REPORT 2

Gamification

How Gamified Learning Impacts Engagement

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Introduction

How do games impact people's engagement? Games and participating in gameplay are often associated with the realms of fun, creativity, and entertainment. An enjoyable game can capture the player's attention and dedication for hours in one sitting. How might we learn from games to create more engaging experiences for people in other areas of their life? Could games be used to make education and work more fun and productive? Gamification is a term that "refers to the use of game elements in non-game contexts" with the goal of taking the fun and addictive parts of games and implementing them into real-world contexts, such as in education and business, to make experiences more engaging for the participant [1]. The use of gamification has drastically increased in recent years, and the North American gamification industry, alone, is valued at $2.72 billion [2]. Recognizable examples of gamification include Reddit's karma system to encourage valuable discussion, game-based platform Kahoot! to make learning fun, and Apple Watch's rings to motivate fitness-activity [3, 4, 5].

What makes gamification effective? Who benefits from gamification? One of the primary problems that educators face in effective learning is the lack of student engagement [6]. This report discusses gamification in education, touching on its relevance to concepts discussed in game theory, its impact on student engagement, how it's presented in popular e-learning applications, and its advantages and limitations in educational settings. We end with a discussion about the use of gamification in two courses, HONORS 221: Game Theory and CSE 373: Data Structures and Algorithms.

Game Concept

Through gamification, educators are able to create opportunities for students to earn utility on tasks that were once seen as menial and boring. Utility, defined in lecture 1 as "whatever players are hoping to maximize" [Lecture 1], can refer to a multitude of things: it can represent the amount of content that a student has deeply understood, the number of artifacts that a student has created through coursework, or a high numerical grade. In any case, utility should reflect a student's sense of accomplishment and happiness with their learning experience. For some students, they feel most satisfied with their learning when they attend office hours every single week and complete every extra credit assignment. For others, waking up on time and having the energy to watch a lecture recording could be the cornerstone of their academic achievements. However one chooses to define a valuable and fulfilling educational accomplishment remains up to the student.

Adding gamification elements allows instructors to either amplify students' initial sources of utility (an example of this is implementing streaks for students who answer questions every

day) or create new ones altogether (such as creating a public class leaderboard to show which students turned in their assignments before the due date). No matter the method, these gamified interactions can give students additional motivation to work on coursework and to maximize their utility along their chosen axes.

The concept of exploration and exploitation can also tie into gamification in education [Lecture 12]. On one hand, having multiple opportunities to resubmit work or learn from past mistakes can give students additional leeway to explore and try new things as part of their learning experience. However, in more traditional classrooms, while gamification is intended to encourage people to explore different opportunities, this can be compromised by students' strong senses of risk aversion. Oftentimes, this manifests in a deep seated desire to exploit known options to maximize overall payoff and guarantee a higher final grade. For example, if an assignment asks students to submit either an essay or video with incentives to meet scaffolded deliverables, most students will opt to submit the format they have the most practice with creating from start to finish (most likely an essay). The risks of struggling to film and produce a video, as well as risks of spending significantly longer on the assignment, may not outweigh the excitement, engagement, and learning opportunities that creating a video can bring.

Two key questions that educators face is: how can I create novel, engaging, and fun experiences for all students while ensuring that they are understanding the content? How can I get my students to be as excited about this subject as I am? Select courses, such as HONORS 221: Game Theory, have begun to find answers to this question.

The Main Course

Traditional Teaching Methods, E-Learning, and Gamified Education

In the traditional and still-widely-used teaching model, students gather in a classroom to acquire knowledge from the teacher. The teacher leads what is taught and how it's taught. Often, the learning process is as follows: (1) The teacher gives a lecture on the learning material. (2) Students are expected to take notes to memorize the content. (3) Students ask the teacher clarifying questions. (4) Students complete related homeworks and are tested on material mastery. The traditional method of teaching is teacher-centric, rather than student-centric, because it falls short in encouraging student engagement and promoting collaborative learning between peers [7]. In these environments, students might feel reluctant to interact with the teacher, ask questions, or answer questions out of fear that they'll dominate the discussion, be wrong and embarrass themselves [8]. The traditional teaching method can be reimagined to be more explorative and fun by considering more effective ways to actively involve students and lessen fears of failure or embarrassment.

E-learning is the "transfer of skills and knowledge via electronic means" [9]. E-learning most commonly includes web-based learning, computer-based learning, and virtual classrooms. The main advantages of e-learning for students are reduction in time and cost, accessibility, opportunity to build technological literacy, personalization and adaptability, less classroom intimidation, and greater interactivity. Students can save time and money by not having to commute to class. Learning can be accessed from anywhere as long as the student has internet access and a compatible device. Students are responsible for their own learning and

are able to work at their own pace. Students engage more with the content because they are less worried about what others in the classroom may think, and e-learning allows for more interactivity. In traditional classroom settings, students ask about 0.1 questions per hour while e-learning programs can prompt students with questions and answer up to 120 times per hour [10]. In 2020, the COVID-19 pandemic drastically changed the educational experience of over a billion students by shutting down in-person classes and shifting students to remote learning [11]. While the use of e-learning technologies had been increasing beforehand, it's now more prevalent than ever, and instructors continue to employ e-learning technologies during the transition back to in-person classrooms. The challenge with e-learning is that, since the pandemic, most students have begun to feel online learning fatigue, a state of weariness and overall lack of energy and motivation to engage [12]. Gamification has been one of the main solutions towards fighting boredom and fatigue by increasing engagement.

Gamified education is the inclusion of game elements in e-learning and has shown to be more engaging and motivating than traditional classes [2]. A study was done in which 577 undergraduate students taking Information Literacy Skills classes were split into two groups; one group would take a gamified version of the course while the other group would take the traditional course. The gamified version of the course employed game elements like a points-system, competition, badges, and leaderboards. The results of this study showed that students who were in the gamified course showed significantly more engagement than students who were in the non-gamified course [6].

A few well known and widely used examples of gamified education include Duolingo, Kahoot!, and Quizlet. Duolingo is a language learning application that tailors the educational experience for each student with the lessons that feel more like a game [13]. Duolingo argues that the game-like approach to learning is proven to foster long-term retention, and that students find learning easier when they're having fun. Kahoot! is a game-based learning platform where users can easily make, play, and share trivia quizzes [4]. Teachers often use Kahoot! as a tool in their classrooms to test students' knowledge. A huge benefit for teachers is that real-time feedback allows them to pause in-between questions if students' responses on the previous question displayed a lack of understanding. Quizlet allows users to make their own study sets and tools based on flashcards [14]. Users can study material in a gamified approach through Match (match term to definition) and Gravity (answer questions within given time) games. Quizlet also offers Quizlet Live, a classroom game activity similar to Kahoot!. The success of these platforms demonstrates the effectiveness of gamification in educational settings and showcases how learning is more enjoyable when made fun.

Key Game Elements

The inclusion of game elements can elicit positive emotions from the participant. There are a few key game elements that this report will discuss: point systems, badge systems, leaderboards, progress bars, and real-time feedback systems [16]. With point systems, points are rewarded for completing tasks and often accumulate to progress the participant towards the next level. The bigger the task, the bigger the reward. In game-based learning, students are rewarded points for answering questions correctly and sometimes can compete for more points by answering questions correctly faster than their peers. Badges can be earned by achieving a milestone or completing a challenge. They are awards that the participant can showcase on their profile. Leaderboards encourage competition between students and support

collaboration by allowing teams of students to compete against each other. People are competitive by nature, and if students want to win against their friends or peers, they'll be more committed to the activity. Progress bars visualize a student's progress and showcase how close they are to the next achievement. Being close to the next level can motivate students to engage for longer periods of time. Real-time feedback systems allow students to get immediate feedback on their performance, whether an answer is right or wrong. This allows students to learn as they progress, question-by-question.

Gamification Encourages Exploration and Engagement

One of the primary issues that hinder student engagement is fear of being incorrect and feeling embarrassed as a result. Gamification addresses this issue. Games for entertainment, such as video games, typically give the player a set number of lives. When a player has multiple lives to spare, they feel more free to explore and take risks because there is little to no real consequence for failing. When a player loses a life, they start over with a new one and continue. Knowing that you can fail and keep trying again is a valuable element of gaming that can be translated into educational contexts through gamification. Gamified education rewards correct responses and has little to no consequences for incorrect responses. It's a system that encourages students to learn through exploration and error. Real-time feedback teaches students what's right and what's wrong, and they're able to put that knowledge towards the next question. Gamified learning increases student engagement by creating an environment where they can feel free to take risks and learn from mistakes.

Advantages and Limitations of Gamified Learning

The main advantages of gamified learning include increased student engagement, autonomy over one's learning, and adaptability. Gamified learning can be done remotely and in in-person settings through the use of electronic devices. Instructors largely benefit from gamified e-learning technologies [9]. Gamification results in high knowledge retention rates. Grading, reporting, and organizing each student's progress is simplified. Basic activities can be automated, and the instructor's role transitions from being the center of attention (traditional teaching method) to being facilitators of learning. Each student has a more personalized educational experience.

While gamified learning has its advantages over traditional teaching methods, it also has limitations. Many of these limitations stem from gamified learning also being an e-learning technology. To participate, students must have access to a device with internet access—laptop, tablet, smartphone. Not all content is suitable for e-learning. For example, work that relies heavily on person-to-person interaction or hands-on work (such as lab work, handling machinery, assembling parts in engineering classes, sculpting in ceramics) would not translate well onto an e-learning platform. In addition, not all humans are suited for e-learning. Some humans thrive better in environments where they can interact with other humans. So the virtual nature of e-learning may create a lack of motivation. A gamification-specific limitation is that over-gamifying an activity or course may lessen the content's seriousness for the participant. Some game elements, such as narratives and characters/avatars, are also less effective when trying to increase engagement.

Different types of students respond to gamification differently. In a usability study on gamified e-learning platforms, researchers found that gamification is also more effective for gamer students versus non-gamer students [15]. Gamer students prefer to use more challenging gamification features and are able to use gamified platforms more efficiently than non-gamer students. Non-gamer students may not prefer to use challenging gamification features. However, all participants agreed that gamified education was better than traditional education.

Discussion

Based on academic research, as well as our personal experiences, gamification has enhanced learning and e-learning significantly. By tapping into students' senses of competition and desires to maximize utility, students are more engaged in coursework, solving a problem exacerbated by the COVID-19 pandemic [6].

However, without any practical or applicable guidelines for how to implement gamification into courses [14], instructors are often forced to experiment and iterate, giving rise to a variety of techniques used in different scenarios. The Discussion will begin with two case studies of gamified courses, one being HONORS 221: Game Theory and the other being CSE 373: Data Structures and Algorithms. Drawing on our learnings of gamification mentioned above, as well as an analysis of existing gamified UW courses, we will also present design suggestions and considerations for future courses with gamification elements. We will conclude by exploring the impacts of gamification on society as a whole.

HONORS 221: Game Theory

A vast majority of classes across the education system, do not employ active learning or gamification techniques to drive student engagement. Courses at the University of Washington are no different. However, for a class centered on game theory, it seems natural and intuitive that gamification elements were embedded in the course structure itself [18]. Key gamification-esque elements in HONORS 221 included, but are not limited to:

- Poll questions, facilitated via Poll Everywhere during a live lecture,
- Scratchoffs, "like a cross between a Scantron and a scratch-off lottery ticket",
- And Gollars, an in-class currency earned through in-class games and spent on a silent auction at the end of the class.

From our anecdotal experiences, the poll questions and scratchoffs were lightweight ways to encourage students to stay active and also collaborate with groupmates to check our understanding and confirm our mastery of the topics in real-time. Poll questions were a good way to engage students with revisiting the concepts from the prior lecture or homework assignments, and the physical nature of scratching the silver film for scratchoffs emulates the same feelings of enjoyment that people may get from scratching lottery tickets. However, as points were tied to both of these activities, and neither supported resubmissions or point make-ups, the stresses of getting the correct answer sometimes interfered with the enjoyment and engagement of clicking a poll answer and getting live feedback. More flexibility with poll questions could have been helpful for reducing this stress among students.

Most interesting to us, however, was the institution of Gollars, a currency that was not transferable to class points and would not impact our grades. Our motivation to earn Gollars was purely driven by our competitive instincts. The flexibility that was missing from poll questions was afforded with Gollars - the system was low stress and low stakes, but high engagement due to all students' desires to win. Although the currency had no real-world value until the end of the quarter, Gollars represented a tangible "investment" that students made into the games that were played during class.

HONORS 221 successfully employed a few gamification techniques to keep student motivation high during lectures. For a game theory class, it is unsurprising that these concepts are cleverly and effectively interwoven throughout the entire class. However, this course is still one of few across the University of Washington campus that incorporates gamification elements, and the small class size undoubtedly makes team and cross-team discussion more fruitful. This begs the question: how do gamification techniques work at scale?

CSE 373: Data Structures and Algorithms

Previously offered as a standard lecture-style computer science course, CSE 373 has undergone significant changes in recent years to incorporate active learning techniques that work with scaling to hundreds of students each quarter. Assistant Teaching Professor Kevin Lin, a CS education researcher, strove to create a more interdisciplinary computer science course that made course content more approachable and applicable to students' everyday lives, as well as their potential future careers as technologists in industry [19].

Many professors in the Allen School, especially teaching professors, recognize the importance of engaging students in real-time. Poll questions are common among 300-level courses, although they are graded minimally and are meant to check for student misconceptions. However, a concept introduced in CSE 373 that is unique to the course is a policy of allowing students to have endless resubmissions.

> "Grading in this course encourages learning through deliberate practice by emphasizing revision and resubmission of work. All coursework is designed around feedback loops where you try something, get feedback, then try again. Grades are based on what you eventually learn through this process." [20]

This novel policy emulates the concept of losing a life and picking back up from where you stopped, dampening the risks and stressors that often come with submitting homework or taking assessments. While this idea is progressive and novel, student teaching assistants have expressed their concerns on how much this truly improves student learning. Are students incentivized to put their best foot forward with each submission, or is the gamification factor disincentivizing genuine learning and interest in the content? While there have not been enough iterations of this course to quantify students' learning and interest with this system in place, these questions are important to ask and answer when evaluating gamified systems. How much of the gamification is helping students engage with content, and how much of it is distracting from the purpose of the class altogether?

Another consideration about gamification at this scale is the amount of resources necessary to deliver instant feedback. The grading volume grows exponentially with endless resubmissions, occasionally overwhelming TAs and leading to grading slowdowns. For a class of almost 200 students, there are 18 teaching assistants, at a ratio of approximately 11 students per staff member [20]. If other courses at UW were to adopt a similar gamification approach, the monetary and time costs of hiring enough teaching assistants could become a major barrier. Outside of the constraints of hiring staff, the benefits of having a smaller staff to student ratio are also clear: students can receive more individualized help, they may not have to wait as long during office hours, and courses can feel more engaging or welcoming as a whole.

Design Considerations

Thus far, the task of implementing gamification into a course has been refined through trial and error from completely separate professors. From our analysis of HONORS 221 and CSE 373, we have identified gamification elements that are already in practice. These case studies have helped us analyze the efficacy of each technique for (1) improving student engagement and (2) adding to their overall learning experience.

Live polling is used in both small and large scale courses, and has been found to be fairly effective for both instructors and students. Poll questions are intended to give students immediate feedback and a bit of pressure from having to select the right answer. For future classes, implementing greater flexibility for the grading portion of this activity, such as dropping the lowest lecture score, may help students engage more with the activity rather than focusing strictly on the points that they could earn. Implementing inclusive design practices, rather than universal design practices, can cater more to students' unique needs rather than creating blanket solutions for all students.

A policy that could be implemented in a smaller scale class is resubmissions. However, instead of allowing students to resubmit every assignment any number of times, limiting the number of resubmissions can decrease grading workload while simultaneously increasing the stakes and engagement for each student's submission. With a limited resubmission scheme, this concept could also be effective at scale, as evidenced by the successes seen in the CSE 14x course series (Introduction to Java Programming, I and II). Resubmissions allow students to explore more, learn from their previous mistakes, and even lower the chances of academic dishonesty by giving students more agency over their learning.

Lastly, an idea that would certainly be interesting to scale is the idea of Gollars, or a quantifiable points-based reward system that does not influence final grades. Although the logistical overhead of managing currency distribution among 200 students could be higher, we believe that tapping into students' innate desires to compete can drive them to engage with course content in the most hands-on way. As researchers continue to make strides in the gamification and e-learning fields, we are excited for lightweight gamification strategies to become more widely adopted to boost student engagement and motivation across all courses.

Why does Gamification Matter?

Gamification has an incredibly high potential to revolutionize the way that students learn. However, since it is still a fairly recent trend, "the practice of gamifying learning has outpaced

researchers' understanding of its mechanisms and methods" [17]. Existing evidence may not be sufficient to support specific conclusions about how gamification can help more than harm. However, the trend of integrating game elements into education is still going strong more than 12 years after the term "gamification" first hit the mainstream. Ad hoc implementations of gamification, as seen in UW courses such as HONORS 221 and CSE 373, have proven to be fairly effective at boosting student engagement and grade point average. It's important to acknowledge that the successes of such classes represent isolated cases, and results may be confounded by factors such as class size, assignment type, learner type, and more.

Another major confounding variable is the COVID-19 pandemic and the rise of e-learning. Beginning in March 2020, educators suddenly found themselves unable to engage their students with virtual learning formats, and sought to implement gamification into their courses to appeal to students' motivations. As we begin a "return to normal" after two years of the pandemic, many instructors are electing to retain select virtual elements during in-person instruction. More and more are embracing the integration of technology within the classroom, whether for recorded lectures or remote live attendance, which is a dramatic shift from before the pandemic. However, when does technology go too far? When does gamification become so realistic that it alters someone's sense of reality or causes them to become too competitive? These are questions that we are still grappling with and have yet to solve.

Though the permeation of gamification into our everyday life has led to many successes and a few setbacks, this field of research is still nascent and developing, and academic results are inconclusive about the long-term positive effects of integrating game elements into non-game contexts. As educators continue to explore and experiment with ways to boost student engagement both within and outside of the classroom, we are hopeful that innovations in gamification can help make education more engaging, exciting, and inclusive.

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