Learning to Gamify Through Design

Integrating Gamification Theory with Teaching Practice

A Thesis Prospectus
In STS 4500

Presented to
The Faculty of the
School of Engineering and Applied Science
University of Virginia
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Computer Science

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December 6, 2024

On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

In a world where new technologies develop as rapidly as they fade into obsolescence, a strong education is essential for students to remain relevant in an ever-changing job market. However, the current United States education system fails to adequately motivate students and prepare them for the workplace and adapts poorly to new learning technologies. Most students consider college as their primary path to employment, with 88% percent of new undergrads citing obtaining a job as their reason for pursuing higher education. Unfortunately, only 34% of students graduated believing their degree sufficiently prepared them for obtaining a job (Strada Education Foundation, 2018).

Many of the school system's shortcomings trace back to its origins in the Industrial Revolution of the late 19th century. Since laborers needed to perform repetitive, manual tasks in factories, schools could more efficiently train students by focusing on rote memorization and mathematical subjects over the humanities and arts (Krishnan, 2020). Later, during the early 20th century, standardized tests such as the SAT lowered the barrier of entry to higher education for lower-class and minority students while providing colleges an scalable way to gauge an applicant's academic abilities (Manhattan Review, 2024). Nowadays, jobs often draw on interdisciplinary expertise and necessitate critical-thinking and social skills, rendering the IQ-centered model obsolete. Education's overreliance on repetition and standardization stifles creativity and limits the definition of success to receiving high STEM test scores and conforming to rules (Fredericks, 2021). A student who does not fit this narrow model may begin to view themselves as unintelligent and soon drop out of school if they do not receive support from teachers (Long, 2017). Therefore, schools can no longer afford to only focus on STEM subjects,

lest the rise of automation and artificial intelligence replace students in the very tasks they were once trained for.

Additionally, the COVID-19 pandemic has amplified schools' inability to provide adequate technical training for teachers. A report from the Center on Reinventing Public Education finds that 85% of teachers were unable to cover as much course thanks to the shift to an unfamiliar virtual learning environment. Without sufficient guidance from teachers, test scores in American students also dropped during remote learning (Pitts et al., 2022). Additionally, long after health safety measures were lifted, many institutions continue to allow students to learn online. Now more than ever, teachers need more funding and training to better support students through online platforms.

One approach to motivating students to learn is gamification, or incorporating game elements, such as leaderboards, achievements, and storylines, into classrooms to make learning more enjoyable and playful to students. Gamifying education can improve student performance and engagement while allowing students to utilize their creative skills in STEM fields. Gamification encourages students to perceive that they are progressing upward on assignments rather than losing points, decreasing the stress of learning new subjects (Berkeley Center for Teaching & Learning, 2015). Despite promising results, gamification still remains a poorly-understood and under-researched field. In several cases, mechanics such as leaderboards impeded student learning, drawing much attention to competition, despite being popular in games (Toda et al., 2018). Meanwhile, educators and parents worry about how game addiction will possibly hinder student learning. Studies show daily session limits incentivized students to spread out their playtime across a week, which led to increased scores (Welbers et al., 2019). Regardless of the medium—physical, tabletop, or electronic—implementing gamification will

require instructors to apply new theories and adapt their teaching models. Therefore, a gamification-based learning system needs to be easy to adopt for both students and teachers and not too costly to use. To this end, this technical project proposes to construct an online platform where instructors can learn how to implement gamification and evaluate its success in the classroom by designing sample courses. Additionally, the research paper will explore how different game elements influence student behavior, informing the contents of the platform.

Teaching Through Design

For gamification to serve as a sustainable technological fix for education, it must address the root of the problem and not the symptoms, be easily quantifiable, and focus on improving an existing technological standard (Sarewitz & Nelson, 2008). Current gamification tools generally make only surface-level changes, and studies do not produce easily assessable results other than increased test scores. For example, Kahoot! and Quizlet are popular programs where students compete against each other via quizzes or minigames. Although both programs are an effective and accessible way to drive student engagement, they are mostly limited to multiple-choice and short answer questions (Houston, 2024). Consequently, they are unsuited for testing students' abilities to apply knowledge to complex scenarios. To fully change students' mindset towards learning, gamification needs to form the foundation of course structures rather than exist as supplemental activities to be implemented at an instructor's discretion.

With these challenges in mind, this project aims to build an interactive website for instructors to learn how to integrate gamification into their classrooms. The website would provide lessons on how to design courses from scratch around gamification, including schedules, assignments, and even classroom jargon. Educators would also have access to detailed

explanations of different game elements that explain how they influence different student behaviors. Ideally, each mechanic will have a page linking to related studies and showcasing real-world examples where the mechanic is successfully used. The proposed artifact could be built with a web framework such as Django, allowing it to be tested and deployed easily and cheaply. For persistent storage, the application can use a local or remote SQL database.

To facilitate adapting gamification to the classroom, the software would allow instructors to construct their own gamified courses. Through "learning by design," educators are more actively engaged in learning about gamification and developing deeper connections to their subjects and teaching styles (Koehler & Mishra, 2005). Additionally, this style presents an excellent opportunity to use gamification to teach gamification. To illustrate, the proposed tool could have instructors progress through a variety of scenarios (or game levels). The players would be tasked to design parts of a course with the goal of eliciting different outcomes, including higher grades, group discussions, or student socialization. As players complete scenarios, they would have access to more advanced game elements (similar to a skill tree) or additional challenges, such as a limited budget.

As with deploying any new system, students will need a way to provide clear feedback to teachers on how well they perceive the course is working. Currently, few studies have rigorously and systematically measured the long-term effects of gamification on students. Because researchers lack a shared method to evaluate the success of a study, results cannot be easily compared to each other. A meta-analysis found 40 out of 51 papers tested multiple game elements simultaneously instead of controlling as many variables as possible, making understanding how individual game elements work more difficult (Dichev & Dicheva, 2017). To make gamification more accessible to students and teachers alike, the website will provide

straightforward, numerical metrics that instructors can use to evaluate the success of a gamified course and surveys that they can give to students (Yordanova, 2021). The future research conducted by this project will help inform what exactly should be listed on the website. Overall, this project hopes to provide teachers with accessible resources to understand how different game elements work to affect learning and recognize when gamification is implemented well. Through learning by design, educators will better be prepared to incorporate gamification into their existing curriculum and teaching practices so they can more easily transition to a gamified learning environment.

Integrating Gamification Theories

Introducing a new technology into a system as mature and complex as education is challenging due to the cost of integrating the new addition into other components. With gamification, teachers need to not only transition to gamified learning environments, but still successfully deliver class material to students and not impact the flow of daily activities. If the added workload of implementing gamification disrupts an educator's ability to perform duties such as course planning, lecturing, or grading, then the student learning experience may suffer.

Luckily, the Technological Pedagogical Content Knowledge (TPACK, formerly TPCK) framework outlines how to best make improvements to current educational methods. Under TPACK, teachers need to be well-versed in three domains of knowledge: Content Knowledge (CK), the subject matter being taught or learned; Technological Knowledge (TK), the ability to use technology in the classroom; and Pedagogical Knowledge (PK), the experience in teaching practices and learning styles (Koehler & Mishra, 2005). For example, a teacher would need to possess enough content knowledge to give informative lectures and technical knowledge to run a

learning management system. Meanwhile, understanding how to structure course activities and assignments would require pedagogical knowledge (PowerSchool, 2022). Here, the definition of technology could be extended to accommodate theories such as gamification. Furthermore, TPACK stipulates that teachers need to blend all three areas of knowledge for students to be successful in learning. To illustrate, knowing what in-class activities are best suited to teach a specific subject falls under PCK, recognizing what game elements are needed to enhance those activities falls under TPK, and understanding how the different elements support that subject falls under TCK. Ultimately, to achieve TPCK, teachers should be comfortable in all three domains and understand how they interact with each other (Koehler & Mishra, 2005).

However, although learning technology is progressing quickly, instructors are falling behind on technological knowledge. A survey of K-12 teachers in the US reveals that on average, teachers felt more confident (roughly 4 out of 5) in content and pedagogy than in technology (roughly 3 out of 5) (Archambault & Crippen, 2009). In the age of online learning, literacy with new learning technology is essential for teachers to ensure proper academic outcomes for their students. Because numerous gamification studies test with gamified software, and schools regularly utilize digital technologies even without virtual learning, a gamified course would likely at least have some electronic component. Due to the interconnectedness of the TPACK domains, professional development must help teachers incorporate both technology and gamification theories into their specific subject matters rather than teaching topics in isolation (Koehler & Mishra, 2005).

To ensure gamification is seamlessly adopted by teachers, new technology must ensure high usability as well as increased student performance. Instructors who specialize in computing subjects or hold advanced postgraduate degrees are an ideal group to test new technologies with

because they possess a high level of computer literacy. Gamification studies done at the university level relating to computer science also have the benefit of more existing data (Zeybek & Saygı, 2024). An experiment with university lecturers in Jakarta showed expectations of increased student learning and ease of use convinced instructors to use gamification more than social factors, such as positive response from colleagues or students (Candra & Handoko, 2024). Moreover, modeling students' player types may be an effective way to accommodate multiple learning styles without placing too much extra burden on instructors (Xiao, 2024). For the technical artifact to support the principles of TPACK, this project will need to examine how gamification relates to different teaching goals and use that information to lessen the mental workload of instructors designing courses.

Research Question and Methods

Improving education requires changing the way teachers adapt new technologies and theories into teaching practices. How can instructors be trained to better design gamified learning systems to achieve specific student outcomes? This project will conduct a meta-analysis of published gamification studies to tabulate common game elements and their observed effects on student performance. These papers can be found in databases such as the Association for Computing Machinery (ACM) Digital Library, SagePub, and ScienceDirect. Additionally, leading researchers in the field often conduct literature reviews that curate many studies. These reviews can serve as a starting point when looking for sources (Dicheva et al., 2015) (Dichev & Dicheva, 2017). These studies usually collapse multiple closely-related keywords into one single category (for example, ranking and leaderboard could be treated as one element), which this study may also do to simplify data analysis.

After collecting data, the most common effects can be calculated for each element based on frequency in the table. The research paper will aim to illuminate the relation between game elements and learning outcomes. Not only will the program provide an accessible source to learn about different available game elements, thereby increasing technical knowledge, but it will also develop technological pedagogical knowledge. Ideally, users of the interactive website will increase their TPK by learning which elements will most likely lead to a desired response in students, and which responses will most likely be triggered by a given element. Since teachers already possess sufficient content and pedagogical knowledge, this website does not intend to explain how different game mechanics are best suited to which subjects (Archambault & Crippen, 2009). Hopefully, after using the website, educators will be equipped to build TCK and PCK on their own, bringing them one step closer to mastering the use of gamification, and future technologies, in classrooms.

Conclusion

In the wake of the COVID-19 pandemic, virtual learning has become a viable alternative to in-person schooling. Soon, gamification may also be a viable, if not better, alternative to traditional teaching. Gamification can increase student motivation by replacing dull, repetitive work with engaging, playful learning and grant students an opportunity to exercise the creative and problem-solving they need for the workplace. One obstacle to widespread adoption of gamified learning technology is schools' inability to quickly adopt new technologies and lack of accessible knowledge on the field.

The main deliverable of this project will be a web application, which will require a meta-analysis of game elements and their results on learning performance. Before designing the

application, requirements must be collected from potential users, namely professors. The requirements phase is planned to last the remaining fall semester, and will yield a list of initial features of the application. The spring semester until spring break will be spent designing and constructing the artifact, with more detailed research being used to refine the scenarios and compile a list of initial game elements and success metrics. After spring break, the software will be validated with users, whose feedback may be used to improve the program.

Due to gamification being a relatively recent field, its benefits are still not fully understood, and companies may accidentally spread misinformation while capitalizing on the hype. Therefore, an interactive resource where teachers can design sample gamified courses would prepare them in integrating gamification into lesson plans, ultimately facilitating its adoption into schools.

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