher Education

Gamification is making an entry into education, as it is in other industries, but it is already common for some teachers to use games in the classroom (Kapp, 2012). The modern student population is familiar with gamelike activities because they grew up with interactive media and video games (Glover, 2013). The most common gamification elements adopted in classrooms are digital badges and leaderboards (Acedo, 2014; Alvarez 2014, Gonzalez, 2012). A number of successful implementations in education of game design mechanics and gamelike techniques have been reported by researchers (de-Marcos, Dominguez, Saenz-de-Navarrete, & Pages, 2014; Stott & Neustaedter, 2013). Student engagement is notably increased by creating a failure-safe environment, where students can restart the game or experiment without fear of failure (Lee & Hammer, 2011).

Leaderboards help students to make a self-assessment as to the mastery of their own ability and provide a necessary reference point (Hoorens & Van Damme, 2012). When leaderboards provide an overview of the entire class performance, they point to opportunities for upward and downward comparisons (Christy & Fox, 2014). Leaderboards, as motivational tools, may pose a risk for some students by applying too much pressure despite any positive influence of superiority for those on top of such listing (Wells & Skowronski, 2012). Frequent comparison of academic performance on gamification electronic leaderboards led in some gamified classrooms to lower exam scores and a decrease in motivation (Hanus & Fox, 2015). Further, competition has the potential to diminish performance, cooperation, and problem solving, and to increase cheating (Orosz, Farkas & Roland-Levy, 2013).

Another gamification mechanism, electronic badges, were investigated to increase participation in an online course (Denny, 2013). The results suggested that students submitted more answers to questions and the duration of engagement was increased thanks to electronic badges (Cunningham & Zichermann, 2011; McGonigal, 2011). However, the quality of responses was not affected, nor was the number of authored questions or perceived quality of the learning environment. Denny (2013) further admits that students who did not use badges also submitted more answers than what was required, indicating that the activity itself might have been intrinsically motivated at its core.

McDaniel, Lindgren, and Friskics (2012) implemented an overlay of badges in the existing learning management system. The badges were to reward certain behaviors and provide comprehensive feedback to participating students and their classmates. Leaderboards were useful to some students, especially to discover badges that were otherwise hidden or badges that their friends were able to acquire. The authors concluded that the overall response of students in the course to the use of badges was marginally positive.

Leaderboards were also used in a study of a custom module in the Blackboard Learn Learning Management System. A group of 36 challenge achievements resulting in trophies and 7 participation achievements resulting in badges were randomly assigned to an experimental group (Dominguez et al., 2013). Participation in the gamification experience in the experimental group was at 44%. Some students expressed in comments that they did not enjoy the leaderboards among other competitive elements. Similar negative impact of leaderboards was recorded by Hanus and Fox (2015).

Dominguez et al. (2013) experimented with 36 gamified challenges delivered as PDF files and collected as screenshots in Blackboard Learn to discover the cognitive, emotional, and social impact of gamification. The gamified experience was sometimes abandoned by students when they developed a perception that the traditional version of the course would take a shorter time to complete (Cunningham & Zichermann, 2011). Analysis of the grades was inconclusive in demonstrating scientifically significant differences (Dominguez et al., 2013). However, the gamified group performed well on practical applications of knowledge, while poorly on written assignments covering the understanding of underlying theoretical concepts. The researchers concluded that the cognitive impact of gamification was not significant. So, while other metrics were not affected, Dominquez et al. submits that gamification may have "a great emotional and social impact on students."

Gamified educational systems appears to increase engagement, but student performance in gamified learning experiments seems to be difficult to influence (Goehle, 2013). Goehle suggests that while students put in extra effort to reach the gamified rewards, there was no evidence of increased academic performance. In a group of 29 students, 93% used the gamified tracking mechanisms to follow their progress, and 89% pursued gamified achievements. Li, Grossman, and Fitzmaurice (2012) built a GamiCAD system, which was a tutorial software with gamification elements. Results here also showed improved engagement, enjoyment, and 20-76% increase in speed of task completion.

A gamified quiz system for medical residents in preparation to certification exams was welcomed by students with 80% participation (Snyder & Hartig, 2013). With a 70% correct response rate and 30% of students requesting more questions, the project could be considered a success. It is unclear how the correct responses on the quizzes transferred into success at the certification examinations. This experiment supported the self-determination theory in making the quiz system voluntary.

Barata, Gama, Jorge, and Gonçalves (2013) conducted a two-year study on engaging engineering students with gamification. A master's level course was equipped with levels, scoring, leaderboards, challenges, and badges. The data was compared to the same course running for three years without gamification. The researchers found that attendance and participation was higher in the gamified version of the course. In addition, students considered the gamified course as more motivating, interesting, and easier to learn than other courses. Benefitting not just students, the study reports that faculty increased their posts by 373%, and the instructors were "getting excited" by the Multimedia Content Production (MCP) course game (Barata et al., 2013). Therefore, the reciprocal nature of engagement (Skinner & Belmont, 1993) is evident in this study along with the need to keep faculty engaged.

In a follow-up study, Barata, Gama, Jorge, and Gonçalves (2014) propose three types of student players with a goal to simplify the design of future gamification experiences that match such preferences. The researchers analyzed course activity data including grades, attendance data, and Moodle activity data. Three types of student players were identified: Achievers, Disheartened, and Underachievers. Achievers demonstrated the highest mean of final grades and highest attendance. The Disheartened demonstrated much lower grades but still high attendance; however, their performance fell drastically around day 45 and did not recover. The final group, the Underachievers, demonstrated the lowest grades and the lowest attendance. The study suggested that even in a gamified environment, various individuals or even groups respond differently.

A different study on game personalities provides a more detailed landscape of player profiles and includes strivers (achievers), slayers (killers or influencers), socializers, and scholars (explorers) (Robson, Plangger, Kietzmann, McCarthy, & Pitt, 2016). The four player types match self-determination theory in a more complete way. Achievers and killers are motivated by competence. Socializers are motivated by relatedness and autonomy. Explorers are motivated by autonomy and competence. Therefore, due to limited focus on grades and attendance in the above study, player personalities were limited to achievement profiles.

Cruz and Penley (2014) applied gamification to a college level course in a two-week activity called The Capitalism Quest for Knowledge. Students reported positive impressions of the competitive nature of the activity as a strong motivator. The researchers found a higher level of participation in the gamified review activity as compared to traditional in-class exercise.

Another successful application of gamification was conducted by Buckley and Doyle (2014). In this three-week exercise based on teaching the national taxation system, undergraduate students utilized an online learning intervention system. Researchers felt that through intrinsic motivation, participation was positively influenced and students built knowledge.

Some studies demonstrated mixed conclusions. Student learning seems to be more difficult to evaluate when positively affected, whereas student engagement and moderate improvement in learning outcomes are noticed (Ibanez, Di-Serio, & Delgado-Koos, 2014). Attali and Arieli-Attali (2015) suggest that results of gamification activities in learning environments may require longer periods of time to manifest as opposed to immediate test scores. Even a 16-week calculus course with gamification elements did not report a significant impact on student academic performance, but it did improve student engagement according to the researcher (Goehle, 2013). In terms of duration of gamification experiments, the enjoyment and usefulness of the novelty in gamified activities seem to decrease over time (Koivisto & Hamari, 2014).

One approach to applying gamification in education is to created an immersive experience based on having authority to modify either the curriculum, instruction, or both (Sheldon, 2012). In this approach, the classroom itself became an interactive, in-person game. Lee Sheldon, a professor at the Indiana University of Bloomington, redesigned his class by applying immersive techniques in completing quests, fighting monsters, and crafting papers. In his book, *The Multiplayer Classroom: Designing Coursework as a Game*, he writes about the success of this approach with the average earned grade increasing by a full letter grade from the previous year.

Another approach to an immersive gamification in higher education is the GradeCraft project from the University of Michigan (Holman, Aguilar, & Fishman, 2013). The software project was initiated to support an introductory course in political science. The goal was to increase student motivation and encourage mastery-driven learning. The online grading system allowed students to choose assignments for a 60% of the total course grade value. The remaining 40% were made up by traditional course activities. Innovative tools, such as a student grade predictor, student progress dashboard, and class standing, led to a positive adoption by students and faculty.

A study of GradeCraft system revealed that there is a correlation between the positive perceptions of students that led to greater motivation and adaptive outcomes available in a gamified grading system (Aguilar, Fishman, & Holman, 2013). Students felt encouraged to work harder, when they had affinity to the grading system. The custom Learning Management System, which GradeCraft became, supported student autonomy and feedback of student progress. The dashboards and other tools helped students to clarify complex decisions about assignments and their path towards mastery in the course.

In 2015 the GradeCraft project was awarded $1.88 million-dollar grant to pursue further development of the project (University of Michigan, 2015). Within the Transforming Learning for a Third Century program at University of Michigan, which was established to encourage faculty to develop innovative ideas for enriching student learning, $25 million dollars were set aside to spark creativity. The awards ranged from $100 thousand to $3 million dollars. The project was titled "Gameful Assessment in Michigan Education (GAME): Building a Community of Engaged Learners and Teachers Supported by GradeCraft".

In 2016 the project was in the 5th year of the pilot phase serving over 40 faculty from K-12 and Higher Education institutions (Lorenzo, 2016). 82 courses with 6,439 students were using the system. A goal of commercial availability was set for Fall of 2017. Currently the system is in beta availability (GradeCraft, 2017). The beta version offers such features as grade predictor, which allows students to set clear goals for their work. The features also include learning analytics for students to stay informed about their work and for instructors to track student progress and choices. In addition, badges are implemented to recognize achievement and a leveling system allows build coursework hierarchy. Finally, the use of leaderboards in the course or participation in them is optional to allow opportunities for competition.

Additional studies show evidence that gamification in education positively influences motivation, engagement, and performance (Burkey, Anastasio, & Sursh, 2013; O'Donovan, Gain, & Marais, 2013; Knautz, Göretz, & Wintermeyer, 2014). Teamwork is another improvement reported in educational environment aided by gamification (Bierre, 2012). A large enrollment course called Introduction to Digital Learning in the Secondary Classroom designed with gamification elements reported high levels of participation and persistence throughout the semester with student attendance between 83–100% and averages between 91–98% (Nadolny & Halabi, 2016).

The above studies demonstrate conflicting views on gamification and limited knowledge of the phenomenon. Granic et al. (2014) suggests that playing video games is beneficial when teaching new forms of thought and behavior. This would suggest that introductory college courses may be good candidates for applying gamification. However, some studies suggest a negative link between games and behaviors including aggression and depression (Ferguson & Olson, 2013; Lemola et al., 2011).

Landers, Bauer, Callan, and Armstrong (2015) continue with the recommendation for practitioners as a caution against unintended, immediate, and longitudinal consequences of gamification in education. Learners, as a diverse group, cannot all be motivated by the use of single tools as leaderboards. Leaderboards may motivate in participation but may decrease intrinsic motivation toward the course objectives. Some learners may be motivated through social context of games to fulfill needs of relatedness, while others may require achievement opportunities to address needs of competence. The goal for practitioners should be to find ways to support all of the basic psychological needs of learners in order to increase motivation and yield the desired outcomes.

Stott and Neustaedters (2013) performed an analysis of gamification in education and came up with four concepts that appear to make gamification projects in education more successful. These concepts are as follows:

1. Freedom to fail
2. Rapid feedback
3. Progression
4. Storytelling

Freedom to fail is linked to multiple lives given in games and an implied encouragement in games for experimentation without the fear for irreversible damage (Stott & Neustaedters, 2013). This approach encourages taking risks and shifting focus from final results back into the process of failure and learning. Formative assessment may be a modern academic recognition of this process. Freedom to fail allows students to explore the consequences of a wrong choice. A dynamic that facilitates freedom to fail is feedback, which must be provided in rapid cycles with low stakes in overall assessment.

Rapid feedback is linked to frequent and targeted assessment that supports learning (Stott & Neustaedters, 2013; Schroeder & Fishbach, 2015). In video games such feedback is provided from moment to moment, with a summary feedback at the completion of levels or other checkpoints. While classroom feedback can take the form of self-paced exercises, or question-and-answer activities, it may also be in the form of visual cues like a progress bar.

The next dynamic in gamification of academic activities is progression. This can be related to scaffolded instruction in modern pedagogy, the interest curve, or just in time teaching (Stott & Neustaedters, 2013). The goal is to support students by organizing information into categories to focus their attention and allow the possibility of a restart upon encountering failure. Such failure may not just be in academic performance, but perhaps in the knowledge of how to take the next step within the course progression (Deci & Ryan, 2014; Schroeder & Fishbach, 2015).

Storytelling, as the next dynamic in successful applications of gamification, has the potential of capturing imagination and ease memorization (Stott & Neustaedters, 2013). When facts are embedded in stories, they are easier for humans to remember. Stories weaved throughout the curriculum can put the learning objectives in a context to increase understanding of the practical value and increase engagement and motivation.

A gap in research of gamification in education is in the application of gameful design for courses with a goal of increasing engagement of students along with faculty. As suggested by Skinner and Belmont (1993), the reciprocal nature of engagement is also affected by the level of engagement on the part of the instructor. The expression *engaged professor* was developed to signal a positive change in the class, which led to increased student engagement (Gasiewski, Eagan, Garcia, Hurtado, & Chang, 2012). Gamification studies should focus on the affective domain of students and creation of gamification tools to engage instructors as well as students during the course.

The need in existing research of classroom engagement and games for learning is expressed as “dearth of studies that investigate the relationship between immersion and learning in game-based learning environments,” especially as it involves fantasy or storification in a course (Hamari et al., 2016). Also, Consalvo and Dutton (2006) mention that “more qualitative studies have been less forthcoming about how games were studied.” Researchers call for more qualitative studies to “extend our understanding of the nature of engagement in games” (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012). A gap emerges in qualitative studies of sufficiently complex practical solutions to address both faculty motivational needs and student needs to produce engagement without deep modifications to the academic structure of introductory courses.

With increased attention on gamification in education, while actual studies provide reports of mixed success, there is a need to explore the specific application of theories and outline the process of how gamification is to improve learning (Landers et al., 2015). Researchers have been recommended to carefully examine motivational theories while studying gamification instead of viewing gamification as a unique and altogether new technique independent of the established motivational theories. Gamification may be considered a packaging for a mixture of well-established, older theories, which work in specific educational applications. The new combination of tools based on motivational theories may provide a unique value (Deci & Ryan, 2014; Tsounis, Sarafis, & Bamidis, 2014; Damij, Levnajić, Rejec Skrt, & Suklan, 2015; Wierts, Burns, Santin, Mack, Blanchard, & Wilson, 2015).

This literature gap seems to be reflected also in educational practice. The New Media Consortium in collaboration with the Educause Learning Initiative produces an annual Horizon Report to indicate future trends for higher education. Reports before 2011, but especially 2011 through 2014, indicate game-based learning or gamification as strong trends. However, 2015 and 2016 reports omit these all together (Johnson, Smith, Willis, Levine, & Haywood, 2011; Johnson, Adams, & Cummins, 2012; Johnson et al., 2013; Johnson, Becker, Estrada, & Freeman, 2014; Johnson, Adams Becker, Estrada, & Freeman, 2015; Johnson et al., 2016). It appears that lack of tools for faculty as well as few models of application methods make gamification in the classroom a concept, which is difficult to implement. Reportedly, NMC CEO, Lerry Johnson, said in 2015 that gamification has not quite taken hold in the classroom (Smith, 2015). He adds: "We don't see it making the mainstream (…) For most people, it's just too hard to integrate and there are no tools to make it easier."

Summary

STEM professional fields in the United States are undergoing faster growth than other commercial areas, but the educational system is unable to produce qualified professionals to support employers (Langdon et al., 2011). This leads to a concern among the highest offices in the U.S. government about the nation's ability to stay competitive in the global economy, especially when it comes to innovation (President's Council of Advisors on Science and Technology, 2012). A charge is made to produce more graduates, but researchers identify student engagement, boredom, alienation, high dropout rates, STEM attrition rates, lack of diversity in student population, and faculty attitudes as obstacles (Fredricks et al., 2004; Swap & Walter, 2015; Chen & Soldner, 2013; Christe, 2013; Price & Tovar, 2014; Ellis et al., 2016).

Gamification is an attempt to package various motivational theories to provide a new value in modifying behaviors and encouraging people to reach their goals (Landers et al., 2015; Vassileva, 2012; Deterding, 2012). Elements of gamification have been adopted in business as rewards programs and other techniques (McGonigal, 2011; Cunningham & Zichermann, 2011;

Werbach & Hunter, 2012; Nelson, 2012). Some studies on playing games find that even playing violent games may boost learning, health, and social skills (Granic et al., 2014), which makes gamification an important candidate in being viewed as a positive force and an appropriate method of motivating people in contexts that previously may not have been associated with games.

One of such contexts, introductory college courses, often presents unique challenges to students and their learning (Yunhui et al., 2016). The challenges vary from undergraduate students' psychosocial difficulties associated with moving away from home, to motivational challenges, and even depression (Reeve, 2012; Hirsch & Barton, 2011). Previous attempts to experiment with gamification in higher education varied from positive reports (Kapp, 2012; Sheldon, 2012; de-Marcos et al., 2014; Stott & Neustaedter, 2013; Denny, 2013; Dominguez et al., 2013; Barata et al., 2013) to negative results (Hanus & Fox, 2015; Wells & Skowronski, 2012; Orosz et al., 2013).

Some studies suggest that grades are not improved through gamification (Dominquez et al., 2013). Instead, student affective domain can be influenced in a positive way as well as their social behavior. This is a significant finding, especially for application of gamification in introductory courses. While grades are generally important to students, the organization may hope for a positive first-year experience in terms of emotional response as well as creating mentorship relationships across introductory courses. The current literature on gamification in education tends to measure grades as the success-determining factor.

A research need is identified in finding unique combinations of gamification mechanics to engage not only students, but also faculty to create reciprocal emotional process promoting supportive relationships and classroom engagement (Landers et al., 2015; Skinner & Belmont, 1993). The complexity of the application should be sufficiently broad to include a variety of player personalities and cover many psychological motivation theories (Landers et al., 2015; Connolly et al., 2012). Tools to make such applications need to be developed and made available to practitioners in order to make gamification in education a mainstream approach (Smith, 2015).

Chapter 3: Research Design Method

The purpose of this case study is to explore and describe through mixed methods research the gamification of a STEM introductory college course, Introduction to Computing, at Grand Valley State University. The study included 501 students who contributed data in form of course evaluations, public review posts, as well as activity data available in a digital gamification system, peer-instruction system, and various cloud-based assignment systems. Gamification was applied to the course through custom software and gameful instructional design.

The research questions presented in this case study are as follows:

- Q1. How does gamification encourage engagement during lectures?
- Q2. How does gamification encourage participation in the activities during the entire length of the course?

Research Methods and Design

This case study was designed as qualitative research, or more specifically, as an exploratory single-case study, which has embedded multiple units of analysis (Yin 2014). A STEM course at Grand Valley State University was selected with a specific instructor and unique, innovative gamification system, which used gameful design of instruction over the period of three years. The chosen exploratory case study method seeks to describe how gamification in STEM education, a contemporary phenomenon, can encourage student engagement and participation.

The case study design was the most appropriate approach for answering the research questions. Investigating student engagement and participation in a gamified course requires consideration of the naturalistic setting in the interpretive style of qualitative research (Marshall & Rossman, 2016; Yin, 2014). Some recorded data was quantitative in nature, which follows

Yin's (2014) principals of mixed methods supporting case study research. In his 1981 definition of a case study, Yin suggests that any combination of such data as fieldwork, archival records, or verbal reports constitute evidence in a case study. It is this full variety of evidence that will answer the research questions and provide a rich description of the phenomenon (Yin, 2014).

As the above literature review demonstrates, there are many theories for motivation and gamification. Researchers admit that a need exists for models or examples in application of such theories within a specific context, applied as a package, and applied as a practical example, therefore requiring consideration of a case study (Landers, Bauer, Callan, & Armstrong, 2015; Vassileva, 2012; Deterding, 2012). The goal of qualitative research is to capture rich and descriptive information to provide a narrative of the phenomenon (Hancock & Algozzine, 2011).

While quantitative data can be collected in an educational context of a specific course, such data could not address the research questions. The focus of the research questions is not on the immediate results produced in terms of grades, but the focus is on the description of methods and techniques of gamification adoption. Measuring the levels of engagement quantitatively is beyond the scope of this case study. Instead, student perceptions that lead to engagement or participation, as well as affinity toward the subject matter, and STEM in general, was recorded and reported on by this case study.

Controlling all necessary variables in an educational quantitative case study may be too complex to evaluate and then generalized to larger populations. Yin (2014) suggests that case studies are generalizable to theoretical propositions, but not populations or universes. Further, Richard Feynman—a Nobel prize-winning physicist, in his book *The Pleasure of Finding Things Out*—notes the difficulty of quantifying facts, which are based on experience (Feynman & Robbins, 1999).

Feynman (1999) proposes that a hypothetical innovator in the field of mathematics may be given a class to teach with the hope that a new idea will improve classroom instruction. Such innovator may be likely to love his own new teaching idea and process, a process of which he is likely to understand very well and be excited about. Notably, his attitude and approach may be more important than the teaching idea itself. Therefore, it is possible that the students are learning more efficiently; however, they are doing so because of the attitude of the instructor, not the method itself. Feynman concludes that in the education field, many experiments are not well controlled, which means they are not repeatable.

This point is well illustrated by a recent study about instructor attractiveness and student learning. The study demonstrated that instructor appearance plays a statistically significant role in student learning (Westfall, Millar, & Walsh, 2016). In the experiment, Westfall et al. asked college students to listen to a 20-minute recording in an introductory STEM course while displaying a picture of an attractive instructor to one group, and to another group an instructor who was rated poorly for attractiveness. This was followed by a quiz. Students who believed that their instructor was attractive performed better in a statistically significant way.

Therefore, when it comes to innovating teaching or, in this instance, considering application of gamification in education, a case study approach seems most intellectually honest, where the delivered report provides a snapshot in time and experience within a unique context. The examination of the participants' stories, behaviors, perceptions, and beliefs, in the context of the phenomenon, provides data to elaborate on their emotions and the application of gamification (Hancock & Algozzine, 2011; Patton, 2015). Explanations provided are supplemented by direct quotations from participants, which help the case study to present the application of gamification from participants' viewpoint (Merriam, 2009).

Critics of the qualitative research sometimes point out that such research is difficult to replicate (Patton, 2015) or findings cannot be generalized to larger populations, or in the case of education, to other classrooms of instructors (Merriam, 2009). Since gamification is a developing field and existing research provides mixed results, it is necessary to better explore and understand the phenomenon before creating hypothesis for testing. It is qualitative research that holds the promise of providing rich understanding of the phenomenon in a specific context (Hennink, Hutter, & Bailey, 2011).

Population

This case study took each student as the unit of analysis. The population in this case study consists of students in the US enrolled in introductory STEM courses. This could consist of students from freshmen to senior standing in various majors of study. Grand Valley State University reported in 2016 a total of 22,081 enrolled undergraduate students, 58.5% female, 41.5% male, 89.1% full-time (GVSU, 2016). The Introduction to Computing course, in the academic year of 2015/2016, was reported to have 1,740 students enrolled (Table 1).

Table 1

Students enrolled in Introduction to Computing (CIS150) at Grand Valley State University

2012-2013	2013-2014	2014-2015	2015-2016
1,561	1,616	1,697	1,740

Sample

The sample of this case study consists of 24 sections of the class, over the period of 6 semesters, with each section varied in size between 24 and 40 students. This represents about

10% of the total University course offering in the Fall and Winter semesters from Fall of 2013 to Winter 2017. The total number of students participating in the gamification was 501. The selection of the sample out of the total of students, who registered for the class, was randomized based on student directed enrollment and instructor administrative assignment of the sections.

Materials/Instruments

In this research study, gamification was applied within the instruction of the course through a mobile app (Machajewski, 2013), which allows students to collect experience points (XP) by autonomous participation in lectures and after-class activities (Machajewski, 2015). Students accumulated XP by entering mission codes in the format of text entries or scanning QR codes. Such missions were assigned as an optional companion to the standardized and coordinated curriculum across multiple sections of this course.

In addition to missions, XP could be earned by completing optional assignments in the Cengage Skills Assessment Manager (SAM) system, Blackboard Learn LMS (Bb), Code.org, and CodeCombat.com systems. The systems were integrated into the app to report student progress into the game application. The course was awarded a Most Inclusive Classroom designation by Blackboard Inc. (GVnow, 2016) and the instructor earned an Exemplary Course Award in Instructional Design (GVnow, 2014; Blackboard, 2017). Gamification in this course included storification based on Viking culture and Amazon Alexa skill “Floki” developed for the course (Machajewski, 2016a). Further, inclusive teaching techniques were utilized to apply gamification principle of includification (GVnow, 2016; Machajewski, 2016b) and learning student names with the aid of Blackboard photo roster (Machajewski, 2016c).

XP became a class currency to be earned and to be exchanged for certain privileges in the course. Students from current or past semesters, under specific conditions, would recommend current students for the privilege of making up late assignments. Such assignments could be purchased with XP. XP could also be used for receiving a LinkedIn recommendation from the instructor. Additionally, XP could be converted into Exam Peace of Mind Points (PofM), which operated like extra credit. XP could improve the position of a player on an optimized electronic leaderboard. The rate of conversion between XP and PofM was determined for each student by their performance in the Boss Level event, which was a computer programming task. Finally, XP could have been lost, under specific conditions, such as absences in the class. The goal of the gameful design of the class is to inspire desire in students to play a good game instead of simply pursuing a grade. A well-played game carries positive experience and determination to prevent any spoiling of it by cheating (DeKoven, 2013).

The course involved 49 graded assignments, which consisted of exams, quizzes, hands-on activities, and projects. The core graded assignments were coordinated at the department level and unchanged in the gamified version of the course. In addition to the 49 graded assignments, 56 ungraded game missions were made available, as well as 23 ungraded hands-on assignments. The extra-credit amount resulting from the gamified Exam Peace of Mind Points, traded in through XP points, was limited to a maximum of 2% of the course total. The amount of extra credit was controlled by the rate of exchange of XP, which varied each semester, depending on the number of custom missions and total XP collected by students in the specific semester. The total XP collected in various semesters ranged from 900 to 1,700 XP. Further, the exchange rate for individual students depended on the their performance in the Boss Level mission.

The data in the study was entered by students in various electronic systems. Blackboard Learn was used for recording journals (Appendix A). The course reviews were facilitated by the IASystem, a service of University of Washington (Appendix B). Additional course and instructor reviews were entered in RateMyProfessor.com (Appendix D). The gamification software included a database of student activity represented by mission completion and a ledger of XP earnings and spending (Appendix E). Lecture participation was documented through Kahoot application results (Appendix F). Additional data sources were identified through activity reports from Code.org (Appendix G) and CodeCombat.com (Appendix H).

Blackboard Learn LMS journals allowed for enrolled students to create short stories readable only to the faculty. The journals contained a set of instructions to prompt students for reflective and formative feedback (Appendix A). The journals were not graded in the course.

The IASystem facilitated the creation and delivery of the University course reviews (Appendix B). The system worked outside of the control of the course instructor. Students received multiple email prompts to complete the course evaluations at the end of the semester. Questions in the course review system varied from numerical ratings to open-ended questions.

RateMyProfessors.com allowed students to post expressions outside of the University controlled technology. The system contains a list of entries for the specific instructor and course within the time window investigated by the study. The ratings were filed anonymously and were available to the public. The data entered in this system will provide a secondary source of course and instructor evaluations (Appendix E).

Kahoot is a peer-instruction system, where students use their smartphones to answer lecture questions. The results of a session were stored in form of a spreadsheet in the Kahoot cloud system (Appendix E). The results included the number of participating students, the list of questions, the individual responses of students.

Code.com (Appendix F) and CodeCombat.com (Appendix G) are online systems for learning computer programming with the assistance of automated tutorials. The systems allowed for user accounts to be grouped into classes. In turn, activity of each student was reported on.

Data Collection, Processing, and Analysis

Data for this case study was collected upon the approval of the IRB at Northcentral University and Grand Valley State University. The data included course evaluations (1002 comments by 342 students). In addition, the data collection included Kahoot results (189 reports), Code.org reports (194 records), CodeCombat.com reports (154 records), and student RateMyProfessors.com posts (182 records), which was documented and coded. The original data collected from the sources was archived in documents and sorted. The research data was extracted from documents and coded. This became a protocol to ensure consistency, reliability, and accuracy in recording findings. Anytime later, the archive data can be retrieved, recoded, or verified. The protocol refers to preserving the original data and creating a new set of documents in the form of notes, coding sheets, and drafts to analyze data.

Coding sheets developed for the qualitative data apply to three sources that contain text content: course reviews, and RateMyProfessors.com posts (Appendix C). The text content of each entry was analyzed and assigned a category or code. In turn, such codes became a summary of the content and a reference to the exact quotes in the sources. Quantitative entries from Kahoot, CodeCombat.com, and Code.org provided numerical data of time and effort put by students to underline the engagement and participation in the course.

Data processing took place in two major steps. First, the data was collected and coded to provide a systematic overview of the qualitative content through identifying themes. Priori codes, or codes developed before any data was reviewed, were used to initiate the process

(Appendix C). The codes were based on research questions of the study, self-determination theory, which is the background for the study, and finally themes likely to be present in the qualitative data based on key words.

The second step in data processing was a cycle of data sampling, improving categories, draft graphing of quantitative representations of the qualitative themes, and explanation building. The cycle in the data processing step is a key in providing rich description of the case study and identifying themes. New grounded codes were added to priori codes, or grounded codes replaced them, as meaning emerged from the analysis of the data.

Once the data was coded the resulting coding sheets enabled retrieval of emerging ideas and themes. The coding sheets were inserted into a Microsoft Access database to allow record manipulation, graphical representation of emerging themes, and further development of appropriate new codes. The emerging information retrieved from the database of codes became an evidence for explanation building and pattern finding. Each data source corresponded to a separate coding sheet (Appendix C).

Data analysis was performed through explanation building within the case study. Casual links were identified among the data by using the priori and grounded codes. Such codes represented labels for ideas in the text or categories of themes. Further, pattern matching was used in assessing collected evidence against expected outcomes (Yin, 2014). The analysis was performed to follow Yin's concept that a case study tries to illuminate a decision or set of decisions: why they were taken, how they were implemented, and with what results.

Official university-distributed course evaluations provided opportunity for archival research. The answers of students to open-ended questions gave insight into their perceptions of the course. The course evaluations allowed for thematic analysis (Hennink et al., 2011). In turn, this allowed for interpretation and identification of patterns within the textual data (Hennink, et al., 2011). The researcher followed connections between the data and emerging themes to capture the essence of the case study questions (Braun & Clarke, 2006).

Journals were used as a method for student reflection based on their engagement and participation in the course. This open-ended forum allowed for personal expressions, opinions, and feelings delivered in participants' own words (Patton, 2015). Kahoot results, Code.org, and CodeCombat.com were stored in form of spreadsheets in the respective vendor systems. Finally, course evaluations, submitted by students anonymously through the university-controlled system and RateMyProfessors.com reviews were collected and coded (Appendix C).

Within the qualitative content analysis certain analytical rules were followed without rash quantification (Mayring, 2000b). The central part of this approach was the system of categories, where each unit of analysis was coded or allocated to categories. Categories were driven by the research questions and include expressions about the evidence of student engagement in the short-term lecture approach (Q1), and expressions about and evidence of long-term course participation (Q2). The current categories and coding were a starting point and were maintained during data analysis as part of feedback loops between coding data, interpreting the data, and revising categories as needed. The text data in this case study requires context, the latent structures of sense are important in the relatively short commentaries. The meaning in such reviews may not be contained in the text itself, but in the qualitative interpretation.

Validity and reliability was ensured in the coding process by establishing a cycle of revisions. The coding process can be considered reproducible and accurate, when the meaning of the source materials reflects the categories assigned in the coding sheet. The subjective interpretation of the content of the text data was necessary and it led to identifying themes and patterns (Hsieh & Shannon, 2005).

Assumptions

This research study acknowledges a number of assumptions. It is assumed that students providing feedback in course reviews, journals, and other sources were not deceptive with their answers. Instead the assumption exists that the participants answered questions honestly and to the best of the ability. Since end-of-semester course reviews are a common practice at the University, students are likely accustomed to providing feedback in an anonymous way without repercussions. Also, since their grade is not dependent on such feedback they may feel comfortable in suggesting improvements in the course and noting positive areas. Some data sources as journals are not anonymous, therefore the assumption is made that some of the negative feedback may be withheld.

Feedback available on RateMyProfessors.com can be posted by the public, which makes it more anonymous, than University reviews. It would be technically possible for an authenticated user to be tracked based on their IASystem review. The publicly accessible and having no affiliation with the University RateMyProfessors.com may be viewed by students as safer and untraceable. It is assumed in this research study that a single student didn't submit multiple reviews or that people who did not participating in the course abstained from posting content.

It is assumed that this study is an accurate representation of the current situation in West Michigan Higher Education environment. The geographic location of the research environment, just west of Grand Rapids, Michigan, provides a representative institution. The institution is a Higher Education institution with 24,000 enrolled students.

It is further assumed that students were assigned at random into the gamified course. Some students might have selected the instructor based on peer recommendations or public posts on sites like RateMyProfessor.com. The participants were not recruited in any special manner.

Another assumption in this study involves relative lack of technical difficulties in operation of the gamification techniques. Since many digital systems are involved, including iOS mobile app (Machajewski, 2013), Android mobile app, Blackboard Learn, Cengage SAM (Cengage, 2014), Kahoot, Quizlet, Amazon Alexa, and others, some difficulties or opinions could be built on operational problems. Qualitative reports of affinity or engagement could possibly suffer due to technical difficulties and not design problems.

Limitations

A few limitations were present in the study. The accuracy of student course evaluations may be flawed, based on confusion between courses. It is possible that students respond to multiple surveys facilitated by the university at the end of a semester and an incorrect course may be evaluated.

While the end-of-semester evaluations were anonymous, the journal entries were not. It is possible that students may limit their criticism knowing that their expressions are associated with their name and visible to the instructor before the end of the course. Another form of limitation exists in the RateMyProfessors.com system as some entries may not be authentic. The system is open to the public and no guarantees are made that users who did not take the class left some reviews.

A limitation of end-of-course evaluations was a possibility of students reviewing the wrong course. Some evidence of this happening was found during qualitative content analysis. For example, this response to an open-ended question indicates a wrong gender of the evaluated instructor: “She went in depth with every topic that we were discussing in class. She gave many examples so we would understand and if we had any questions she would answer them the best she could. She would ask if we had any questions before we started class and constantly throughout the lecture. She would post extra videos on blackboard if people were interested in further research of the topics being discussed.”, “I thought my instructor did well in the course and did everything she needed to do for her students to be successful. She always offered help outside of class if we needed further explanations.” Other indicators of students evaluating the wrong class included comments about when assignments were due and about Power Point presentations used in the class. Since in this class all assignments have always been due on Sunday at midnight and Power Point is not used, some inconsistency exists. However, this inconsistency was marginal in numbers.

While the end-of-course evaluations were meant for anonymous and confidential communication, some students had the perception that other students would read the comments, similar to RateMyProfessors.com. When asked the question “This is the first semester for the CIS Success Center, what suggestions or comments do you have for us as we plan for next semester?”, a student responded “Didn't go, take szymon and you won't have to.”

The limitations were mitigated by critical thinking process applied to the coding of the entered data. If the entry indicated a mistake it was marked. In this case, a protocol was used to mark the entry on the coding sheets as rejected. In turn, the rejected entries were not included in the analysis process.

Delimitations

The purpose of this case study is to explore the application of gamification in a STEM introductory college course. The choice was made for an exploratory case study approach.

Instead of measuring performance in the course based on grades, the focus of this study was on the experience of students and their qualitative feedback. Further, introductory courses often present unique challenges in covering multiple sections with mandated curriculum and limited flexibility left to the course instructors. Therefore, the research questions set a scope of the study to describe the methods of promoting engagement and participation by gamification instead of measuring student performance.

Comparison of a gamified course against a traditional course is outside of the scope of this research. The effectiveness of classroom instruction is dependent on many variables, which post practical challenges in controlling them in order to evaluate instruction effectiveness. The generalization of this case study is to theories, not larger populations (Yin, 2014). Further, the generalization is analytical in nature, therefore not enumerating frequencies for a statistical generalization.

Ethical Assurances

Kim and Werbach (2016) suggest that applying gamification to fulfill the goals of the designer may lead to exploitation or manipulation, or may even have an effect on the moral decisions of involved parties. While a gamification definition developed by the Gartner Institute (Burke, 2014) proposes that gamification is the use of game mechanics and experience design to digitally engage and motivate people to achieve their goals, it is important to admit that the goals of the game participants and the designer goals may not all overlap. The objectives within the game are artificially modified to accommodate strategic goals of the instructor and academic organization.

The current ethical dilemma is whether the strategic goals of retention in STEM programs or positive emotional approach to the subject matter are in the best interest of all participants. Given the problems in the industry culture of STEM workplace, it is not clear if encouraging girls to take up work in STEM is in their best interest. Journalists alert that “women leave technologies in droves” (Lie, 2015). This may also be the case for other populations, which are not yet covered by studies.

This case study in gamification of introductory college courses leverages autonomy as a main driver of the self-determination theory (Ryan & Deci, 2000). Within the study, the gamification in the course is always optional. While students may have a limited choice of enrolling in the class or dropping the class, only the standard curriculum guided by the coordinated syllabus is required. Therefore, while participation in the class is not optional, participation in the gamification is guided by informed and ongoing consent.

The risk of applying gamification to an educational environment in this study is mitigated by retention of the standard curriculum. While research studies are being published both in support and against gamification (Faiella & Ricciardi, 2016; Hanus & Fox, 2015), the lessons learned point to a design challenge. This applies the entire scope of the self-determination theory including autonomy, relatedness, and competence.

In this case study, the rigor of the competence element is maintained by the same assessment tools as used in other sections of the course without gamification. Further, in previous studies of gamification, screenshots were used to show evidence of completed work (Dominquez et al., 2013). In this study, the Cengage SAM system is utilized (Cengage, 2014), which requires demonstration of skill in an emulated Microsoft Office environment. The progress in this environment is used for both standard examinations and gamified activities.

Summary

This research was designed as an exploratory case study to provide a rich description of a contemporary phenomenon, which is gamification in education. The focus of the research questions was on engagement and participation of students in STEM learning activities. The naturalistic setting and interpretive style aimed to provide a rich description of the evidence and narrative of the phenomenon (Yin, 2014; Marshall & Rossman, 2016).

The sample of the case study was extracted out of a larger population of students in the US, who are enrolled in the STEM courses. The sample consists of about 501 students enrolled in a gamified version of the Introduction to Computing course at Grand Valley State University. Materials and instruments used in the case study include gamification software developed specifically for this course. The software included a mobile app for multiple operating systems and a web based infrastructure to support student collaboration and subject matter exploration. Experience points were tracking student practice, failure, and exploration of non-graded activities.

The data was collected from the course evaluations, Kahoot results, Code.org reports, CodeCombat.com reports, and student RateMyProfessors.com posts. The data was coded and sorted according to qualitative content analysis principles. A coding cycle ensured revisions and appropriate selection for codes. As themes and ideas emerged, the analysis allowed exploration of the phenomenon.

Chapter 4: Findings

The purpose of this qualitative case study is to explore and describe the gamification of a STEM introductory college course, Introduction to Computing, at Grand Valley State University. The findings will demonstrate emerging themes and patterns obtained though qualitative content analysis. Following the connections between the qualitative data and reporting the results will address the research questions:

Q1. How does gamification encourage engagement during lectures?

Q2. How does gamification encourage participation in the activities during the entire length of the course?

Trustworthiness of the Data

The data in this exploratory case study is made up of 1002 comments made by students in course evaluations, 182 RateMyProfessor.com entries, and activity data collected from the custom gamification system, Cengage Skill Administration Manager (SAM) system, Code.org, and Codecombat.com. The 1184 comments were processed through qualitative content analysis to produce categories, which resulted in 331 extracts grouped based on emerging themes and patterns. The categories were adjusted in a cycle of revisions following the patterns found in the data.

The two main sources of qualitative data in this case study were University managed end-of-course evaluations and RateMyProfessors.com comments about the course. Both sources provided anonymous data, however they fell in two distinct domains. Before completing course evaluations students provided their credentials to access University resources. In contrast, RateMyProfessors.com was an external service in relation to the University and a publicly accessible system. A triangulation of the qualitative data between the systems helped to establish verification, reproducibility, and validation. Student reflective journals, written by students during the course, were also collected for the case study. However, they were not used in detailed analysis due to possible bias. They were written with the knowledge the instructor would see the names of the students along with the content.

Further, some quantitative data was collected in the custom gamification system and other sources. Quantifying engagement and participation in terms of numerical responses in evaluations, number of optional tasks completed, frequency of feedback and others allowed for an alternate view of engagement to qualitative data. The triangulation of methodologies delivered data sets that complement each other.

This case study uses 15 course sections as data sources for the application of gamification. While these are all students and do not represent diverse stakeholder perspectives, some data triangulation exists in the multiple groups being investigated. Data triangulation improves validity of the study.

This exploratory case study provides thick descriptions of the participants' experiences. It relies on public data and restricted data. The goal of the study was to provide comprehensive and coherent reconstruction of the information obtained from participants to establish confirmability.

Results

The course Introduction to Computing, at Grand Valley State University, was a coordinated course with approximately 30 sections each semester. The content of the course was centrally managed. This content included the textbook, exams, quizzes, Cengage SAM tutorials, and Cengage SAM projects. All graded assignments were standardized across the course sections. The course consisted of 49 graded assignments, 3 performance exams, 2 summative exams, and a self-paced project. The content of the course was broad including over 700 computing terms in the theory section along with hands-on skills in Microsoft Word, Excel, and Access.

The course was delivered primarily to non-computing majors and it was a required course in many academic programs. A theme in the collected data emerged of students dreading the course either based on their own previous experiences with computing or anecdotal stories shared by their peers. Many comments stressed lack of interest in computing prior to the course. Some of the comments stated: “The book tried really hard to be interesting, which I appreciate, but holy cow it is long and boring! That may be because I am not a computer person at all and the content was of no interest to me”, “Going into CIS150 I was so scared because everyone told me it was the worse class ever”, “I was really uninterested in this class when I originally signed up, but it was required by my major."

The custom gamification system was applied to the course in the Fall of 2015. The case study data extends over 4 semesters of Fall 2015, Winter 2016, Fall 2016, and Winter of 2017. It includes 15 class sections and 501 students. The course was delivered in 16-week semesters. The undergraduate population at Grand Valley State University in 2016 consisted of students, who were 58.5% female, 41.5% male, 89.1% full-time. The total enrollment in all sections of the case study course, Introduction to Computing, had 1,740 enrolled students out of a total of 22,081 undergraduate population.

Research question 1. How does gamification encourage engagement during lectures?

Student engagement during lectures as a theme was simplified to 187 expressions in the data set. Student engagement is a composite idea that means a level of attention, curiosity, interest, optimism, and passion demonstrated by students during a learning period (Strati, Schmidt, & Maier, 2017; Appleton, Christenson, & Furlong, 2008; Fredericks, Blumenfeld, & Paris, 2004). Student engagement may be intellectual, emotional, behavioral, physical, or social. The results of the case study are group by these themes. Opposite concepts include being bored, dispassionate, disaffected. Some of the key expressions involved in the qualitative content analysis were based on the word engagement itself, but also on expressing interest, emotional affinity, and references to having fun.

Lecture engagement is indicated by student activity in the Kahoot peer-instruction or classroom response system. Within most lecture sessions a Kahoot was run containing between 6 and 12 questions. Such questions served as prompts for class discussion and visual aids. Students connected to the peer-instruction system by using their own phones or laptops. Between Fall 2015 and Winter 2017 a total of 189 Kahoots were run in 15 sections with a gradual adoption from few in 2015 to a Kahoot in most lectures in Winter 2017.

Intellectual

Intellectual engagement was evident in course evaluations through responses to the following open-ended question: “Was this class intellectually stimulating? Did it stretch your thinking? Why or why not?” Qualitative analysis was performed on the responses to evaluate the meaning in two categories of “yes” or “no”.

Example responses evaluated to “yes”:

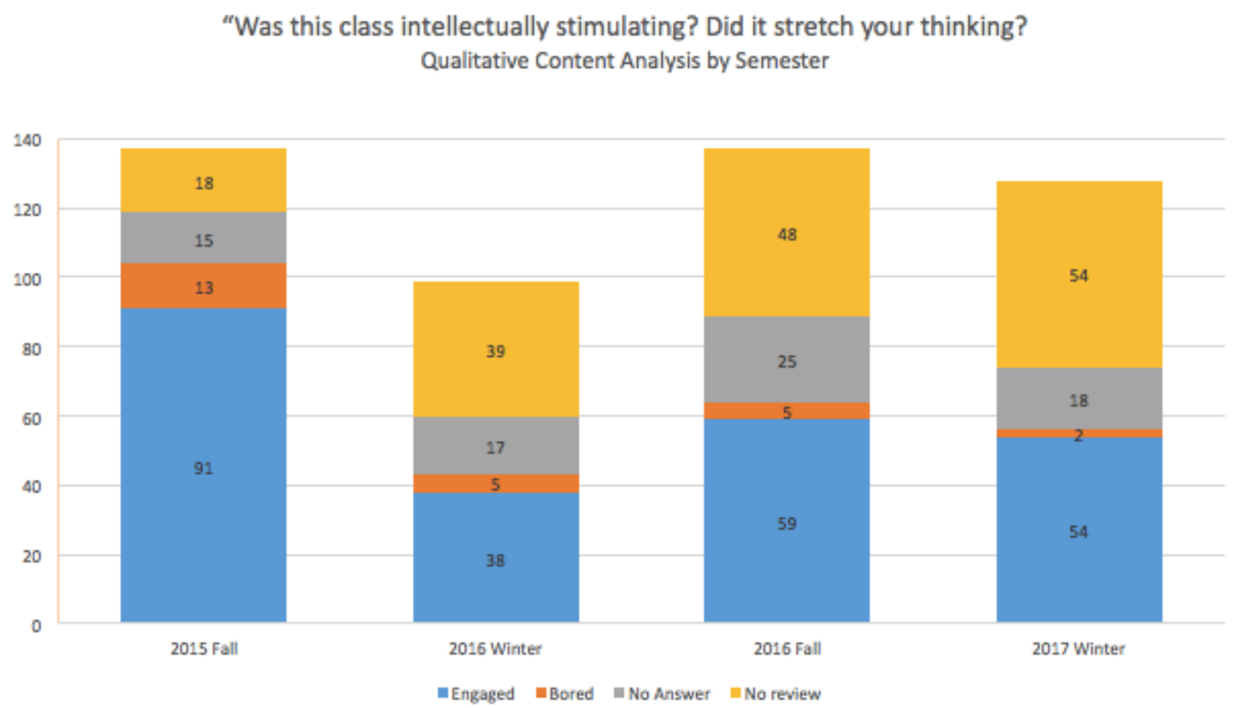
“This class made me think outside of the box because the coding was very hard and I had no clue how to do it, but I had to become creative to finish it”, “Yes, he always challenged us to do more but brought about in a very fun way!”, “It did, because it pushed the boundaries of my intellect like no other class has.”, “yes because each class we learned a variety of different things involving computers as well as being challenged through "the game" to go above and beyond what was required", "Yes, the use of the games in class and the apps really helped me learn in a more effective way in which I actually retained the information taught.", "A lot of the information was a repeat since I have taken a similar course in high school however, (…) made the class very stimulating with the Kahoot games and his app.", "Yes. With the app I went above what I normally would have done and it encouraged me to do things such as the coding games and going to the technology showcase. ", "This class was definitely one of the more thought provoking classes as the instructor connected other ideas such as philosophy, science, and business into one class ", "Yes because he brought in things from outside of just the book work about technology and really engaged me throughout the whole semester. He did great things that made me want to learn about this class and its topics as well as kept it fun and upbeat."

Example responses evaluated to No:

"No, this class was pretty straight forward I thought. If you took the time to do all the assignments then nothing was really that hard. This class was very useful though, I learned some things about word and excel I never knew and got to learn about access which wasn't too bad. Learning about hardware was also very intriguing. ", "No, this class was the easiest course I've taken yet at Grand Valley. Honestly, I should've tested out of it because I already knew the majority of what we were talking about in class. ", "Class material was not very hard.", "No so boring", "No, but that is because of the type of class this is. It is a class made to teach you how to use programs like Microsoft word, excel, and access."

Figure 1 demonstrates the "yes" category as Engaged, "no" as Bored labels. Additionally, the responses are set in perspective of the total students enrolled in the course and the number of students who completed the survey. The number of students, who completed the survey, but did not respond to the gamification questions is also indicated. The proportion of engaged to bored students increases each semester from 88% to 96%. The Fall 2015 semester received more reviews than later semesters.

Figure 1.



Course evaluations asked the question: "Relative to other college courses you have taken: The intellectual challenge presented was: (scale 0 - Much Lower, 4 - Average, 7 - Much Higher)". The average rating across four semesters was 5.2. This reflects an above average intellectual challenge relative to other courses taken by students, who completed evaluations.

The questions posted during Kahoot sessions were anchors for classroom discussion. A student mentions: "explaining the Kahoot answers was especially helpful." The technical discussions of content between Kahoot questions helped to cover the curriculum course content. To this end a student noted: "The lectures in between Kahoot problems were sometimes too long." However, Kahoots were mentioned in a positive light extensively. A student summarizes:

"The Kahoots were fun and made the class interactive. I really enjoyed the lecture because it just interested me and I felt like I learned something every time I went to class."

Emotional

The lecture level engagement was often indicated in the case study data by students reporting the experience of fun. Some excerpts include: "He made it fun to go to class", "we learned while having fun and we learned a lot", "making class fun and interactive, fair and entertaining", "he made me ENJOY coming to class; always made the class very fun", "he turned a very boring class into one of my favorites. He makes class fun and teaches in ways that help students learn", "had a good time in his class. was never bored", "he made the class fun and made it seem like a game." While not precisely defined, having fun does indicate the elements of engagement like attention, curiosity, interest, optimism, and passion.

Not all reviews indicated the experience of fun, some reported the opposite: "no, boring as hell" or "Kahoot was fun but didn't really help me." Another example of a negative perception was in the response to the question: "What aspects of the class detracted from your learning?", the answer given by a student: "the lectures." Figure 1 above provides a relative proportion of negative expressions in the data set. While the figure is specifically addressing engagement though intellectual stimulation, it provides an insight on the percentage of the negative comments in the reviews in this and other categories. One of the expressions pertaining to lectures, which was evaluated to a negative feedback states: "Professor taught class by using Kahoot quizzes and I felt like I wasn't learning the material. He expected us to read the chapters before class but then class time felt useless. I would rather be taught what I needed to know when I come to class. That's the point of class."

This view of covering content in class for the purpose of exams was deliberately addressed in the design of lectures. Lectures were for talking about things students could not learn on their own such as sparking interest in the subject matter, social learning, and understanding the deeper meaning behind the course content. A student commented on the process of figuring things on their own: “I have never been in a more engaging class than this one. The Kahoot and phone game technology integration with lecture really helped make the class enjoyable and educated students at the same time. This class did stretch my thinking and challenged me to figure things out on my own, which in turn educates students more.”

RateMyProfessors.com, with 246 ratings, included the following top 5 tags selected by students: respected (100), lots of homework (84), caring (68), hilarious (49), gives good feedback (48). Additional tags relating to lecture engagement indicated: amazing lectures (22), participation matters (17). 100% of students who rated the course, after 5/25/2016 when this feature was added, indicated they would take the instructor again given opportunity.

An indicator of engagement were the reports of the use of humor in class. The RateMyProfessors.com data set shows that 49 out of 246 respondents marked the class as “hilarious” and 11 out of 181 comments included the word “funny”. Some humorous moments were built into Kahoot questions. For example, some questions would create a cognitive dissonance, where no answer seems correct or all answers were correct. Since students could select only one answer, there was an emotional tension created. Sometimes, nobody in the class would answer a question correctly. Humor was used to diffuse such situations.

Enjoyment of lectures indicates emotional engagement. Course evaluations in three of the gamified semesters included custom questions. One of them, rated on a 1-5 (1=Strongly

Disagree; 5=Strongly Agree) scale stated: Q2. I enjoyed lectures in this class. The question was answered by 132 students with an average of 4.4.

Sample expressions reflecting emotional engagement in the class are: “He is so funny, caring, and amazing lecturer”, “He cares so much about his students and is always finding ways to make sure they do their best in the class. He's SO approachable and very understanding”, “I love this professor. One of my favorite professors I have had at Grand Valley. Really wants students to do well and sincerely cares”, “He is the sweetest teacher and really wants his students to succeed”, “Professor (…) would go out of his way to make sure I was doing ok both in class and in my life”, “He genuinely cares about all of the students and knows that most students are taking this for gen-ed requirements. This helps in the long run because you learn super cool information and take-a-ways from the class instead of just sitting through a boring computer class”, “He is one of the best teachers I have had in my 4 years at this school. He truly cares about how much the students learn and what they take away from the class.“ 27 out of 181 comments on RateMyProfessors.com included an expression of feeling cared for during the course.

Behavioral

Students made a connection between engagement and in-class competition: “The competition in class kept me engaged”, “the lectures and the Kahoot games were very helpful”, “He is so funny and makes his lectures interesting. He brings the competitor out in his students. He always has games to be played during his lecture to get through material and it makes the class go by a lot faster.” 55 course evaluation comments out of 342 responding students, who left 1002 comments, and 25 RateMyProfessors.com comments out of 182 reviews mentioned competition or classroom games in a positive light.

One of the comments brings out: “This class absolutely met my goals for taking it. I wanted to learn and feel confident with Word and Excel and I achieved that. (…) he made it all a game. He lectured via online, real time quiz games and it was very effective teaching for me and my competitive personality. I don’t love computer concepts but I enjoyed this class (…).”

The Kahoot system provided a ranked standing within a lecture and after each completed question. The competition was based on answering faster and more accurately than other students during lectures. At the end of the entire Kahoot session the top three performing students were recognized on the screen. After each question, the screen would display top 5 students and the instructor would recognize the students.

The recognition was based on students raising their hand as their Blackboard username was called. Students signed in with the Blackboard user name to grant XP for the session in the game system. The instructor would then say their real first name from memory or attempt to learn that name. This helped the instructor to learn the names of students, but also allowed for a social element in the lecture process. The instructor made it a goal to learn student names and in addition to the Kahoot exercise, the Blackboard Learn photo roster aided in this effort. The classroom size ranged from 25 to 40 students.

Engagement was also linked to a variety of methods utilized in lectures. “He made many unique and fun methods of teaching to help make the class interesting”, “He used a variety of different teaching skills, which helped me understand the material better”, “I loved the way lectures were set up and I really didn't feel like I was in a formal lecture, which significantly helped my learning”, “The classroom was very hands on and the learning facilitated student interaction which helped to maintain our interest”, “all of the class participation, it kept me paying attention”, “discussion was very interesting and stimulating.” While Kahoots helped to anchor the lectures in the required content, a variety of methods appealed to students in keeping the sessions interesting.

Effort was required to participate in classroom activities and to complete homework assignments. Course evaluations indicated that students put more effort in this class than other courses. Four engagement questions were reported in the data set and rated on the scale of 0 to 7 (0 - Much Lower, 4 - Average, 7 - Much Higher). The results presented are averages across all sections. Relative to other college courses you have taken: The intellectual challenge presented was: 5.2; The amount of effort you put into this course was: 5.6; The amount of effort to succeed in this course was: 5.7; Your involvement in course (doing assignments, attending classes, etc.) was: 5.8.

Game missions were introduced in varied time intervals to promote the concept of unpredictability and to optimize reinforcement. This further led to maintaining positive behaviors like class attendance. The autonomy the instructor had in releasing missions or creating new ones contributed to instructor engagement.

Physical

Physical activity in the classroom included operating the mobile app to complete missions or Kahoots. Some activities like Quizlet Live required that students move around the class and find their assigned groups. Also, midway through a lecture a 60 second period of guided dancing helped to introduce physical activity. Getting up for the activity was required, dancing itself was not. Perspectives on this activity were mixed.

Students noted: "(…) He lectures by playing quiz games. (…) Even had us get up and dance to break up the lecture", "The biggest distraction that the teacher thought was fun and a good idea was making us dance in class", "Stop making kids dance when you are the only one dancing." The activity was not rigidly scheduled, instead depending on the overall activity level in the class it was added as needed. A student with a note of disappointment commented: "No suggestions, except we stopped dancing in class about half way through the semester. The class was unique and fun."

The mobile app created for the class included a direct link to Kahoot from a button titled "Lecture Participation". Occupying the hands of students with their phones created a physical activity that helped them stay focused on class activities. During lectures text or QR Code game codes were shared as answers to lecture-summative questions, codes for attendance, or challenges. Collecting codes as artifacts was a key game design for in-person interaction. QR Codes in the game were either generated or adopted based on codes already displayed in public places. Some out-of-class game missions involved finding building maps or campus art to scan associated QR Codes.

Social

Social engagement during lectures was accomplished by the peer-instruction system, Kahoot, by Quizlet Live, and by game recommendations. Upon earning 500XP students could recommend someone else in the class to unlock late assignments achievement. This allowed requests to purchase late assignments and created peer connections between engaged students and those who felt they needed to turn in late assignments. When a late assignment was completed the mentor student received more experience points.

Kahoots helped in lecture social engagement, because the questions and answers were only available on the main projector screen, which required students to look up and stay aware of the classroom activities. Kahoots were alternated between a Classic Kahoot, one student per phone, and a Team Kahoot, which meant a single phone would allow feedback from 2 to 4 students in a group. The group Kahoot allowed for added collaboration between students as they reached consensus on the answer. The points earned in a Classic Kahoot were added to the experience point ledger for each student after a lecture.

A student comment on social engagement stated: “Continue the Kahoots. Please do more quizzlet lives! Working with teams is awesome”, “good job of getting everyone involved which made the learning easier”, “the class discussion got everyone involved”, “I liked it because it was different from other classes. Playing Kahoots/Quizlet was fun because it got everyone involved”, “the games actually helped a lot, instead of boring lectures the games helped everyone pay attention.”

Research question 2. How does gamification encourage participation in the activities during the entire length of the course?

RQ1 reported on engagement during individual lectures. It was a short-term, event-based engagement. Long-term participation in the course, such as attendance, homework completion, are defined here as engagement throughout the course. Certainly, engagement during lectures as reported on in RQ1 contributed to students coming back to class. However, a number of other themes became apparent in the qualitative content analysis to support participation in the entire length of the course.

Attendance

Attendance in the course was tracked with Kahoot activities, hidden mission codes, and protection codes. This was for informational purposes for the instructor and students. Students were not punished for absences in terms of a course grade component. A student comments: “Even though he doesn't take attendance, almost the whole class shows up every Mon/Wed. I feel that Prof (…) really works for the students in his class instead of expecting students to come to class because they're afraid they'll fail if they don't."

Students used their Blackboard username to login to the Kahoot. This allowed the mobile app to credit them with experience points. In some cases, at the end of a lecture a key question was asked, where the answer was a mission code. Before students left the room the answer was revealed to all present.

The experience point ledger allowed to tie all lectures together. Those in attendance were contributing to it from lecture to lecture. Therefore, performance on Kahoots, attendance, and other classroom activities were connected into a semester-long journey. A student commented: "I LOVED the game, it was an amazing incentive to come to class and stay interested but also something that was fun and extra."

Participation in the course included in-class activities with attendance as its foundation, but it also included homework, which was extensive in this course. The course syllabus indicated that in addition to the 3 hours of classroom activity, students were expected to reserve additional 6 hours a week to complete homework. The extensive hands-on practice, which was a method of ensuring the transfer of applied knowledge, was part of course participation. A student indicated: "the homework and projects really engraved the lessons."

A storification element of the Vikings allowed for metaphors that applied to Computer Science and helped students remember technical concepts. In the case of "protection codes" students were told that Scandinavian trolls were roaming the campus looking for experience points. To protect experience points students needed to be present during scheduled lectures to receive the current protection mission code. A mission with negative amount of experience points was added to accounts without the current protection code. A student comments about storification: "(…) lectures never really feel like class because you're usually playing games or talking about Vikings."

Effort in the design of the class lectures was to provide some practical and intellectual value each time in addition to the required course terminology. A student comments on this: "This class was definitely one of the more thought provoking classes as the instructor connected other ideas such as philosophy, science, and business into one class." Students were more likely to attend the class, when they were intellectually stimulated. An element of unpredictability of how the technical issues will be related to other topics they may already have interest in opened a door for curiosity.

The classroom response system helped students realize that they were learning during lectures. When students answered incorrectly in a Kahoot, it served as evidence of their ignorance and then the correct answer was explained or discussed. A clear progress in mastery or competence in the subject was visible to lecture participants. A student commented: "I felt like I learned something every time I went to class."

Management of Anxiety

The gamified lectures and clear outline of graded and optional assignments in the Blackboard course contributed to a low pressure learning environment. A student noted: "Zero stress or pressure in this class allowed me to do extremely well. Also, the real-life application example allowed me to increase my life as an individual." Being able to track their own progress helped to underline a growing mastery in terms of computer skills, therefore building confidence. Removing academic stress from the class was certainly by design. Approaching the course as a game and communicating this on the first day of class helped students to set aside bias to the subject matter and approach the content in a playful way.

The terminology used promoted reduction of stress. Extra credit points were called Peace of Mind points, which meant that each Peace of Mind point evaluated approximately to one question on a midterm or final exam. This made the practical value of the extra credit very clear and focused attention on reduction of stress during exams.

Instead of calling a student grade menu "My Grades" in the Blackboard Learn LMS, it was renamed to My Progress. Instead of calling the ranking screen "Leaderboard", it was called "Experience Ranking". This screen in the mobile app was accessible through the "Progress" tab, which listed missions completed most recently by students and missions completed most often. This data was displayed on a moving gallery, which promoted the concept of ongoing activity. The leaderboard was further optimized to only display 10 neighboring players with an option to see the top 30 overall players. A full ranking of all players was not available.

For many students taking off the edge in terms of stress led to willingness to attend lectures and continue participation in the course. The connection between learning, play, and mastery of actual skills is highlighted by this comment: "I think that one of the reasons this class was effective was because learning and play were united in a unique way. We were given independence to learn at our own pace, and we were introduced to a variety of different areas in the world of computers. (…) was charismatic about the content of the class, and I think it inspired students to do well. The skills that I value the most are probably the skills we developed using MS Office, because I think that these are things that I can use everyday at the university, but also in the workplace. Other skills that I appreciate are just a better general knowledge of computers."

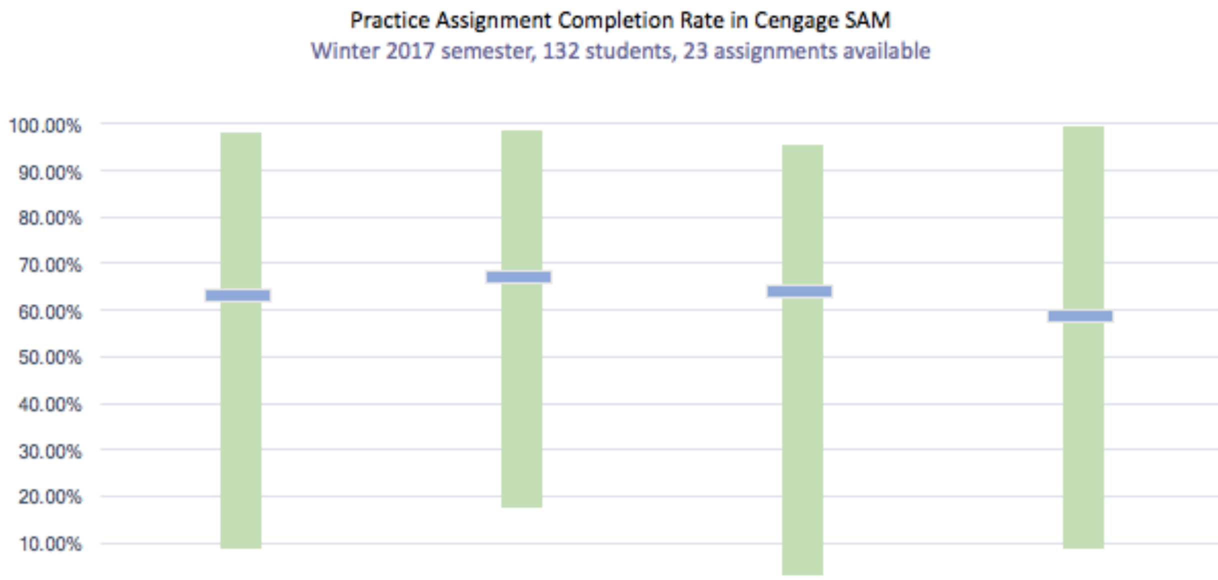
Another approach of the game design to lessen the stress levels was to take attention away from official grades. The system of experience points introduced a secondary system of rewards. In an evaluation, when asked for suggestions, a student wrote: "Nothing. I love the professor, love the class, and would not suggest anything differently. I was told to take the class with this professor by a friend and I am really grateful I listened. Not only do I have a better understanding of the topic, but I feel like I really learned something and with some classes I am focused more on the grade than the subject, and that was not the case at all for this class."

Assignment Completion

Evidence of participation in the course throughout the semester can be gleaned from the Cengage SAM system activity. There were 49 graded assignments in the course in Cengage SAM system. However, there were also 23 optional assignments, which allowed students to practice Microsoft Word, Excel, and Access applications. 490 students out of the 516, who registered for the course, completed some hands-on optional Cengage SAM assignments.

A review of Cengage SAM gradebooks in the Winter 2017 semester reveals that all students completed some optional assignments during that semester, with a minimum of 3% success rate, average of 63%, and at least one student reaching completion of 99.6% (Figure 2). The completion rate was calculated by adding the total scores on assignments instead of counting completed assignments. These optional assignments produced experience points instead of course grades. The practice likely contributed to greater mastery of the subject matter.

Figure 2.



	Class A	Class B	Class C	Class D
MIN	9%	17%	3%	9%
MAX	98%	99%	95%	100%
AVG	63%	67%	64%	59%

Students reported a higher involvement in this course than other courses. The course evaluations included four engagement questions, one of them stated: “Relative to other college courses you have taken: Your involvement in course (doing assignments, attending classes, etc.). was: (scale 0 - Much Lower, 4 - Average, 7 - Much Higher).” Students reported higher than average involvement in completion of assignments and class attendance across the four semesters with an average of 5.8 rating.

Timely Feedback

Timely feedback was accomplished by designing the course in the Blackboard Learn LMS to include each graded assignment as a separate gradable item and setting clear due dates on assignments through the semester. A student noted: “(…) very straight forward weekly schedule.” Cengage SAM generated a detailed report within minutes of project submission: “(…) assignments let you know the score and you can correct the mistakes.”

The Blackboard's mobile app, which includes an automated notification system, kept students informed of their grades and course progress. This gave students the time and opportunity to consider completion of optional assignments, game missions, and lecture attendance. A manual gradebook sync was performed each week to import current grades from the Cengage SAM system into Blackboard Learn, export experience points from Cengage SAM and Kahoot systems into the custom game system.

To complement the automated feedback, an email shortcut was present in the Blackboard course and in the game app to encourage asynchronous communication. A theme of the instructor's willingness to help, which indicates feedback, is present in the data. 46 mentions of being helpful are present in the 181 RateMyProfessors.com comments. Students wrote: "He emails back in a timely manner"," responds to emails as soon as possible, sometimes late at night"," he responds quickly to emails, and if you ever need any extra help, he is very approachable and very willing to help."

Whenever possible, the feedback was accelerated. For example, text or QR Code game missions were granted and credited immediately within the game system. NetApp certification mission, Boss Level missions in Code.org or CodeCombat.com allowed the instructor to view an internal gradebook and verify who completed the missions. However, students were asked to submit a screenshot of their progress from those systems and an appropriate game code would be displayed to them immediately through Blackboard Learn adaptive release feature. Missions could be revoked if needed in special circumstances. The same functionality of adaptive release was used when encouraging students to explore the Blackboard Learn system. Upon finding certain areas of the course and clicking on "Marked Reviewed" buttons, adaptive release would also display the game code immediately and the mobile app would credit the experience points immediately.

A student noted: “I learned I can’t just wait and cram homework at the last minute with this class, I have to spread it out and start early. I also never in a million years thought I could make a website on my own so that was cool.” The timely feedback concept is not just a gamification goal; it is part of good instructional design. When students know how they are performing in class they can make additional choices based on that knowledge. Due dates allowed opportunity for the concept of late assignments.

Mastery of the Material

Practical skills in Cengage SAM system were learned by following tutorials and then completing self-paced projects. However, projects could be turned in 5 times with corrections after receiving detailed feedback. Creating this failure-safe environment contributed to an increase in mastery and confidence. A student noted: “If you do all the assignments and then do the practices before exams and quizzes you will be golden. Longer weekly homework assignments let you know the score and you can correct the mistakes for a 100% every time”, “Allows chances to redo assignments.”

As a reflection, after completing the class, students were asked four questions about the gamification approach. The questions were present in three semesters of the case study and were answered by 132 students. The following questions were rated on a 1-5 scale (1=Strongly Disagree; 5=Strongly Agree) and resulted are in averages: Q1. After taking this class my confidence in using computers increased: 4.6; Q2. I enjoyed lectures in this class: 4.4; Q3. The game system in this class encouraged me to do additional practice, which otherwise I would not do: 4.5); Q4. This class was a well-played game: 4.5.

There was a positive feedback on each question, however, the questions about an increase of confidence and being encouraged to additional practice reflect growth in mastery of the subject matter. As reported earlier, many students dreaded the course ahead of time and did not feel like it was of interest. Students who completed the evaluations participated in the course with an impression of their skills and confidence growing.

Course Completion

The total enrolled students in 4 semesters and 15 sections was 516. 15 students dropped the course, most in the first two weeks of the class. This means that 3% of students dropped the course. Maintaining student interest and creating milestones, like achievements or Boss Level mission, created a mindset of expectation and anticipation. When asked on the evaluation, what contributed to your learning, a student responded: "All of the different things to do. Kahoot, Game Codes, Sam Learning, Boss Level."

The course was outlined through a path of intermediate milestones. Four achievements, marked in the mobile app gamer profile, were available to students. The first achievement was reached at 500 experience points opening the capacity to recommend other students for late assignments. The second achievement, opening ability to trade for Peace of Mind Points, was opened through a game code shared in a midterm preparation lecture session by entering a text code. The third achievement was opened when someone else recommended the player and opened capacity to purchase late assignments. The fourth achievement was connected with completion of the Boss Level mission.

The Boss Level event was a final mission in the course-long game. Upon completion of the mission students would either receive 50% Peace of Mind Point exchange rate or 300 XP to help complete late assignments. Initially the Boss Level was based on the Accelerated

Introduction to Computer Science activity on Code.org. Later, JavaScript and Python programming courses were used on CodeCombat.com. In the Code.org mission, out of 373 students, 194 participated and completed on average 32 levels writing 189 lines of code. In CodeCombat.com, out of 364 students, 154 completed on average 13 levels and spent 36 minutes on the assignment.

The gamification allowed students to be involved beyond the duration of their own class. By recommending students in current classes, the course alumni could continue to be in touch with the system. The recommendations are required to purchase any late assignments. Creating mentorship relationships, or at least relationships with past students who may share some comments about their experience in the course, was a way to increase the social quality of the course game.

Collecting experience points through the length of the semester allowed for continuity of participation in the course. Since missions, or visible milestones of activity, were issued more often than grades, they provided a path to completion with more frequent feedback. To illustrate this, in an answer to the question "Was this class intellectually stimulating?" students wrote: "Yes (…) and really engaged me throughout the whole semester. He did great things that made me want to learn about this class and its topics as well as kept it fun and upbeat", "Yes, (…) game approach to the class was very motivating throughout the semester and taught how to prioritize time, how to effectively use computer applications."

During the 4 semesters examined in the case study 525 users registered in the game and completed 15,117 missions. The missions included 648 late assignment makeups, 362 course alumni recommendations, 2478 attendance checks, and 4277 art explorations. Figure 3 and Figure 4 show the frequency of completed missions and game registration periods. Figure 3 demonstrates distinct dips at the start of a semester and peaks toward the end as student participation in mission activities increased toward the conclusion of the course. Figure 4 demonstrates high registration in the game system at the start of each semester.

Figure 3.

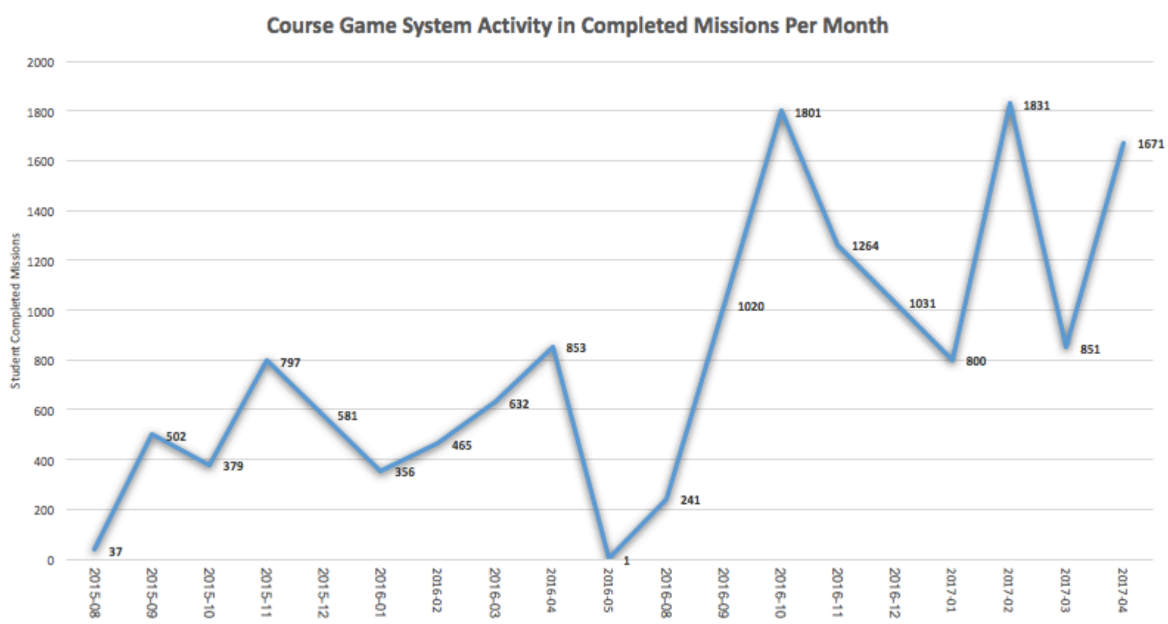
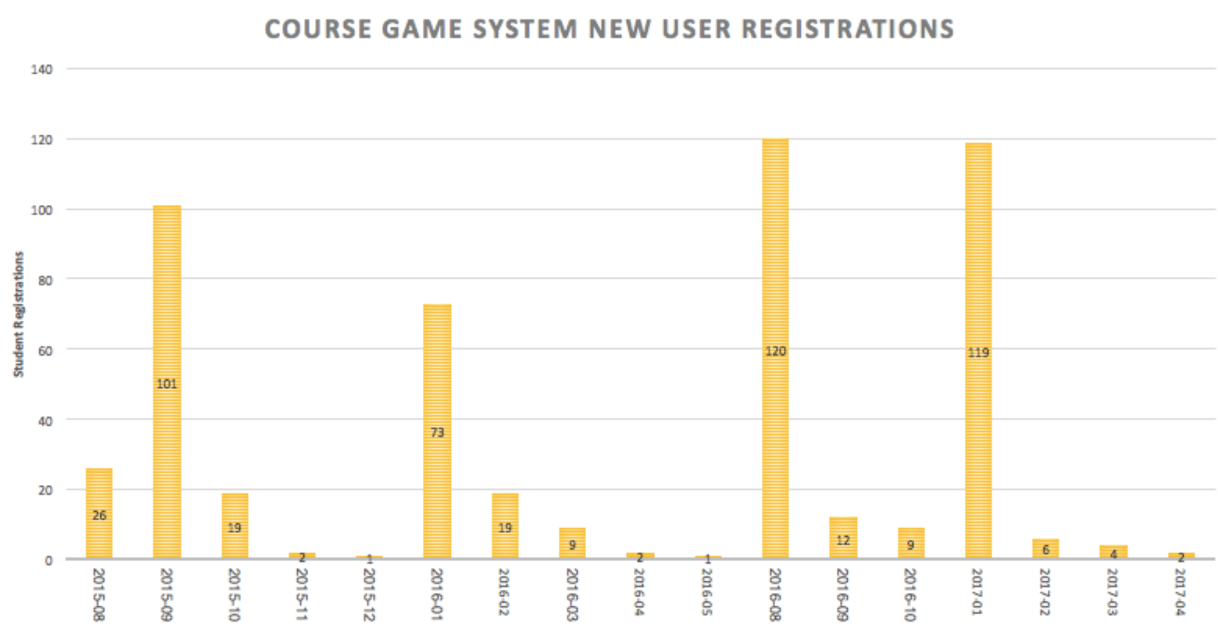


Figure 4.



An element of novelty was associated with the use of the semester-long game. A student comment states: "The game was really cool and different." The exploration of various Computer Science points of interest in optional game missions likely added to the attitude of exploration and unpredictability. However, the variety of topics covered by optional game missions contributed to an increase of interest in some students. A student noted the semester-long approach in this comment: "He has a game you play all semester. You earn points in the game by completing extra assignments and participating in class."

Upon completion of the course, students reflected about a change of attitude toward the subject matter. Their participation in the course-length activities resulted in an improved affinity and new interest toward the STEM field. Students noted: "I was really uninterested in this class when I originally signed up, but it was required by my major. (…) made it really interesting and fun and easy to understand for someone who doesn't care much about computers. I am now genuinely interested and at least somewhat informed in the basics of this field. I am glad I had to take this class, which I never expected myself to say, and Professor(…) is the main reason it was enjoyable", "The game helped me practice and gain interest in the subject."

Additional Findings

In order to provide a deeper understanding of the case study and experiences of the participants, additional findings and designs are reported. Such findings do not apply directly to the research questions; however, they may be helpful to practitioners or researchers. They provide a background for the findings reported above.

Course Evaluation Participation

At a high level, the frequency of student feedback indicates engagement in the course. Pre-gamification completion rate of course evaluations was at 44%, while in the gamified course the rate was 68%. Figure 5 demonstrates the number of students who responded to course evaluations prior to gamification application. Out of 597 enrolled students, 261 responded in evaluations. Figure 6 demonstrates the frequency of response after the gamification was applied. Out of 501 students, 342 responded. Two versions of the end-of-course evaluations were collected; the first version covered Fall 2013 to Winter 2015 and the second version covered Fall 2015 to Winter 2017. The application of gamification coincided with introduction of a new course evaluation system at the University level.

Figure 5.

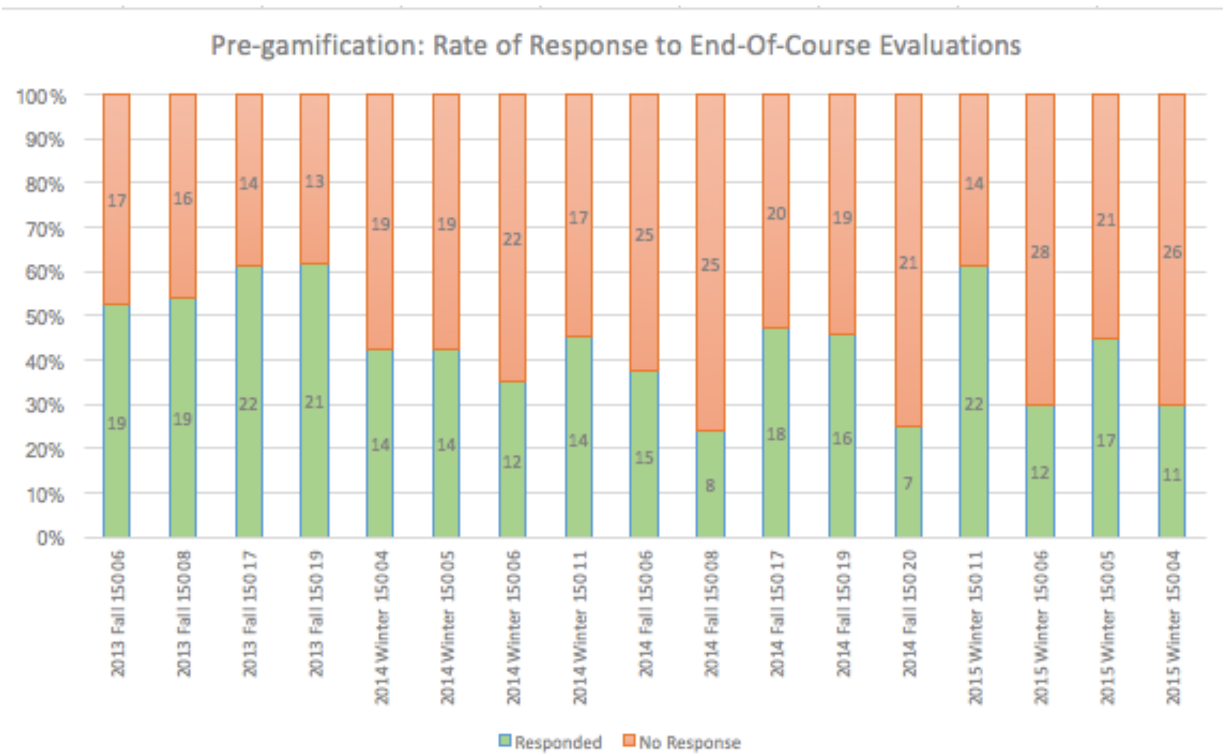
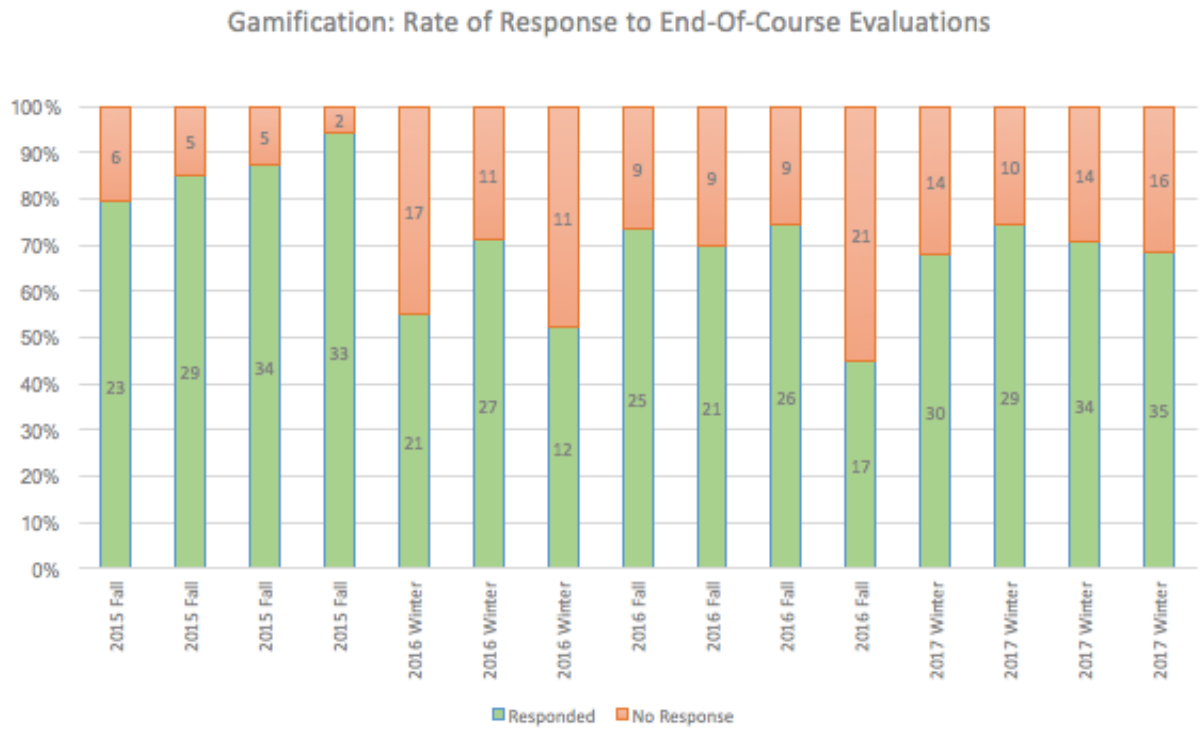


Figure 6.



Pre-gamification student engagement

It is important to note that instruction of this course received positive feedback even before the application of gamification. A well-designed course is a good candidate for gamification to increase student engagement and instructor engagement. The key affective domain questions in the pre-gamification feedback (Fall 2013, Winter 2014, Fall 2014, Winter 2015) were identified in questions 14, 23, and 33. The scale in the evaluation form ranged from 1= high (Strongly Agree), to 5 = low (Strongly Disagree). The data was reported as average across the four semesters.

Question #14 I enjoyed taking this course. 2.13

Question #23 This instructor used a teaching style that kept my attention throughout this course: 1.74

Question #33 This instructor motivated me to do my best work for this class: 1.67

Course Quality

The IASystem course evaluation calculated the Overall Summative Rating as well as the Challenge and Engagement Index (CEI). The Overall Summative Rating represents the combined responses of students to the four global summative items and is presented to provide an overall index of the class's quality. The scale ranged from 0=lowest to 5=highest. The semester averages were: Fall 2015: 4.6; Winter 2016: 4.4; Fall 2016: 4.7; Winter 2017: 4.6. Minimum across all semesters was 4.0 and maximum 4.9.

The Challenge and Engagement Index (CEI) combines student responses to several IASystem items relating to how academically challenging students found the course to be and how engaged they were. The scale ranged from 0=lowest to 7=highest. The semester averages were: Fall 2015: 4.7; Winter 2016: 5.0; Fall 2016: 5.2; Winter 2017: 4.9. Minimum across all semesters was 4.3 and maximum 5.7.

Data collected from RateMyProfessors.com shows that the instructor of the course held the 7th overall ranking in May of 2017 at Grand Valley State University in terms of the number of students rating the course (246) out of 3242 instructors recorded by the system. In the time period covered by the data the instructor taught the Introduction to Computing course exclusively. Within the top 20 ranked instructors at the University, he received the highest rating of 4.7. The minimum rating within the top 20 was 2.0 and median 3.4. The ratings start on August 30th, 2013 and remained positive until the start of the gamification project in Fall of 2014. Data collected for the needs of this case study spans from Fall of 2014 to Winter of 2017.

The end-of-semester review system in the last two semesters added a decile indicator for comparison across college and overall institution. This data was available for 8 sections of the class. The College decile rating in the Fall of 2016 was reported as: 9^{th}, 9^{th}, 9^{th}, 7^{th} and Winter 2017: 9^{th},9^{th},8^{th}, 8^{th}.

Evaluation of Findings

Findings documented in RQ1, concerning the short-term engagement in lectures, reflected a plethora of motivational theories. The acquired needs theory suggests that frequent recognition of efforts and accomplishments motivates people (Moorer, 2014; Tsounis, Sarafis, & Bamidis, 2014). The classroom-response system facilitated student expression and immediate feedback. Activation theory maintains that motivated people perform activities based on mental arousal between overstimulation and boredom (McClelland & Liberman, 1949; Scott, 1966). Novelty, variation, and uncertainty are some of the stimuli that can lead to activation and were present in Kahoot driven lectures.

Attribution theory claims that people are motivated when they can explain the world around them (Harvey, Madison, Martinko, Crook, & Crook, 2014; Roesch & Amirkham, 1997). As they do, they tend to assign blame as personality traits for others, and as external reasons for themselves. The Kahoot system allowed for questions to be asked, which required an explanation. As students made mistakes in answering, they owned their wrong answers and were motivated to understand their own failure.

Escape theory could be applied to the storification of the course and Kahoot lectures allowing for escape from boredom. With many trepidations present at the start of the course, exploring the subject matter through the view of Vikings and playfulness of games allowed students to escape the negative feelings. In connection with overjustification effect theory, taking focus away from grades allowed for intrinsic motivation to affect attendance and assignment completion, because the reason for work was no longer the grade, but experience points that actually held the promise of improving the course experience itself.

RQ2 results addressed course-long participation and course completion. The VIE theory suggests that people are motivated to contribute towards a positive and likely outcome with a clearly outlined path (Vroom, 1964; McClelland & Liberman, 1949; Damij, Levnajić, Rejec Skrt, & Suklan, 2015). The completion of course missions and specific benefits from the game for students motivated them to attend lectures and complete optional practice assignment.

The goal-setting theory explains why detailed feedback in Cengage SAM projects, with ability to resubmit assignments to improve, were motivating (Locke & Latham, 2015; Tsounis, Sarafis, & Bamidis, 2014; Schroeder, & Fishbach, 2015; Latham, Brcic, & Steinhauer, 2017). Also, the affect perseverance theory applied to students completing simple missions during lectures and later completing more difficult and time-consuming practical assignments for the satisfaction of reaching the game milestones.

Endowed progress effect theory explains the need to finish an already started process (Nunes & Dreze, 2006; Schroeder & Fishbach, 2015). Students were driven to complete the collection of experience points by participating in lectures. The investment model theory and the side-bet theory affected students as they collected small digital artifacts in the form of missions or experience points. This led to a commitment, where students became motivated to stick with the course assignments in view of their previous investment of time and effort as documented in the experience point ledger.

The case study results reveal that the game mechanics and dynamics were designed to appeal to four major player personality types identified in gaming culture (Robson, Plangger, Kietzmann, McCarthy, & Pitt, 2016; Taylor, 2006). Strivers (achievers) had an opportunity to earn experience points and achievements. Slayers (killers or influencers) had opportunity to participate in Kahoot competitions and rank themselves on an optimized leaderboard. Socializers were able to work in Team Kahoots, receive recommendations, plan to recommend others in the current or future semesters. Scholars (explorers) were able to collect a variety of mission codes and explore the subject matter in a non-grade focused, autonomous approach.

Finally, results in both research questions echo self-determination theory in pursuit of autonomy, relatedness, and competence. Student grades were not penalized if they didn't participate in lectures or if they didn't play the course game. Lecture engagement and course game participation were autonomous. Elements of social-relatedness were present in Kahoot interactions and student game recommendations. Competence was increased with each explained Kahoot question as well as ongoing hands-on practices. The lack of direct connection between the grade and the game activities maintained autonomy, more authentic relatedness to the subject matter, and self-driven increase in competence making in-class and after-school activities intrinsically motivated.

Summary

The findings of this case study explored and described the application of gamification in an introductory STEM college course. Through the process of qualitative content analysis patterns emerged to identify elements that promoted lecture engagement and semester-long mechanics to promote participation in the course. The lecture themes identified in qualitative content analysis included intellectual engagement, emotional engagement, behavioral engagement, physical engagement, and social engagement. The course-long themes to promote participation included attendance, management of anxiety, assignment completion, timely feedback, mastery of the material, and course completion. Additional findings reported increased participation in the student course review process after gamification was applied and the high quality instructional design of the original course.

Chapter 5: Implications, Recommendations, and Conclusions

This case study was designed to be an exploratory research to communicate knowledge through narrative. While in the context of Higher Education, the human motivational theories and reported gamification methods apply in other areas of business, especially in enterprise learning, employee development, or customer engagement. The problem statement of this research touches on the deficit of skilled workers in STEM industries as well as high attrition rates away from STEM academic fields. An experience focused process of using intrinsic motivation in introducing new students to STEM majors, and retaining them, will contribute to mitigating those problems.

The findings identified intellectual engagement, emotional engagement, behavioral engagement, physical engagement, and social engagement as components in gamification of short-term events such as lectures. Long-term participation in the course was reported in categories of attendance, management of anxiety, assignment completion, timely feedback, mastery of the material, and course completion. The methods included active learning through Kahoots, tracking student progress with experience points, and facilitating a system of earning and spending points as a course currency.

Figure 1 documented that 91% of the respondents felt intellectually stimulated in the introductory class. 95% of students completed additional hands-on practice assignments (Figure 2). Students rated their experience as a well-played game at 4.5 on a 1 to 5 = high scale. The positive responses to the methods were echoed by the expression: “Keep doing the game format for the class it keeps it interesting.”

Implications

In view of the findings of this case study, the application of gamification in academic courses requires short-term and long-term design. Event-based engagement was outlined in results for RQ1. Long-term approach was reported in results for RQ2. Tying short-term events into a course-long system allows for providing immersive feedback throughout the course and focus on course progress instead of grades.

Research question 1. How does gamification encourage engagement during lectures?

Literature review presented earlier suggested that more examples of gamification in education are needed, especially methods packaged into an adaptable system (Landers, Bauer, Callan, & Armstrong, 2015; Vassileva, 2012; Deterding, 2012). These are required to encourage mainstream adoption of gamification (Smith, 2015). When considering gamification in classroom activities, researchers report a dearth of studies about the immersion in game environments associated with storification (Hamari et al., 2016). Researchers call for more qualitative studies in this area to understand the nature of engagement in games (Consalvo & Dutton, 2006; Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012). This case study provides findings and a case study on student use of a working gamification prototype.

Gamification in this case study was presented as a functional package. In addition, the custom gamification system could be scaled across large numbers of students by combining multiple course sections into a single game. Within this case study, 3 to 5 sections played concurrently covering up to 150 students in an instance of the game.

An important implication, based on the results of the case study, is that students are willing to operate their own digital devices during lectures in a college course to participate in active learning with Kahoot. At times faculty may hesitate to adopt audience response systems in fear of situations, where some students are unable to arrange for a device like a laptop, tablet, or smartphone. Even in cases, when smartphones are missing in the class due to battery problems or other difficulties, Kahoots can be played in a team mode. This allows a single device to be shared across two or more students. This case study demonstrates the use of both approaches, the Classic Kahoot, one phone per student, and the Team Kahoot.

Engagement during lectures was reciprocated in both directions between the instructor and the students. This is documented in the findings of emotional engagement and management of anxiety as students commented about instructor's enthusiasm and active involvement in lectures. A comment documents: "(the instructor) was charismatic about the content of the class, and I think it inspired students to do well." The reciprocal nature of engagement thrives when both instructors and students feel engaged (Skinner & Belmont, 1993).

Prensky (2009) wrote about digital natives, who represented students intuitively savvy in technology in contrast to older generations, which must exert effort to learn technology and perhaps never master it at the level of the natives. He also indicated that students are bored in classes, because while playing games at home, they had realized what true engagement felt like. A similar metaphor could be used today about faculty.

A generation of new faculty comes out of the gaming culture of the 70's, 80's, and 90's, who also remember what it feels like to be immersed in a highly engaging activity of video games. The average age of a male gamer is 35 and 44 for females (Entertainment Software Association, 2016). When instructors are asked to teach introductory courses, which may appear elementary and lacking academic challenge, it may be necessary to create additional engagement for the faculty. Perhaps allowing them to add gamification elements in their teaching could provide an engagement spark. The autonomy for faculty to share their current interests and research through course optional missions may contribute to increased faculty engagement.

As generations of students and instructors carry childhood experiences based on playing games with high levels of engagement, the metaphor of a well-played game may be a very effective and powerful teaching tool. It allows for setting the minds of students at ease, while communicating new ideas. New ideas often require new metaphors. Playing a good game, and looking back at it with satisfaction, involves obeying the rules, slowly increasing skills through grunt work (grinding in games), and collaborating with others. Such concepts can be applied to education in academic integrity, teamwork, clear identification of learning objectives, and other basic principles of instructional design for learning.

Research question 2. How does gamification encourage participation in the activities during the entire length of the course?

An implication of this case study in relation to semester-long engagement is the role of instructional design in delivering gamified courses. Prior to the Fall of 2015, starting in 2013 and extending over 17 sections, the non-gamified course received positive end-of-semester evaluations including promising engagement indicators. As reported in additional findings, on a scale of 1 = high to 5 = low the average response on engagement questions was 1.8. The application of the gamification system aimed at increasing student engagement and participation in an already well-designed and well-executed course. While comparisons are difficult between the pre-gamification and post-gamification results, the student response rate to end-of-course evaluations increased from 44% to 68%.

Therefore, gamification in this case study was not the only prerequisite for positive student feedback in the STEM introductory course. The gamification was built on the foundation of an award-winning instructional design effort (GVnow, 2014; Blackboard, 2017), clear and accessible online resources within the course, and award-winning educator executing the course (GVnow, 2016). It should not be concluded that adding selected elements of gamification to any course, or especially adding an environment of gamification into a poorly executed course, should have similar positive results.

The semester-long design of gamification presented in this case study demonstrates a bridge between disinterest and emotional investment on the background of the STEM field. Students initially indicated that before participating in the class their interest in computers was low. Later they reported an increase in the level of interest and new-found affinity towards STEM. Such motivational bridge can be reused in other environments, where self-beliefs or trepidations prevent engagement. While the main content, which remains unchanged, meets the regulatory requirements, the intrinsic motivation places participants in a new frame of mind.

One of the key themes in the case study data was the generation of new interest through a variety of tools, not a single, specific one. A sample expression states: “He turned a very boring class into one of my favorites. He makes class fun and teaches in ways that help students learn.” The composition of the engagement methods, incorporating the lecture level and course level gamification strategies, facilitated a reported increase in affinity to the subject matter over the duration of the course. Likely, adoption of individual tools would not have the same effect as the full set of short and long-term gamification strategies.

Lutz Bornmann and Werner Marx from the Max Planck Society in Germany wrote about the Anna Karenina principle as a way of thinking about success in science experiments (Bornmann, & Marx, 2012). According to the principle, success in science at the excellence level requires all key elements to be fulfilled. A single element unfulfilled may lead to systemic failure. For this reason, experiments are often unsuccessful in their own unique and particular ways.

Gamification in this case study was a complex system of many tools in two main categories: short-term engagement and long-term participation. Adoption of just a few of them, such as a leaderboard, a points system, or classroom response system may not lead to the gamified culture among the students and high levels of motivation, which was reported in the data of this case study

Conversely, unsuccessful studies of gamification should not reflect a general lack of applicability of gameful design in academic courses. Instead, such studies should be considered in the light of the Anna Karenina principle focused on the missing elements either in short-term game or long-term game design. The prevailing important conditions for success in gamification may be more difficult to identify in successful case studies of the phenomenon, while in the unsuccessful experiments they may be easier to document. The unsuccessful case studies may shed light on a possible long list of required criteria for gameful design of instruction.

Recommendations for Practice

In March of 2016 a request for quotation (RFQ) was submitted to Open Systems Technologies in Grand Rapids, Michigan (Open Systems Technologies, 2016). The RFQ covered a commercial software re-development of the working prototype of the gamification system presented in this case study. Faculty from the University of Illinois at Chicago (UIC) expressed an interest in adopting a similar gamification system in their courses. In order to apply for an academic grant, a cost estimate was needed. The cost of developing the system based on the prototype was quoted at $269, 640.

An appropriate grant had not been secured in a timely manner, however, a pilot of the prototype software was deployed at UIC in the Fall of 2016. In April of 2017 a general adoption process for faculty has been made public under https://game.dataii.com. This includes deployment of the demo app in Apple App, Google Play, and Amazon Underground app stores.

Practitioners in STEM introductory courses are encouraged to apply for adoption of the gamification system described in this case study. A demo app is available for preview. The system can be adopted at the rate comfortable to the instructor.

Recommendations for Future Research

Future research in semester-long engagement should utilize a feature of the Kahoot system, that prompts players for their opinion and emotional state after completing the peer-instruction session. The survey asks students if they enjoyed the session and if they felt they learned from it. This survey was not utilized in this case study, but plotting student interest and engagement over the period of the semester would provide an important data point.

The activity of tracking this feedback may communicate to students that their emotional state is being paid attention to. Their progress can serve as feedback to the instructor on the academic quality of the sessions. It would also provide feedback to the instructor, which would encourage the faculty and generate energy in the course relying on the reciprocal principal of engagement (Skinner & Belmont, 1993).

A future research should include comparison of gamified courses against the same course taught by other instructors, who believe in the methods of teaching they practice. The course evaluation system by IASystems provides the organizational level indicator. This may serve as a comparison element to measure student engagement across multiple sections of the same course.

Conclusions

This case study explored gamification of a STEM introductory college course. The data covered 15 course sections over 4 semesters, a total of 501 students. 1184 participant comments were processed through the qualitative content analysis to identify emerging themes. The categories of intellectual engagement, emotional engagement, behavioral engagement, physical engagement, and social engagement were reported to address RQ1. The categories of attendance, management of anxiety, assignment completion, timely feedback, mastery of the material, and course completion were reported to address RQ2.

The problem of worker deficit in the US within STEM fields and high attrition rates away from STEM academic programs may be mitigated by altering the experience of students in introductory courses. Documenting examples of gamification strategies addresses the call of previous researchers to help instructors adopt gamified teaching. The use of human motivational theories packaged into a gamification system will allow schools to leverage intrinsic motivation in program recruitment and completion.

This study indicates that focus on lecture engagement along with semester-long student participation in the course provides an immersive feedback environment that motivates students. In addition, faculty creating ad-hoc missions are able to discover new intellectual challenges in teaching elementary courses to rekindle their own engagement in the course. The department administration may allow such innovation of their instruction, because there is no need to modify the core content of the course.

References

Acedo, M. (2014). 10 specific ideas to gamify your classroom. Retrieved from http://www.teachthought.com

Appleton, J. J., Christenson, S. L., & Furlong, M. J. (2008). Student engagement with school: Critical conceptual and methodological issues of the construct. Psychology in the Schools, 45, 369–386. doi:10.1002

Aguilar, S., Fishman, B., Holman, C. (2013). Leveling-Up: Evolving Game-Inspired University Course Design. In Williams, C.C., A. Ochsner, Dietmeier, J., & C. Steinkuehler (Eds.), Proc. GLS 9.0 (pp. 46–52). Pittsburgh, PA: ETC Press. DOI: 10.13140/2.1.4154.0805

Akutsu, T., Gordon, R. K., & Noguchi, K. (2014). Critical pedagogy and children's musical flow: Curriculum design and assessment. *Critical Practice in P-12 Education: Transformative Teaching and Learning: Transformative Teaching and Learning*, 170.

Alderfer, C. (1972). *Existence, relatedness, & growth*. New York: Free Press.

Alt, D. (2014). First-year female college students' academic motivation as a function of perceived parenting styles: A contextual perspective. *Journal of Adult Development, 22,* 63–75. http://dx.doi .org/10.1007/s10804-014-9201-2

Alvarez, M. (2014). Reassessing my gamification approach. Retrieved from http://www.gamifyingmyclass.com

Amabile, T. M., DeJong, W., & Lepper, M. (1976). Effects of externally imposed deadlines on intrinsic motivation. *Journal of Personality and Social Psychology*, 34, 92–98.

Anderson, C., & Gantz, J. F. (2013). Skills Requirements For Tomorrow's Best Jobs Helping Educators Provide Students with Skills and Tools They Need. Retrieved from https://pdfs.semanticscholar.org/12e3/e201ed45c57916fee1e9c154ca7e15722093.pdf

Aranya, N. and Jacobson, D. (1975). An empirical study of theories of organizational and occupational commitment, *Journal of Social Psychology*, 97, 15–22.

Attali, Y., & Arieli-Attali, M. (2015). Gamification in assessment: Do points affect test performance? *Computers and Education, 83*, 57–63.

Aubrey, J. & Coombe, C. (2011). An investigation of occupational stressors and coping strategies among EFL teachers in the United Arab Emirates. In C. Gitsaki (Ed.), *Teaching and Learning in the Arab World*, (pp.181-201). Bern, Switzerland: Peter Lang AG.

Barata G., Gama S., Jorge J., Gonçalves D. (2013), *Engaging engineering students with gamification*, in: Proceedings of the International Conference on Games and Virtual Worlds for Serious Applications (pp. 24–31).

Barata, G., Gama, S., Jorge, J., & Gonçalves, D. (2014). Identifying student types in a gamified learning experience. *International Journal Of Game-Based Learning*, *4*(4), 19–36. doi:10.4018/ijgbl.2014100102

Barlet, M.C., Spohn, S.D., 2012. Includification: A Practical Guide to Game Accessi- bility [WWW Document]. Includification. URL: /http://www.includification. com/AbleGamers_Includification.pdfS (accessed 09.10.14).

Berg, B. L., & Lune, H. (2012). *Qualitative research methods for the social sciences* (8th ed.). Boston, MA: Pearson Education.

Blackboard (2017). Blackboard Announces Winners of 2017 Catalyst Awards. Press Release. Blackboard Inc.

Bloom, B. S. (1984). The 2 Sigma Problem: The Search for Methods of Group Instruction as Effective as One-to-One Tutoring. Educational Researcher, 13(6), 4. doi:10.3102/0013189X013006004

Bogost, I. (2011). Persuasive games: exploitationware. *Gamasutra.*

Bonwell, C. C., and Eison, J.A. (1991). *Active learning: creating excitement in the classroom*. ASH#-ERIC Higher Education Report No. 1, Washington, D.C.: The George Washington University, School of Education and Human Development.

Bornmann, L., & Marx, W. (2012). The Anna Karenina principle: A way of thinking about success in science. *Journal Of The American Society For Information Science & Technology*, *63*(10), 2037-2051. doi:10.1002/asi.22661

Braun, V., & Clarke, V. (2006). *Using thematic analysis in psychology. Qualitative Research in Psychology*, 3(2), 77-101. doi:10.1191/1478088706qp063oa

Brehm, J. W. (1966). A theory of psychological reactance. New York, NY: Academic Press.

Bridgeland, J., Milano, J., Rosenblum, E., & Civic, E. (2011). Across the Great Divide: Perspectives of CEOs and College Presidents on America's Higher Education and Skills Gap. *Civic Enterprises*.

Buckley, P., & Doyle, E. (2014). Gamification and student motivation. *Interactive Learning Environments, (October)*, 1–14.

Burke, B. (2014). *Gartner Redefines Gamification*. Retrieved from http://blogs.gartner.com/brian_burke/2014/04/04/gartner-redefines-gamification/

Burkey, D. D., Anastasio, M. D. D., & Suresh, A. (2013). *Improving student attitudes toward the capstone laboratory course using gamification.* Paper presented at the annual conference and exposition of the American Society for Engineering Education, Atlanta, GA.

Burning Glass Technologies. (2015). The Human Factor: The Hard Time Employers Have Finding Soft Skills. Retrieved from http://burning-glass.com/research/baseline-skills/

Business Roundtable (2012). *Roadmap for growth.* Retrieved from http://businessroundtable.org/studies-and-reports/roadmap-for-growth-education/

Carnevale, A. P., Rose, S. J., & Cheah, B. (2011). *The college payoff: Education, occupations and lifetime earnings.* Washington, DC: The Georgetown University Center on Education and the Workforce.

Carnevale, A. P., Rose, S. J., & Hanson, A. R. (2012). *Certificates; Gateway to Gainful Employment and College Degrees*. Washington, DC: The Georgetown University Center on Education and the Workforce.

Cengage. (2014). *SAM Helps Intimidated Students Gain Confidence and Proficiency with Computer Technology.* Retrieved from http://www.machajewski.org/szymon/files/ss_sam_machajewski.pdf

Chang, M. J., Eagan, M. K., Lin, M. H., & Hurtado, S. (2011). Considering the Impact of Racial Stigmas and Science Identity: Persistence Among Biomedical and Behavioral Science Aspirants. *Journal of Higher Education, 82*(5): 564–596.

Chen, X., & Soldner, M. (2013). STEM attrition: College students' paths into and out of STEM fields: Statistical analysis report. (NCES 2014-001). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC. Retrieved from http://nces.ed.gov/pubs2014/2014001rev.pdf

Chou, Y. K. (2015). Actionable Gamification: Beyond Points, Badges, and Leaderboards. Octalysis Media.

Christe, B. (2013). The Importance of Faculty-Student Connections in STEM Disciplines: A Literature Review. *Journal Of STEM Education: Innovations And Research*, *14*(3), 22-26.

Christy, K. R., & Fox, J. (2014). Leaderboards in academic contexts: A test of stereotype threat and social comparison explanations for women's math performance. Computers & Education, 78, 66e77. http://dx.doi.org/10.106/j.compedu.2014.05.005

Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. *Computers & Education*, *59*(2), 661–686. doi:10.1016/j.compedu.2012.03.004.

Consalvo, M. and Dutton, N. (2006). Game analysis: Developing a methodological toolkit for the qualitative study of games. Game Studies: The international journal of computer game research, 6(1). Retrieved from: http://gamestudies.org/0601/articles/consalvo_dutton

Conway, S. (2014). Zombification?: Gamification, motivation, and the user. *Journal Of Gaming & Virtual Worlds*, *6*(2), 129. doi:10.1386/jgvw.6.2.129_1

Cruz, L., & Penley, J. M. (2014). Too cool for school?: The Effects of gamification in an advanced interdisciplinary course. *Journal of Teaching and Learning with Technology, 3*(2), 1–11.

Csikszentmihalyi, M., (1991). Flow: The Psychology of Optimal Experience. Harper

Cunningham, C., Zichermann, G., (2011). Gamification by Design: Implementing Game Mechanics in Web and Mobile Apps. O'Reilly Media, Sebastopol, CA.

D'Lima, G. M., Winsler, A., & Kitsantas, A. (2014). Ethnic and Gender Differences in First-Year College Students' Goal Orientation, Self-Efficacy, and Extrinsic and Intrinsic Motivation. *Journal Of Educational Research*, *107*(5), 341–356. doi:10.1080/00220671.2013.823366

Damij, N., Levnajić, Z., Rejec Skrt, V., & Suklan, J. (2015). What Motivates Us for Work? Intricate Web of Factors beyond Money and Prestige. *Plos ONE*, *10*(7), 1-13. doi:10.1371/journal.pone.0132641

de-Marcos, L., Domínguez, A., Saenz-de-Navarrete, J., & Pages, C. (2014). An empirical study comparing gamification and social networking on e-learning. Computers & Education, 75, 82e91. http://dx.doi.org/10.1016/j.compedu.2012.12.020

Deci, E. L., & Ryan, R. M. (2014). The importance of universal psychological needs for understanding motivation in the workplace. *The Oxford handbook of work engagement, motivation, and self-determination theory*, 13-32.

DeKoven, Bernie. 2013. *Well-Played Game: A Player's Philosophy*. Cambridge, London: MIT Press.

Denny, P., (2013). The effect of virtual achievements on student engagement. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. Presented at CHI13'. ACM, pp. 763–772.

Deterding, S., (2012). Gamification: designing for motivation. Interactions 19, 14–17.

Dicheva, D., Dichev, C., Agre, G., & Angelova, G. (2015). Gamification in Education: A Systematic Mapping Study. *Journal Of Educational Technology & Society*, *18*(3), 75–88.

Domínguez, A., Saenz-de-Navarrete, J., de-Marcos, L., Fernández-Sanz, L., Pagés, C., Martínez-Herráiz, J.-J., (2013). Gamifying learning experiences: practical implications and outcomes. Comput. Educ. 63, 380–392. http://dx.doi.org/10.1016/j. compedu.2012.12.020

Doyle, T. & Zakrajsek, T. (2013). *The new science of learning: How to learn in harmony with your brain.* Sterling, VA: Stylus Publishing.

Eagan, K., Herrera, F.A., Garibay, J. C., Hurtado, S., and Chang, M. (2011). *Becoming STEM Protégés: Factors Predicting the Access and Development of Meaningful Faculty-Student Relationships*. Los Angeles: Higher Education Research Institute.

Early, D. M., Rogge, R. D., & Deci, E. L. (2014). Engagement, Alignment, and Rigor as Vital Signs of High-Quality Instruction: A Classroom Visit Protocol for Instructional Improvement and Research. *High School Journal*, *97*(4), 219–239.

Early, D. M., Rogge, R. D., & Deci, E. L. (2015). Engagement, Alignment, and Rigor as Vital Signs of High-Quality Instruction: A Classroom Visit Protocol for Instructional Improvement and Research, *97*(4), 219–239. http://doi.org/10.1353/hsj.2014.0008

Edwards, K. M., Gidycz, C. A., & Murphy, M. J. (2015). Leaving an abusive dating relationship: A prospective analysis of the investment model and theory of planned behavior. *Journal of interpersonal violence*, *30*(16), 2908-2927.

Eickhoff, C., Harris, C. G., De Vries, A.P., Srinivasan, P., (2012). Quality through flow and immersion: gamifying crowdsourced relevance assessments. In: Presented at SIGIR'12. ACM, Portland, OR, pp. 871–880.

Ellis, J., Fosdick, B. K., & Rasmussen, C. (2016). Women 1.5 Times More Likely to Leave STEM Pipeline after Calculus Compared to Men: Lack of Mathematical Confidence a Potential Culprit. *PLoS ONE*, *11*(7), e0157447. http://doi.org/10.1371/journal.pone.0157447

Else-Quest, N. M., Mineo, C. C., & Higgins, A. (2013). Math and science attitudes and achievement at the intersection of gender and ethnicity. *Psychology Of Women Quarterly*, *37*, 293-309. doi:10.1177/0361684313480694

Emdin, C. (2011). Affiliation and alienation: hip-hop, rap, and urban science education. *Journal Of Curriculum Studies*, *42*, 1–25. doi:10.1080/00220270903161118

Emdin, C., & Lee, O. (2012). Hip-hop, the 'Obama effect,' and urban science education. *Teachers College Record*, *114*, 1-24. Retrieved from http://proxy1.ncu.edu/login?url= http://search.ebscohost.com/login.aspx?direct=tru e&db=psyh&AN=2012-16299-004&site=ehost-live

Entertainment Software Association. (2013). 2013 Essential Facts About the Computer and Video Game Industry. Retrieved from http://www.isfe.eu/sites/isfe.eu/files/attachments/esa_ef_2013.pdf

Entertainment Software Association. (2016). 2016 Essential Facts About the Computer and Video Game Industry. Retrieved from http://essentialfacts.theesa.com/Essential-Facts-2016.pdf

Enzle, M. E., & Anderson, S. C. (1993). Surveillance intentions and intrinsic motivation. *Journal of Personality and Social Psychology,* 64,257–266.

Erdogan, N., & Stuessy, C. L. (2015). Modeling Successful STEM High Schools in the United States: An Ecology Framework. *International Journal Of Education In Mathematics, Science And Technology*, *3*(1), 77–92.

Espinosa, L. L. (2011). Pipelines and Pathways: Women of Color in Undergraduate STEM Majors and the College Experiences That Contribute to Persistence. *Harvard Education Review, 81*(2): 209–240.

Evans, P. (2015). Self-determination theory: An approach to motivation in music education. *Musicae Scientiae*, *19*(1), 65-83. doi:10.1177/1029864914568044

Faiella, F. Ricciardi, M. (2016). Gamification and learning: a review of issues and research. *Journal of e-Learning and Knowledge Society,* [S.l.], v. 11, n. 3, Sep. 2015. ISSN 1826-6223.

Ferguson, C. J., & Olson, C. K. (2013). Friends, fun, frustration and fantasy: Child motivations for video game play. *Motivation and Emotion, 37,* 154–164. doi:1007/s11031-012-9284-7

Festinger, L. (1957) *A theory of cognitive dissonance*, Stanford, CA: Stanford University Press.

Feynman, R. P., & Robbins, J. (1999). *The pleasure of finding things out: The best short works of Richard P. Feynman*. Cambridge, Mass: Perseus Books.

Finn, J. D. (1989). Withdrawing from school. *Review of Educational Research*, 59, 117–142.

Fredricks, J. A., Blumenfeld, P. C., and Paris, A. (2004). School engagement: potential of the concept: state of the evidence. *Review of Educational Research*, 74, 59–119.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okorafor, N., Jordt, H., and Wenderoth, M. P., (2014). Active learning increases student performance in science, engineering, and mathematics. Proceedings of the National Academy of Sciences (PNAS), 111(23),8410-8415.

Gartner (2012). Gamification: engagement strategies for business and IT. Report G00245563

Gasiewski, J. A., Eagan, M. K., Garcia, G. A., Hurtado, S., & Chang, M. J. (2012). From Gatekeeping to Engagement: A Multicontextual, Mixed Method Study of Student Academic Engagement in Introductory STEM Courses. *Research in Higher Education*, *53*(2), 229–261. http://doi.org/10.1007/s11162-011-9247-y

Glover, I. (2013). Play as you learn: Gamification as a technique for motivating learners. In: J. Herrington, A. Couros & V. Irvine (Eds.) Proceedings of World Conference on

Educational Multimedia, Hypermedia and Telecommunications (Vol. 2013, pp. 1999-2008). Chesapeake, VA: AACE.

Goehle, G., (2013). Gamification and Web-based Homework. Primus: Probl. Resour. Issues Math. Undergrad. Stud. 23, 234–246. http://dx.doi.org/10.1080/ 10511970.2012.736451.

Gonzalez, A. (2012). Gamifying my classes. Retrieved from http://www.educatoral.com/ wordpress/2012/07/16/gamifying-my-classes/.

Gorin, A. A., Powers, T. A., Koestner, R., Wing, R. R., & Raynor, H. A. (2014). Autonomy support, self-regulation, and weight loss. *Health Psychology, 33,* 332–339. http://dx.doi.org/10.1037/ a0032586

GradeCraft (2017). GradeCraft Beta. University of Michigan. Retrieved from https://beta.gradecraft.com/features

Grand Valley State University GVSU, (2016) GVSU Office of Institutional Analysis. Quick Facts. Retrieved from https://www.gvsu.edu/ia/quick-facts-current-49.htm

Granic, I., Lobel, A., & Engels, R. E. (2014). The benefits of playing video games. *American Psychologist*, *69*(1), 66–78. doi:10.1037/a0034857

Greene, D. Sternberg, B. and Lepper, M. R. (1976) Overjustification in a token economy, *Journal of Personality and Social Psychology*, 34, 1219–1234

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

Gunnell, K. E., Crocker, P. R., Mack, D. E., Wilson, P. M., & Zumbo, B. D. (2014). Goal contents, motivation, psychological need satisfaction, well-being and physical activity: A test of self-determination theory over 6 months. *Psychology of Sport and Exercise*, *15*(1), 19-29.

GVnow. (2014). Blackboard Catalyst Award. Retrieved from http://www.gvsu.edu/idel/szymon-machajewski-31.htm

GVnow. (2016). Faculty awarded for inclusive classrooms. Retrieved from https://www.gvsu.edu/gvnow/2016/faculty-awarded-for-inclusive-classrooms-9481.htm

Hamari, J. (2015). Do badges increase user activity? A field experiment on the effects of gamification. *Computers In Human Behavior*, doi:10.1016/j.chb.2015.03.036

Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J., & Edwards, T. (2016). Full length article: Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning. *Computers In Human Behavior*, *54*170-179. doi:10.1016/j.chb.2015.07.045

Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J., & Edwards, T. (2016). Full length article: Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning. *Computers In Human Behavior*, *54,* 170-179. doi:10.1016/j.chb.2015.07.045

Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J., & Edwards, T. (2016). Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning. *Computers in Human Behavior*, *54*, 170-179.

Hamm, J. M., Stewart, T. L., Perry, R. P., Clifton, R. A., Chipperfield, J. G., & Heckhausen, J. (2013). Sustaining primary control striving for achievement goals during challenging transitions: The role of secondary control strategies. *Basic and Applied Social Psychology, 35,* 286–297. http://dx .doi.org/10.1080/01973533.2013.785404

Hancock, D. R., & Algozzine, B. (2011*). Doing case study research: A practical guide for beginning researchers* (2nd ed.). New York, NY: Teachers College Press.

Hanus, M., & Fox, J. (2015). Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance. *Computers & Education*, *80*152–161.

Harvey, P., Madison, K., Martinko, M., Crook, T. R., & Crook, T. A. (2014). Attribution theory in the organizational sciences: The road traveled and the path ahead. *The Academy of Management Perspectives*, *28*(2), 128-146.

Hennink, M., Hutter, I., & Bailey, A. (2011). Qualitative Research Methods. Thousand Oaks, CA: Sage.

Hirsch, J. K., & Barton, A. L. (2011). Positive social support, negative social exchanges, and suicidal behavior in college students. *Journal of American College Health*, 59(5), 393-398.

Hofacker, C., de Ruyter, K., Lurie, N., Manchanda, P., & Donaldson, J. (2016). Gamification and Mobile Marketing Effectiveness. *Journal Of Interactive Marketing*, *34*(Mobile Marketing), 25–36. doi:10.1016/j.intmar.2016.03.001

Holman, C., Aguilar, S., & Fishman, B. (2013). GradeCraft: What can we learn from a game-inspired learning management system?. In *Proceedings of the Third International Conference on Learning Analytics and Knowledge* (pp. 260-264). ACM.

Hoorens, V., & Van Damme, C. (2012). What do people infer from social comparisons? Bridges between social comparison and person perception. Social & Personality Psychology Compass, 6, 607e618. http://dx.doi.org/10.1111/j.1751-9004.2012.00451.x

Huczynski, A. A. & Buchanan, D. A., 2013. Organizational Behaviour. Eighth Edition ed. Harlow: Pearson.

Hull, C. (1943). *Principles of Behavior*. New York: Appleton-Century-Crofts.

Ibanez, M-B., Di-Serio, A., & Delgado-Kloos, C. (2014). Gamification for engaging computer science students in learning activities: A case study. *IEEE Transactions on Learning Technologies, 7*(3), 291–301.

Johnson, L., Adams Becker, S., Cummins, M., Estrada, V., Freeman, A., and Hall, C. (2016). *NMC Horizon Report: 2016 Higher Education Edition*. Austin, Texas: The New Media Consortium.

Johnson, L., Adams Becker, S., Cummins, M., Estrada, V., Freeman, A., and Ludgate, H. (2013). *NMC Horizon Report: 2013 Higher Education Edition*. Austin, Texas: The New Media Consortium.

Johnson, L., Adams Becker, S., Estrada, V., and Freeman, A. (2015). *NMC Horizon Report: 2015 Higher Education Edition*. Austin, Texas: The New Media Consortium.

Johnson, L., Adams, S., and Cummins, M. (2012). The NMC Horizon Report: *2012 Higher Education Edition*. Austin, Texas: The New Media Consortium.

Johnson, L., Becker S., Estrada, V. & Freeman A. (2014). *NMC Horizon Report: 2014 Higher Education Edition*. Austin: The New Media Consortium. http://cdn.nmc.org/media/2014-nmc-horizon-report-he-EN-SC.pdf.

Johnson, L., Smith, R., Willis, H., Levine, A., and Haywood, K., (2011). *The 2011 Horizon Report.* Austin, Texas: The New Media Consortium.

Joseph, J. (2016). *What are the top factors that prevent women and racial/ethnic minority employees from leaving engineering professions or the tech industry?* Retrieved from Cornell University, ILR School site: http://digitalcommons.ilr.cornell.edu/student/104

Kanat-Maymon, Y., Benjamin, M., Stavsky, A., Shoshani, A., & Roth, G. (2015). The role of basic need fulfillment in academic dishonesty: A self-determination theory perspective. *Contemporary Educational Psychology*, *43*1–9. doi:10.1016/j.cedpsych.2015.08.002

Kapp K. M. (2012), *The gamification of learning and instruction*, San Francisco, Pfeiffer.

Kelly, G. E. (2012). Lecture attendance rates at university and related factors. *Journal of Further and Higher Education*, *36*, 17–40.

Kim, T., & Werbach, K. (2016). More than just a game: ethical issues in gamification. *Ethics & Information Technology*, *18*(2), 157. doi:10.1007/s10676-016-9401-5

Knautz, K., Göretz, J., & Wintermeyer, A. (2014). Gotta catch'em all. Game design patterns for guild quests in higher education. In *iConfernce 2014 Proceedings* (pp. 690–699).

Kohan, W. (2013). Plato and Socrates: From an Educator of Childhood to a Childlike Educator?. *Studies In Philosophy & Education*, *32*(3), 313-325. doi:10.1007/s11217-012-9348-x

Koivisto, J., & Hamari, J. (2014). Demographic differences in perceived benefits from gamification. *Computers in Human Behavior, 35*, 179–188.

Kriegbaum, K., Villarreal, B., Wu, V. C., & Heckhausen, J. (2016). Parents still matter: Patterns of shared agency with parents predict college students' academic motivation and achievement. *Motivation Science*, *2*(2), 97–115. doi:10.1037/mot0000033

Kuchlich, J. (2005). Precarious Playbour: Modders and the Digital Games Industry. *The Fibreculture Journal*. 5(25).

Lam, J., & Rahma, Y. (2014). Top Management Commitment to Lean: The effects of side-bets on the implementation's success.

Lander, E. S., & Gates, S. J. (2010). Prepare and inspire. *Science (New York, N.Y.)*, *330*(October), 151. http://doi.org/10.1126/science.1198062

Landers, R. N., Bauer, K. N., Callan, R. C., & Armstrong, M. B. (2015). Psychological theory and the gamification of learning. In T. Reiners & L. C. Wood (Eds.), *Gamification in education and business* (pp. 165–186). Cham, Switzerland: Springer.

Langan, E., Lonsdale, C., Blake, C., & Toner, J. (2015). Testing the Effects of a Self-Determination Theory-Based Intervention with Youth Gaelic Football Coaches on Athlete Motivation and Burnout. *Sport Psychologist*, *29*(4), 293–301.

Langdon, D., McKittrick, G., Beede, D., Khan, B., and Doms, M. (2011). *STEM: Good Jobs Now and for the Future.* U.S. Department of Commerce. Washington, DC: Economics and Statistics Administration. Retrieved from http://www.esa.doc.gov/sites/default/files/reports/documents/stemfinaljuly14.pdf.

Latham, G. P., Brcic, J., & Steinhauer, A. (2017). Toward an Integration of Goal Setting Theory and the Automaticity Model. *Applied Psychology*, *66*(1), 25-48.

Ledford, G., Lawler, E. (2015). Using Motivation Theory to Improve Gamification. Center for Effective Organization. University of Southern California. Retrieved from https://ceo.usc.edu/using-motivation-theory-to-improve-gamification/

Lee J., Hammer J. (2011), Gamification in Education: What, How, Why Bother? *Academic Exchange Quarterly*, 15(2).

Lee, H., Doh, Y.Y., 2012. A study on the relationship between educational achieve- ment and emotional engagement in a gameful interface for video lecture systems. In: Proceedings of the 2012 International Symposium on Ubiquitous Virtual Reality. Presented at ISUVR 2012. IEEE, pp. 34–37.

Lemola, S., Brand, S., Vogler, N., Perkinson-Gloor, N., Allemand, M., & Grob, A. (2011). Habitual computer game playing at night is related to depressive symptoms. *Personality and Individual Differences, 51,* 117–122. doi:10.1016/j.paid.2011.03.024

Levy, A., DeLeon, I. G., Martinez, C. K., Fernandez, N., Gage, N. A., Sigurdsson, S. Ó., & Frank-Crawford, M. A. (2016). A quantitative review of overjustification effects in persons with intellectual and developmental disabilities. *Journal of Applied Behavior Analysis*.

Li, W., Grossman, T., Fitzmaurice, G., (2012). GamiCAD: A gamified tutorial system for first time AutoCAD users. In: Proceedings of the 25th Annual ACM Symposium on User Interface Software and Technology. Presented at UIST'12. ACM, Cambridge, MA, pp. 103–112.

Lie, T. (2015). *Why are women leaving the tech industry in droves?* Retrieved from http://www.latimes.com/business/la-fi-women-tech-20150222-story.html

Locke, E., & Latham, G. (1990). *A theory of goal setting and task performance*. Englewood Cliffs, NJ: Prentice Hall.

Locke, E., & Latham, G. (2015). Breaking the rules: a historical overview of goal-setting theory. *Advances in Motivation Science*, *2*(15), 99-126.

Lorenzo, G. (2016). University of Michigan Turns Courses Into Games. EdSurge News. Retrieved from https://www.edsurge.com/news/2016-10-20-university-of-michigan-turns-courses-into-games

Machajewski, S. (2013). CIS150. [Mobile application software]. Retrieved from https://itunes.apple.com/us/app/cis150/id944850769?mt=8

Machajewski, S. (2015). Educational Gamification System and Gameful Teaching Process, US Patent Application No. 14/922,321.

Machajewski, S. (2016a). Computers Storified in Viking History by Floki. *Amazon Alexa Skill*. Amazon.

Machajewski, S. (2016b). Building Inclusive University Culture by Gameful Design of Teaching. Lilly Conference. http://scholarworks.gvsu.edu/cisotherpubs/1

Manna, R., Saha, R., Geetha, G., (2012). Complexity analysis of image-based CAPTCHA. In: Proceedings of the 2012 International Conference on Computing Sciences. Presented at ICCS 2012. IEEE, Phagwara, pp. 88–93.

Marra, R., Rodgers, K., Shen, D., & Bogue, B. (2012). Leaving engineering: A multi-year single institution study. *Journal of Engineering Education, 101*(1), 6–27.

Marshall, C., & Rossman, G. B. (2016). *Designing qualitative research* (6th ed). Thousand Oaks, CA: Sage.

Mastascusa, E., Snyder, W., & Hoyt, B. (2011). *Effective instruction for STEM disciplines: From learning theory to college teaching.* San Francisco, CA: Jossey Bass.

Maulana, R., Opdenakker, M., & Bosker, R. (2014). Teacher–student interpersonal relationships do change and affect academic motivation: A multilevel growth curve modelling. *British Journal Of Educational Psychology*, *84*(3), 459–482. doi:10.1111/bjep.12031

McClelland, D. C., & Liberman, A. M. (1949). The effect of need for achievement on recognition of need-related words. *Journal of Personality*, *18*(2), 236-251.

McDaniel, R., Lindgren, R., Friskics, J., (2012). Using badges for shaping interactions in online learning environments. In: Proceedings of the 2012 IEEE International Professional Communication Conference. Presented at IPCC 2012. IEEE, Orlando, FL, pp. 1–4.

McGonigal, J., (2011). *Reality is Broken: Why Games Make Us Better and How They Can Change the World.* Penguin Books, New York, NY.

McNeill, M. D. J., Charles, D. K., Burke, J. W., Crosbie, J. H., McDonough, S. M., (2012). Evaluating user experiences in rehabilitation games. J. Assist. Technol. 6, 173–181. http://dx.doi.org/10.1108/17549451211261290.

McQuilkin, L. C. (2014). A grounded theory approach to the construction of a uniform and sustainable resiliency development theory (Doctoral dissertation, The University of Phoenix).

Merriam, S. B. (1988). *Case study research in education.* San Francisco, CA: Jossey- Bass.

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. San Francisco, CA: Jossey-Bass.

Micari, M., & Pazos, P. (2012). Connecting to the professor: Impact of the student–faculty relationship in a highly challenging course. *College Teaching, 60*(2), 41–47. doi:10.1080/87567555.2011.627576

Mollit, D. S., 2016. *Study Book: Managing People.* 12th Edition ed. Bradford: Bradford University School of Management.

Moorer, C. J. (2014). The TEACH Method: An Interactive Approach for Teaching the Needs-Based Theories Of Motivation. *Journal Of College Teaching & Learning*, *11*(1), 9–12.

Morneau, R. A., Van Herreweghe, W. G., Little, J. W. H., Lefebvre, D.B. (2012). Energy company perspective on virtual worlds/3-D immersive environments. In: Proceedings of

SPE Intelligent Energy International 2012. Presented at SPE Intelligent Energy International 2012, pp. 329–340.

Muntean, C. I. (2011). Raising engagement in e-learning through gamification. *Proceedings 6th International Conference on Virtual Learning ICVL* (pp. 323–329), Cluj-Napoca, Romania, Europe.

Nadolny, L., & Halabi, A. (2016). Student Participation and Achievement in a Large Lecture Course With Game-Based Learning. *Simulation & Gaming*, *47*(1), 51. doi:10.1177/1046878115620388

National Research Council NRC. (2012). *Monitoring Progress Toward Successful K−12 STEM Education: A Nation Advancing?* Washington, DC: National Academies Press.

National Science Board NSB. (2012). *Science and Engineering Indicators 2012*. Arlington, VA: National Science Foundation.

Nelson, M. J., (2012). Soviet and American precursors to the gamification of work. In: Proceedings of the 16th International Academic MindTrek Conference. Presented at MindTrek'12. ACM, pp. 23–26.

Neuhauser, A., Cook, L. (2016). U.S. News/Raytheon Annual STEM Index. *U. S, News and World Report.*

Nunes, J. C. and Dreze, X. (2006). The endowed progress effect: how artificial advancement increases effort. *Journal of Consumer Research*. 32, 504–512.

O’Donovan, S., Gain, J., & Marais, P. (2013). A case study in the gamification of a university-level games development course. In *Proceedings of the South African Institute for Computer Scientists and Information Technologists Conference*, East London, South Africa (pp. 242–251). New York, NY: Association for Computing Machinery.

O'Mara, J., (2012). Process drama and digital games as text and action in virtual worlds: developing new literacies in school. Res. Drama Educ 17, 517–534. http: //dx.doi.org/10.1080/13569783.2012.727624.

Obama, B., & Biden, J. (2013). Remarks by the president and the vice president on gun violence. Retrieved from http://www.whitehouse.gov/ photos-and-video/video/2013/01/16/president-obama-introduces-plan- reduce-gun-violence#transcript

OECD (2016), *Skills Matter: Further Results from the Survey of Adult Skills*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789264258051-en

Olafsen, A.H., Halvari, H., Forest, J., & Deci, E.L. (2015). Show them the money? The role of pay, managerial need support, and justice in a self-determination theory model of intrinsic work motivation. *Scandinavian Journal of Psychology*, 1-10. doi:10.1111/sjop.12211

Olson, K. (2010). An examination of questionnaire evaluation by expert reviewers. Field Methods, 22(4), 295-318. doi:10.1177/1525822X10379795

Open Systems Technologies (2016). Statement of Work: Gamification Project Delivery. SOW#102426

Opdenakker, M. C., & Minnaert, A. (2011). Relationship between learning environment characteristics and academic engagement. *Psychological Reports*, *109*(1), 259–284.

Orosz, G., Farkas, D., & Roland-Levy, C. (2013). Are competition and extrinsic motivation reliable predictors of academic cheating? *Frontiers in Psychology*, 4(87), 1e16. http://dx.doi.org/10.1080/10508422.2013.877393

Pascarella, E. T., & Terenzini, P. T. (2005). *How college affects students* (2nd ed.). San Francisco, CA: Jossey-Bass Publishers.

Patton, M. Q. (2015). *Qualitative research and evaluation methods* (4th ed.). Thousand Oakes, CA: Sage.

Pennebaker, J. W. and Sanders, D. Y. (1976) American graffiti: Effects of authority and reactance arousal. *Personality and Social Psychology Bulletin*, 2, 264–267

Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. Journal of Educational Psychology, 82(1), 33–40.

Prensky, M. (2009). H. sapiens digital: From digital immigrants and digital natives to digital wisdom. *Innovate: journal of online education*, *5*(3), 1.

President's Council of Advisors on Science and Technology PCAST. (2012). *Engage to Excel: Producing One Million Additional College Graduates With Degrees in Science, Technology, Engineering, and Mathematics*. Washington, DC: Author.

Price, D. V. and Tovar, E. (2014) Student Engagement and Institutional Graduation Rates: Identifying High-Impact Educational Practices for Community Colleges, *Community College Journal of Research and Practice*, Vol 38, No 9, pp 766–782.

Provasnik, S., Kastberg, D., Ferraro, D., Lemanski, N., Roey, S., and Jenkins, F. (2012). *Highlights From TIMSS 2011: Mathematics and Science Achievement of U.S. Fourth- and Eighth-Grade Students in an International Context* (NCES 2013-009). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC.

Reeve, J. (2012). A self-determination theory perspective on student engagement. In S. L. Christenson, A. L. Reschly & C. Wylie (Eds.), Handbook of research on student engagement (pp. 149–172). New York, NY: Springer.

Richter, G., Raban, D. R., & Rafaeli, S. (2015). Studying Gamification: The Effect of Rewards and Incentives on Motivation. In T. Reiners & L. C. Wood (Eds.), *Gamification in Education and Business* (pp. 21–46). Cham: Springer International Publishing. http://doi.org/10.1007/978-3-319-10208-5_2

Robson, K., Plangger, K., Kietzmann, J. H., McCarthy, I., & Pitt, L. (2016). Game on: Engaging customers and employees through gamification. *Business Horizons*, *59*29-36. doi:10.1016/j.bushor.2015.08.002

Rodriguez, L. M., Neighbors, C., Rinker, D. V, & Tackett, J. L. (2015). Motivational Profiles of Gambling Behavior: Self-determination Theory, Gambling Motives, and Gambling Behavior. *Journal of Gambling Studies*, *31*(4), 1597–1615. http://doi.org/10.1007/s10899-014-9497-7

Roesch, S. C. and Amirkham, J. H. (1997) Boundary conditions for self-serving attributions: Another look at the sports pages. *Journal of Applied Social Psychology*, 27, 245–261.

Rouse, K. E., (2013). Gamification in Science Education: The Relationship of Educational Games to Motivation and Achievement (Ph.D.). The University of Southern Mississippi, Ann Arbor.

Ruiz-Primo, M.A., Briggs, D., Iverson, H., Talbot, R., Shepard, L.A. (2011). Impact of undergraduate science course innovations on learning. *Science 331*, 1269–1270.

Ryan, R. M. (1982) Control and information in the intrapersonal sphere: An extension of cognitive evaluation theory. Journal of Personality and Social Psychology, Vol 43,pp 450-461.

Ryan, R., & Deci, E. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*, 68–78.

Saran, C. (2015). A business case for gameplay at work. *Computer Weekly*, 19–22.

Schoenleber, M., & Berenbaum, H. (2012). Shame regulation in personality pathology. *Journal Of Abnormal Psychology*, *121*(2), 433–446. doi:10.1037/a0025281

Schroeder, J., & Fishbach, A. (2015). How to motivate yourself and others? Intended and unintended consequences. *Research in Organizational Behavior*, *35*, 123-141.

Scott, W. E. (1966). Activation theory and task design. *Organizational Behavior and Human Performance*, 1, 3–30.

Sheldon, Lee (2012). The Multiplayer Classroom: Designing Coursework as a Game. Boston, MA: Cengage Learning.

Sherman, D. K. and Kim, H. S. (2002). Affective Perseverance: The Resistance of Affect to Cognitive Invalidation, *Personality and Social Psychology Bulletin*, Vol. 28 No. 2, 224-237.

Sitzmann T. (2011), A Meta-Analytic Examination of the Instructional Effectiveness of Computer-Based Simulation Games, *Personnel Psychology*, 64(2), 489–528

Skinner & Belmont (1993). Motivation in the classroom: Reciprocal effects of teacher behaviour and student engagement across the school year. *Journal of Educational Psychology*, 85(4), 571–581.

Smith, F. (2015). Report: Is it Game Over for Gamification? Retrieved from http://www.edtechmagazine.com/k12/article/2015/06/k-12-nmc-horizon-report-preview-it-game-over-gamification

Snyder, E., Hartig, J., (2013). Gamification of board review: a residency curricular innovation. Med. Educ. 47, 524–525. http://dx.doi.org/10.1111/medu.12190

Statista. (2016). Statistics and facts about the casino industry. Retrieved from https://www.statista.com/topics/1053/casinos/

Stinebrickner, T.R., and Stinebrickner, R. (2011). *Math or Science? Using Longitudinal Expectations Data to Examine the Process of Choosing a College Major*. NBER Working Paper No. 16869. Cambridge, MA: National Bureau of Economic Research.

Stott, A., & Neustaedter, C. (2013). Analysis of gamification in education. Retrieved from http://carmster.com/clab/uploads/Main/Stott-Gamification.pdf.

Strati, A. D., Schmidt, J. A., & Maier, K. S. (2017). Perceived challenge, teacher support, and teacher obstruction as predictors of student engagement. *Journal Of Educational Psychology*, *109*(1), 131-147. doi:10.1037/edu0000108

Stroet, K., Opdenakker, M. C., & Minnaert, A. (2013). Effects of need supportive teaching on early adolescents' motivation and engagement: A review of the literature. *Educational Research Review*, *9*, 65–87.

Swap, R. J., & Walter, J. A. (2015). An Approach to Engaging Students in a Large-Enrollment, Introductory STEM College Course. *Journal Of The Scholarship Of Teaching And Learning*, *15*(5), 1–21.

Täht, K., Must, O., Peets, K., & Kattel, R. (2014). Learning motivation from a cross-cultural perspective: a moving target?. *Educational Research & Evaluation*, *20*(4), 255. doi:10.1080/13803611.2014.929009

Terlutter, R., Capella, M. L., (2013). The gamification of advertising: analysis and research directions of in-game advertising, advergames, and advertising in social network games. J. Advert. 42, 95–112. http://dx.doi.org/10.1080/ 00913367.2013.774610

The White House. (2016). *Educate to Innovate*. Washington, DC. Retrieved from http://www.whitehouse.gov/issues/education/educate-innovate

Taylor, T.L. (2006). Play Between Worlds: Exploring Online Game Culture. The MIT Press. p. 69. ISBN 0262201631.

Tsounis, A., Sarafis, P., & Bamidis, P. (2014). Motivation among Physicians in Greek Public Health-Care Sector.

University of Michigan. (2015). U-M funds six learning transformation grants through Third Century Initiative. University of Michigan News. Retrieved from http://ns.umich.edu/new/releases/22895-u-m-funds-six-learning-transformation-grants-through-third-century-initiative

Uysal, A. (2016). Full length article: Commitment to multiplayer online games: An investment model approach. *Computers In Human Behavior*, *61*357-363. doi:10.1016/j.chb.2016.03.028

Vandercammen, L., Hofmans, J., & Theuns, P. (2014). The mediating role of affect in the relationship between need satisfaction and autonomous motivation. *Journal of Occupational and Organizational Psychology, 87*(1), 62-79. doi:10.1111/joop.12032

Vansteenkiste, M., Lens, W., & Deci, E. L. (2006). Intrinsic Versus Extrinsic Goal Contents in Self-Determination Theory: Another Look at the Quality of Academic Motivation. *Educational Psychologist*, *41*(1), 19-31. doi:10.1207/s15326985ep4101_4

Vansteenkiste, M., Simons, J., Lens, W., Sheldon, K.M., & Deci, E.L. (2004). Motivating learning, performance, and persistence: The synergistic role of intrinsic goals and autonomy support. *Journal of Personality and Social Psychology*, 87,246–260.

Vasquez H., Fuentes A., & Kypuros J. (2015) Interventions to improve lower-level engineering gatekeeper courses, *Proceedings of the ASEE GSW Regional Conference*

Vassileva, J. (2012). Motivating participation in social computing applications: A user modeling perspective. *User Modeling and User-Adapted Interaction, 22*(1), 177–201.

Vroom, V. H. (1964). *Work and motivation*. New York: Wiley.

Wagner, M., Christe, B., & Fernandez, E. (2012). *Comparing first year engineering technology persisters and non-persisters*. Paper presented at American Society of Engineering Education Annual Conference, San Antonio, TX.

Weiyun, C., & Hypnar, A. J. (2015). Elementary School Students' Self-Determination in Physical Education and Attitudes Toward Physical Activity. *Journal Of Teaching In Physical Education*, *34*(2), 189–209. doi:10.1123/jtpe.2013-0085

Wells, B. M., & Skowronski, J. J. (2012). Evidence of choking under pressure on the PGA tour. Basic & Applied Social Psychology, 34, 175e182. http://dx.doi.org/10.1080/01973533.2012.655629.

Werbach, K., Hunter, D., (2012). For the Win: How Game Thinking Can Revolutionize.

Westfall, R. S., Millar, M., & Walsh, M. (2016). 'Effects of instructor attractiveness on learning': Corrigendum. *Journal Of General Psychology*, *143*(4), 311. doi:10.1080/00221309.2016.1218704

Whitson, J. R. (2013). Gaming the Quantified Self. *Surveillance & Society*, *11*(1/2), 163.

Wierts, C., Burns, M. J., Santin, S. A., Mack, D. E., Blanchard, C. M., & Wilson, P. M. (2015). Comparing motivational differences between competitive and recreational weight trainers using Organismic Integration Theory: A replication and extension study. *Journal of Exercise, Movement, and Sport*, *47*(1).

Williams, G. C., Halvari, H., Niemiec, C. P., Sørebø, Ø., Olafsen, A. H., & Westbye, C. (2014). Managerial support for basic psychological needs, somatic symptom burden and work-related correlates: A self-determination theory perspective. *Work & Stress*, *28*(4), 404–419.

Yeager, D. S., & Dweck, C. S. (2012). Mindsets That Promote Resilience: When Students Believe That Personal Characteristics Can Be Developed. *Educational Psychologist*, *47*(4), 302–314. http://doi.org/10.1080/00461520.2012.722805

Yin R. K. (1981) The Case Study Crisis: Some Answers. *Administrative Science Quarterly*. March 1981;26(1):58-65. Available from: Business Source Complete, Ipswich, MA. Accessed February 17, 2017.

Yin, R. K. (2014). *Case study research: Design and methods* (5th ed.). Thousand Oaks, CA: Sage.

Yoo, S.J., Han, S., & Huang, W. (2012). The roles of intrinsic motivators and extrinsic motivators in promoting e-learning in the workplace: A case from South Korea. *Computers in Human Behavior, 28*, 942-950. doi:10.1016/j.chb.2011.12.015

Yunhui, H., Wei, L., & Jiang, W. (2016). Relationship Between Intrinsic Motivation and Undergraduate Students' Depression and Stress: The Moderating Effect of Interpersonal Conflict. *Psychological Reports*, *119*(2), 527-538. doi:10.1177/003329411666151

Appendix A

Instructions in the Journal assignment inside of the Blackboard Learn LMS:

Saga is a word originating from Old Norse meaning "what is said" or "story”. Vikings didn't write records of their activities. Instead, their history is primarily written by their enemies or, a few centuries after the events, by Icelandic scribes based on memories. The Romans used to say: “Victors write history.” Our lives are stories, stories that start and end in the mind. Constructing a better reality requires a good understanding of what your experience is and what your story is so far.

What to write?

To get started you may first write a brief summary of the contents of a lecture, lab activity, group discussion or reading material. Then reflect upon these activities - record your own thoughts, ideas, responses and reactions to any of the above activities. Make notes about concepts, questions you have, and any confusion that may arise. Use the journal to explore possible solutions to problems being raised in class or alternative activities to the ones presented in class. Record new insights and problem solving strategies realized during discussions with fellow students and instructors. The journal reflects your own thoughts and ideas. Be as original as you can.

Follow these steps:

1. Reflect, think. What are your reactions? What are your feelings?

2. Spill. Write, record, ignore the 'delete' button.

3. Analyze, explain, gain insight. What was really going on? What sense can you make of the situation?

4. Edit and save.

Sample entries:

"This week I lost my job because my employer thought I was not consistent in my work. At first I was a little upset, because I'm always on time, and I complete what I can by the end of the day. I couldn't figure out what she meant by stating that I wasn't consistent in my work. After thinking about the situation, I realized that I can only complete the work assigned to the best of my ability. What she doesn't realize is that the problem started because I constantly received incomplete reports. Whoever ends up with my former job will have the same issues if that problem isn't addressed first. However, knowing that I did what I could will allow me to continue to move forward with a positive outlook for the future."

"Last week's lecture presented the idea that science is the most powerful form of evidence. My position as a student studying both physics and law makes this an important issue for me and one I was thinking about while watching the 'The New Inventors' television program last Tuesday. The two 'inventors' (an odd name considering that, as Smith (2002) says, nobody thinks of things in a vacuum) were accompanied by their marketing people. The conversations were quite contrived, but also funny and enlightening. I realised that the marketing people used a certain form of evidence to persuade the viewers (us?) of the value of the inventions. To them, this value was determined solely by whether something could be bought or sold—in other words, whether something was 'marketable'. In contrast, the inventors seemed quite shy and reluctant to use anything more than technical language, almost as if this was the only evidence required – as if no further explanation was needed."

Why to write a learning log?

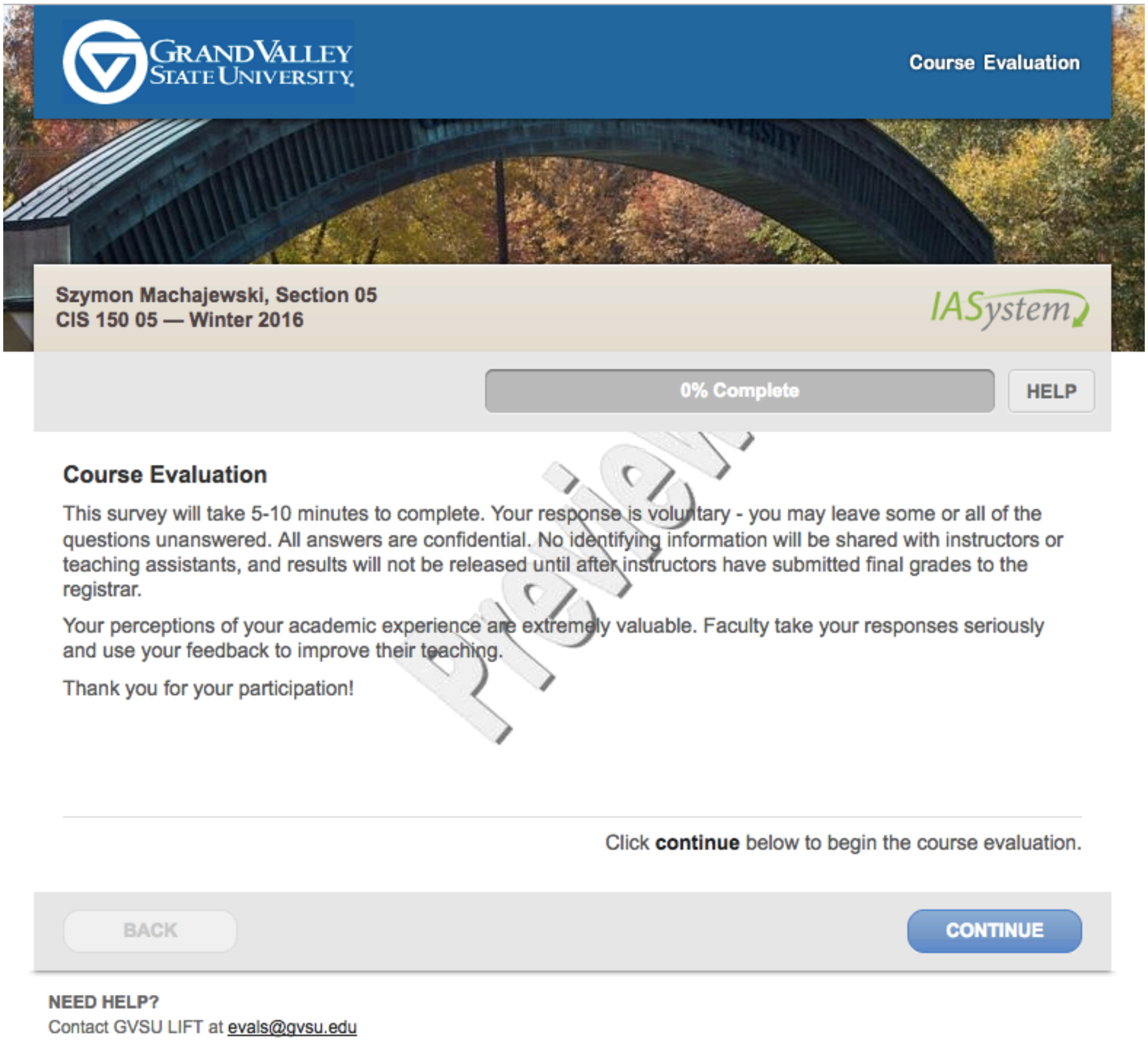
1. To make sense of things that happened. Just the act of writing down the details of what happened may give you perspective that you may not have otherwise considered had you just continued to think about it.

What aspects of this class detracted from your learning?2. To speculate as to why something is the way it is. Your views can come from your own common sense, or from something you have heard at a lecture or read in a book. Either way, speculating why something is the way it is can be a very useful exercise in reasoning.

3. To get thoughts and ideas out of your head. Writing down your thoughts can help relieve pressure or help resolve problems. It will also help you focus the task at hand.

Appendix B

University facilitated course reviews through IASystem:



	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
After taking this class my confidence in using computers increased.	○	○	○	○	○
This class was a well played game.	○	○	○	○	○
I enjoyed lectures in this class.	○	○	○	○	○
The game system in this class encouraged me to do additional practice, which otherwise I would not do.	○	○	○	○	○

On average, how many hours per week have you spent on this course, including attending classes, doing readings, reviewing notes, writing papers and any other course related work?

From the total average hours above, how many do you consider were valuable in advancing your education?

What grade do you expect in this course?

In regard to your academic program, is this course best described as:

Relative to other college courses you have taken:

	Much Higher			Average			Much Lower
Do you expect your grade in this course to be:	○	○	○	○	○	○	○
The intellectual challenge presented was:	○	○	○	○	○	○	○
The amount of effort you put into this course was:	○	○	○	○	○	○	○
The amount of effort to succeed in this course was:	○	○	○	○	○	○	○
Your involvement in course (doing assignments, attending classes, etc.) was:	○	○	○	○	○	○	○

	Excellent	Very Good	Good	Fair	Poor	Very Poor
Course organization was:						
Clarity of instructor's voice was:						
Explanations by instructor were:						
Instructor's ability to present alternative explanations when needed was:						
Instructor's use of examples and illustrations was:						
Quality of questions or problems raised by the instructor was:						
Student confidence in instructor's knowledge was:						
Instructor's enthusiasm was:						
Encouragement given students to express themselves was:						
Answers to student questions were:						
Availability of extra help when needed was:						
Use of class time was:						
Instructor's interest in whether students learned was:						
Amount you learned in the course was:						
Relevance and usefulness of course content were:						

	Excellent	Very Good	Good	Fair	Poor	Very Poor
The course as a whole was:						
The course content was:						
The instructor's contribution to the course was:						
The instructor's effectiveness in teaching the subject matter was:						

BACK CONTINUE

NEED HELP?
Contact GVSU LIFT at evals@gvsu.edu

Was this class intellectually stimulating? Did it stretch your thinking? Why or why not?

What aspects of this class contributed most to your learning?

What aspects of this class detracted from your learning?

What suggestions do you have for improving the class?

Appendix C

Section I. Course Evaluations Coding Sheet

1. **Course Evaluations – priori codes**

The following quantitative questions will be coded on a separate sheet per class:

"After taking this class my confidence in using computers increased" 1 – 5

"This class was a well played game" 1 – 5

"I enjoyed lectures in this class" 1 – 5

"The game system in this class encouraged me to do additional practice, which otherwise I would not do" 1 – 5

"On average, how many hours per week have you spent on this course, including attending classes, doing readings, reviewing notes, writing papers and any other course related work?" (Under 2 2-3 4-5 6-7 8-9 10-11 12-13 14-15 16-17 18-19 20-21 22 or more)

Coding sheet for the quantitative data questions:

Response ID (numerical data, auto incremented, ex: 1)

Semester (ex: Winter 2016)

Question ID (ex: 5)

Median Value

Mean Value

Data: (Comma delimited list of response ranges, ex: High 5, Low 2)

Open ended questions 1-4.

Was this class intellectually stimulating? Did it stretch your thinking? Why or why not?

What aspects of this class contributed most to your learning?

What aspects of this class detracted from your learning?

What suggestions do you have for improving the class?

Coding sheet for the 4 questions:

Response ID (numerical data, auto incremented, ex: 1)

Semester (ex: Winter 2016)

Question ID (ex: 5)

Engagement

Participation

Competition

Attendance

Class Game

Self-determination Theory driven priori codes:

Autonomy (expressions indicate autonomy to participate or engage in activities)

Relatedness (social activities, relating with others)

Competence (path toward mastery, improvement, learning)

Section II. RateMyProfessors.com Coding Sheet.

Question 10: Here's your chance to be more specific:

Coding sheet for Question 10:

Response ID (numerical data, auto incremented, ex: 1)

Date recorded (ex: 1/1/2015)

Engagement

Participation

Competition

Attendance

Class Game

Self-determination Theory driven priori codes:

Autonomy (expressions indicate autonomy to participate or engage in activities)

Relatedness (social activities, relating with others)

Competence (path toward mastery, improvement, learning)

Section III. Journals Coding Sheet.

The Blackboard Learn Journals offer a single comment fields with multiple entries per student.

Coding sheet for Journal Entry:

Response ID (numerical data, auto incremented, ex: 1)

Date recorded (ex: 1/1/2015)

Student ID (unique number to anonymize the author; numerical data, auto incremented, ex: 1)

Engagement

Participation

Competition

Attendance

Class Game

Self-determination Theory driven priori codes:

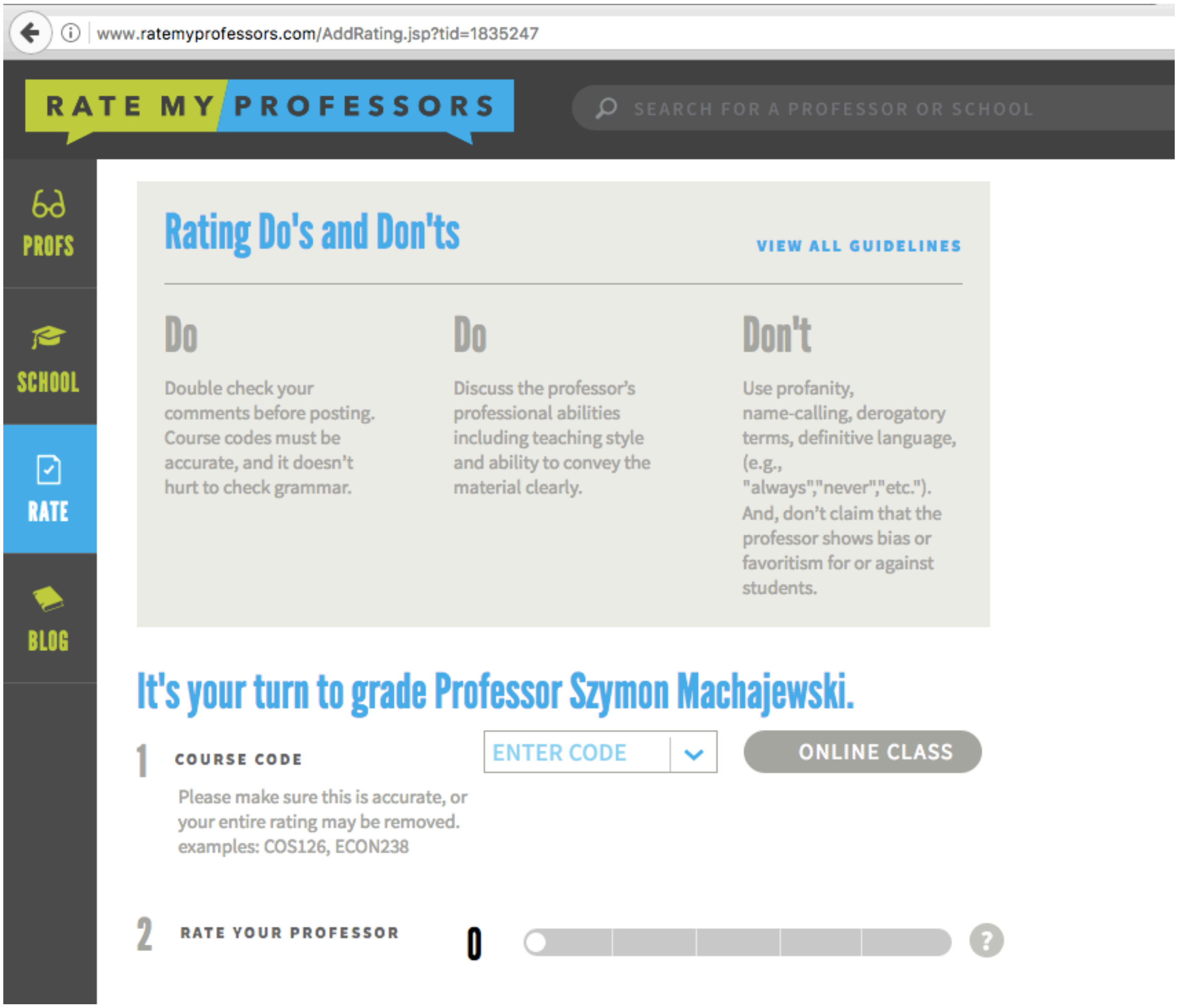
Autonomy (expressions indicate autonomy to participate or engage in activities)

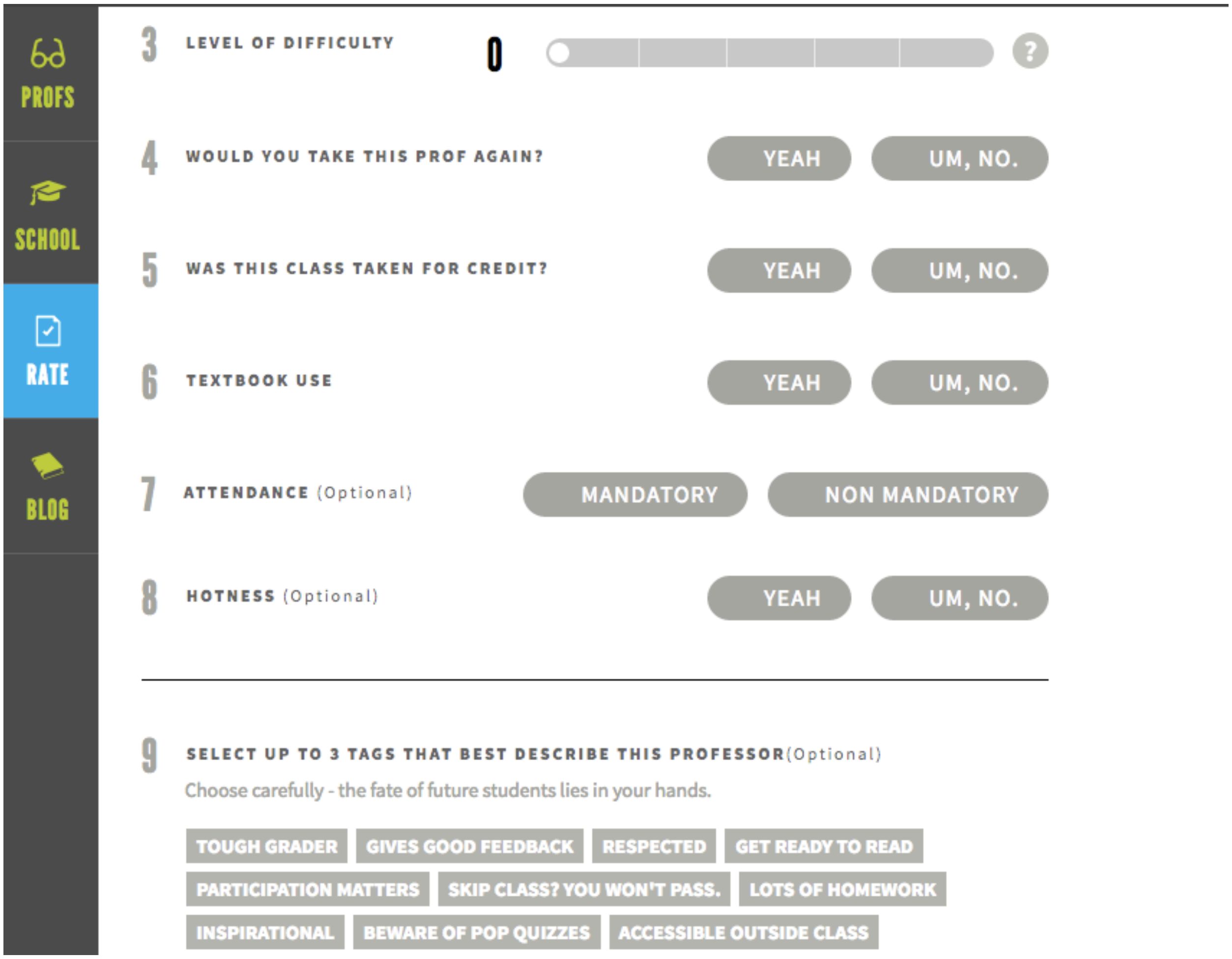
Relatedness (social activities, relating with others)

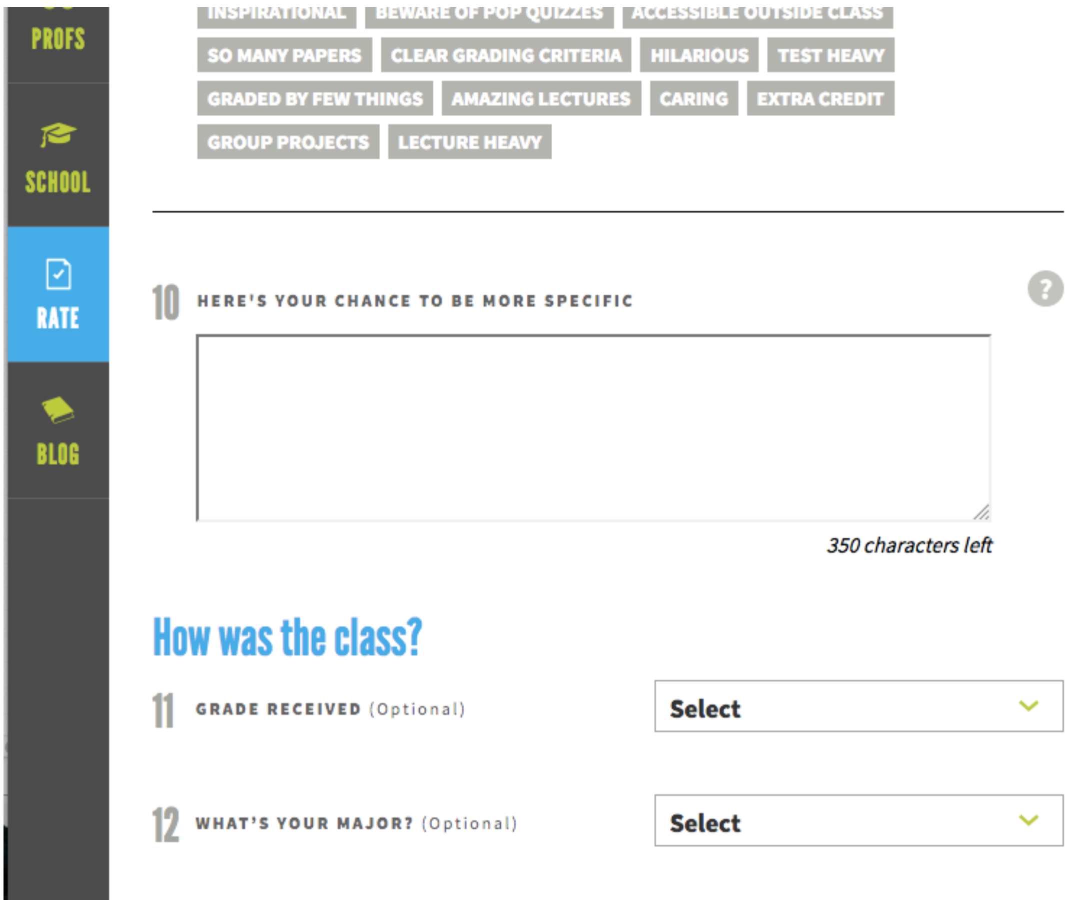
Competence (path toward mastery, improvement, learning)

Appendix D

RateMyProfessors.com review form:

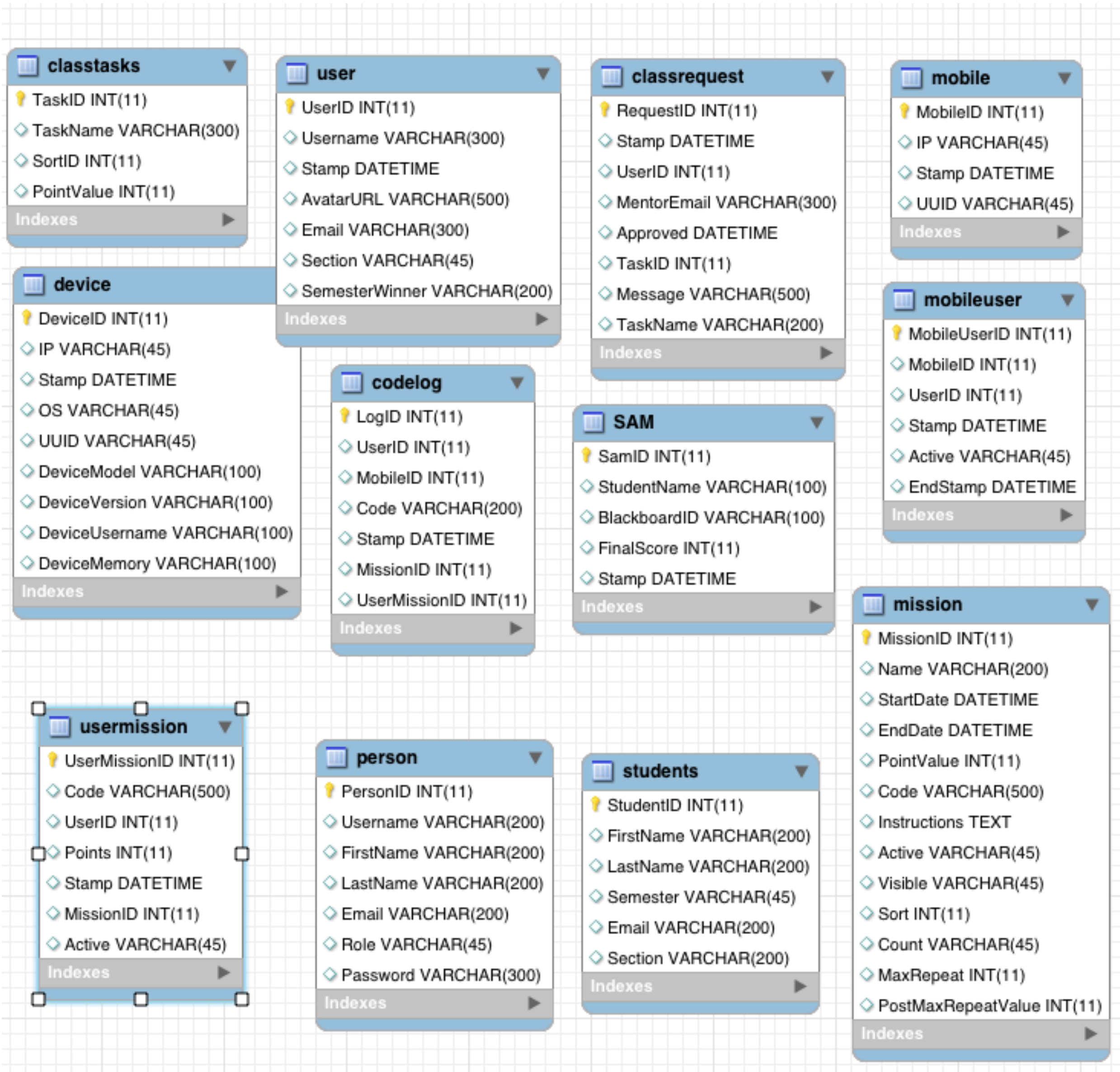



PROFS
SCHOOL
RATE
BLOG
3 LEVEL OF DIFFICULTY
0
4 WOULD YOU TAKE THIS PROF AGAIN?
YEAH
UM, NO.
5 WAS THIS CLASS TAKEN FOR CREDIT?
YEAH
UM, NO.
6 TEXTBOOK USE
YEAH
UM, NO.
7 ATTENDANCE (Optional)
MANDATORY
NON MANDATORY
8 HOTNESS (Optional)
YEAH
UM, NO.
9 SELECT UP TO 3 TAGS THAT BEST DESCRIBE THIS PROFESSOR (Optional)
Choose carefully - the fate of future students lies in your hands.
TOUGH GRADER
GIVES GOOD FEEDBACK
RESPECTED
GET READY TO READ
PARTICIPATION MATTERS
SKIP CLASS? YOU WON'T PASS.
LOTS OF HOMEWORK
INSPIRATIONAL
BEWARE OF POP QUIZZES
ACCESSIBLE OUTSIDE CLASS


PROFS
SCHOOL
RATE
BLOG
INSPIRATIONAL
BEWARE OF POP QUIZZES
ACCESSIBLE OUTSIDE CLASS
SO MANY PAPERS
CLEAR GRADING CRITERIA
HILARIOUS
TEST HEAVY
GRADED BY FEW THINGS
AMAZING LECTURES
CARING
EXTRA CREDIT
GROUP PROJECTS
LECTURE HEAVY
10 HERE'S YOUR CHANCE TO BE MORE SPECIFIC
?
350 characters left
How was the class?
11 GRADE RECEIVED (Optional)
Select
12 WHAT'S YOUR MAJOR? (Optional)
Select

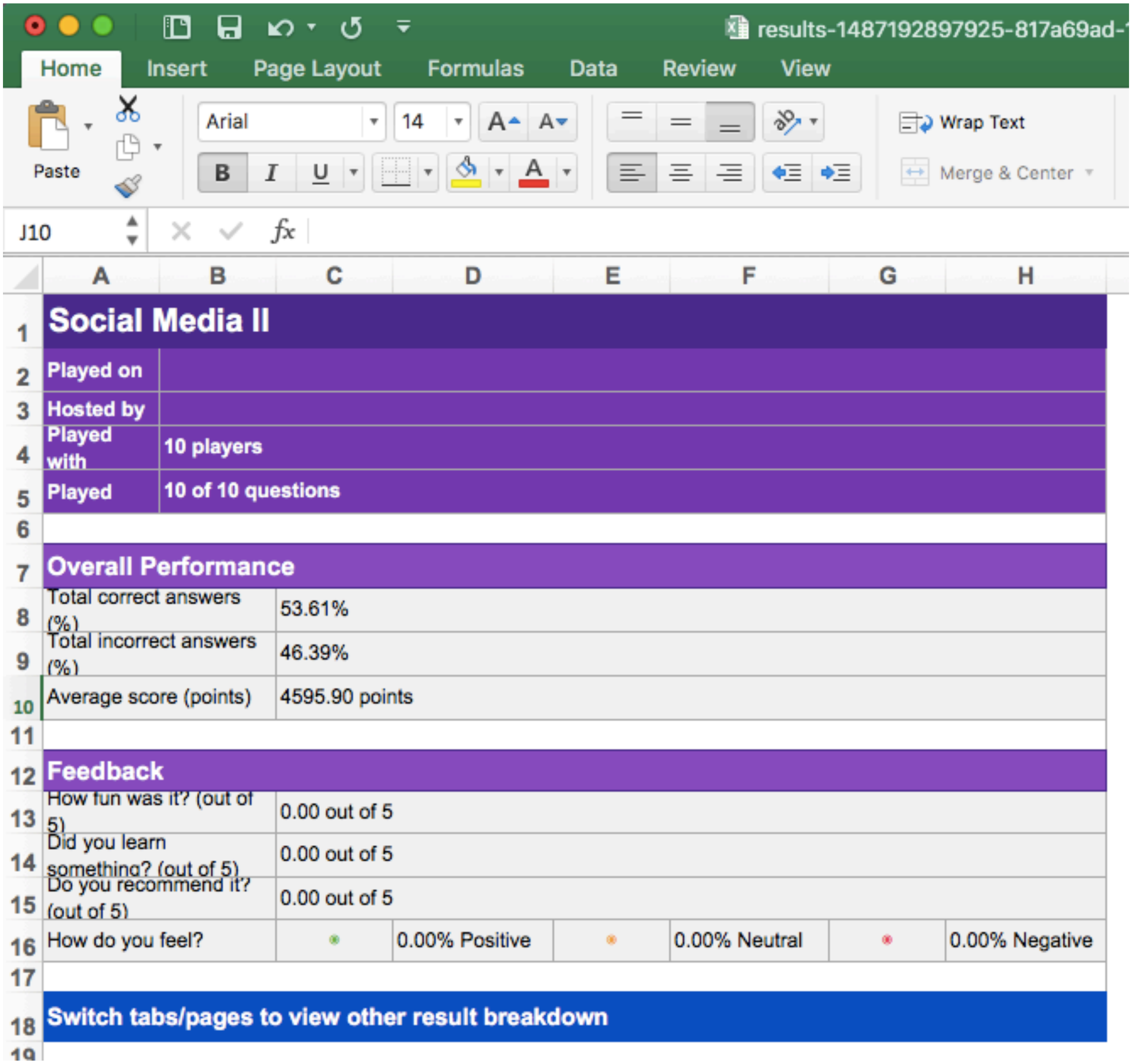
Appendix E

Gamification software with a ledger of XP and evidence of activity:



Appendix F

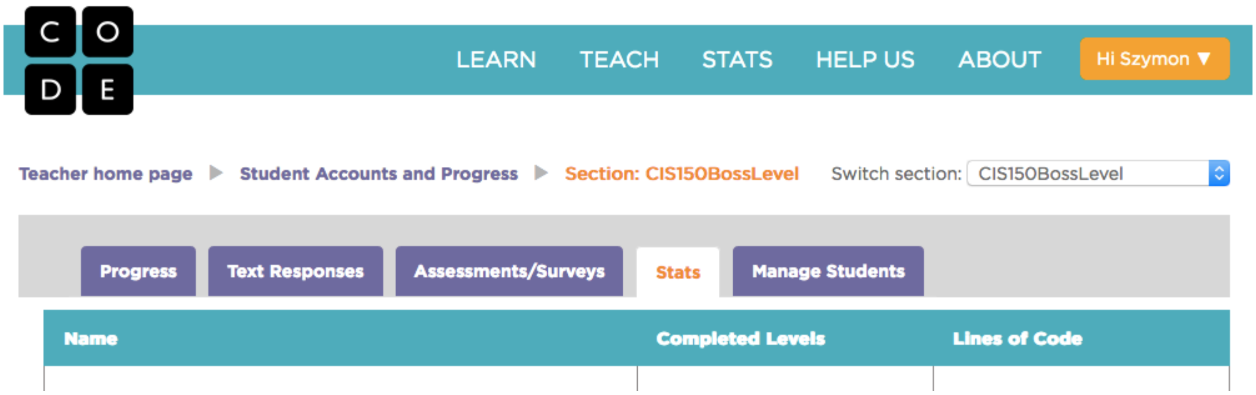
Kahoot results in the cloud system.



	A	B	C	D	E	F	G	H
1	Social Media II							
2	Played on							
3	Hosted by							
4	Played with	10 players						
5	Played	10 of 10 questions						
6								
7	Overall Performance							
8	Total correct answers (%)		53.61%					
9	Total incorrect answers (%)		46.39%					
10	Average score (points)		4595.90 points					
11								
12	Feedback							
13	How fun was it? (out of 5)		0.00 out of 5					
14	Did you learn something? (out of 5)		0.00 out of 5					
15	Do you recommend it? (out of 5)		0.00 out of 5					
16	How do you feel?			0.00% Positive		0.00% Neutral		0.00% Negative
17								
18	Switch tabs/pages to view other result breakdown							

Appendix G

Code.org activity report.



Appendix H

CodeCombat.com activity report.

Name	Username	Email	Total Levels	Total Playtime	CS1 Levels	CS1 Playtime	Concepts
John	Smith	jsmith@gma	18	1 hour	18	1 hour	Basic Syntax, Arguments, Strings, While Loops, Variables