Designing and Evaluating Gamified Open Educational Tools for Connected Learning

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

By
Breenice Lee

November 3, 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.

ADVISORS

Professor Sean Murray, Department of Engineering and Society

Introduction

Education serves as one of the most powerful tools to aid in class mobility for many students globally, powering the American Dream that anyone can succeed with hard work. Unfortunately, following the COVID-19 pandemic, many students have fallen behind in their education, specifically five months behind in mathematics and four months behind in reading on average by the end of the school year, potentially making $49,000 to $61,000 less from future job prospects. The effects of distance learning adversely affect minority and low-income students who fell an additional month behind (Dorn, 2021). This deepens the socioeconomic class disparity for these students, who may be the sole contrivance to lift their family from an otherwise static economic position (Abramitzky et al., 2019).

Although the pandemic has intensified challenges related to academic performance and educational equity, these issues are deeply rooted in longstanding problems within the American education system. Nearly 90% of K-12 schools are struggling to hire enough teachers (Delarosa, 2023). This staggering shortage of teachers results in a decline in overall student performance, as it makes it impossible for teachers to provide personalized instruction due to the disproportionate ratio of students. The continued lack of personalized education will prevent students from regaining proficient academic skills.

My STS topic will primarily focus on the system analysis of effective open educational resources (OER), followed by a discussion on their potential to equalize education. As an open, free resource, online OERs can reduce financial barriers for instructors with insufficient state budget to support their teaching. Intra-institutional funding inequality can be attributed to nearly half of public school funding being sourced from local government property taxes. This results in students from wealthier areas receiving better funding for their education. For perspective, New

Jersey spent $17,379 per student while Utah spent only $6,452 per student. The large disparity between state funding still exists, even after adjusting for regional variations in costs. This manifests as unequal access to learning resources depending on the property values of the student's local district. Currently lottery programs like METCO attempt to bridge the socioeconomic gap through physical connection, by chartering students from the underfunded, segregated Boston city to affluent, socially isolated suburbs. Additionally, online OERs can adapt to a student's pace and learning preferences, providing personalized and inclusive education that supports students who may be falling behind.

In the Age of Information, digital addiction, which affects roughly a quarter of the general population, has rapidly increased. While subsects of this addiction, like internet and media addiction offer external promises of recognition and peer validation, video game addiction is perplexing in that it has no promise of any of those rewards, even winning. What exactly drives nearly 8% of the global population to voluntarily lose sleep, socialization, repetitive tasks all for a game that won't guarantee winning any real reward (Meng et al., 2022)? Since the dawn of the first video game, *Pong,* multi-billion dollar gaming companies have mastered the art of harnessing an energy similar to gambling to profit off of adolescents pouring hundreds of hours to their products. My technical project aims to inspire the inherent gaming compulsion that is in everyone to encourage students to learn with their own intrinsic drive to be challenged.

My technical project aims to address the ongoing issue of students falling behind academically and teachers struggling to meet the diverse needs of every students' by utilizing online tools in education. Specifically through extending access and increasing engagement through educational mini games that are personalized to the user's skill level. By analyzing past iterations of educational resources and popular addictive games, my final project will present the

primary elements of what makes a education tools effective and online games and media so addictive in order to design a tool that utilizes the irresistible components of technology for a more ethical purpose of supplementing existing in-person education.

As technology progresses and mutates faster than legislation and research could ever dream of keeping up with, users should stop and become more aware of the impact gaming creates. Becoming aware of how popular game mechanics keeps users hooked can be the first step to understanding and eventually use to their own advantage. Through my STS research on the capability of OERs to democratize education and my technical project on applying the addictive mechanics of popular games for educational purposes, I hope to leverage these insights to design an education tool for my technical project that promotes interpersonal connection and intrinsic learning.

Technical Topic

My technical project involves the design and development of an online game that applies the addictive nature of popular games to inspire an innate motivation to learn in K-12 students. The project will be designed based on mechanics of effective educational games and general games, then evaluated based on both student and instructor feedback following usage to teach/learn one module. This tool will be designed based off of the Blended Learning Model developed by Mind Research Institute. It is a method of teaching with a combination of in-person instruction and additional online content with students “control over time, place, path and/or pace, and at least in part at a supervised brick-and-mortar location away from home” (Nisbet, 2014). This model was chosen to align with the tools' intentions to supplement instructor lessons, extending a teacher’s impact in teacher shortages by motivating learning outside of the classroom.

The lesson plan focuses on developing conceptual understanding of mathematical topics, by omitting written instructions to challenge the user to experiment with the game mechanics and gain a deeper understanding of the math topic, similar to ST math's approach to conceptual learning. The lack of written instructions strengthens the product's ability to engage users by presenting math as a puzzle game, rather than a problem to be solved through memorized formulas and rule sets.

The questions will be categorized into multiple difficulties and problems types (i.e. number types or operations) to gradually increase the difficulty level based on what types of problems the user struggles with most. The incremental difficulty will introduce a heuristic challenge designed to motivate students by nurturing their confidence in their ability to solve the puzzle. This approach balances between frustration from overly difficult tasks and boredom from overly simple ones, in a healthy level of stress, *eustress,* to engage users and sustain a flow state that players experience when hooked onto an exciting gaming session. Unlike the popular OER *IXL*, there will be no penalties for answering a question incorrectly, which was a source of the primary complaint of educators, parents and students alike. The steep penalty incurred from a single incorrect answer significantly discouraged students from believing that they could master a skill and promoted unhealthy relationships between student's self-assessed intelligence and qualitative scores. Alternatively, my technical project will provide visual feedback of the student's virtual character falling when a question is incorrectly answered, portraying failure as a natural and enjoyable part of the learning process. This game mechanic mimics the popular game, Super *Monkey Ball 2,* that similarly portrayed failure. The positive feedback is reported to help make the test players feel agency in their ability to control the game's outcome

(McGonagall, 2011). This approach aims to remove the fear of failure, encouraging users to view it as an opportunity to learn and keep progressing.

My technical project will address existing issues in education including students experiencing academic setbacks and difficulty of understaffed teachers in catering personalized educations to each of their students. In particular it will alleviate the pressure of understaffed teachers to manage both students' academic and social development by extending access to practice and encouraging interactions between other students.

Students will be encouraged to collaborate with their peers or mentors through a multiplayer option. The multiplayer option will offer two modes: one where a partner collaborates to solve problems with their peer, and another where they act as an opponent, challenging their peer by crafting difficult obstacles or puzzle problems. A points system will reward players bonuses, or extra points for collaborating and writing helpful hints on questions. The points will not be public to other players to avoid numerical comparisons between students, only visible to the instructor. The points will not only serve to help the instructor gain individualized feedback on students' progress, to help cater in-person instructors individualized to each students' needs.

This also serves as an alternative resource for students without access to supplementary help, i.e. parental assistance or private tutoring services. existing study tools will be added to the application along with game mechanics known to be effective at increasing usage.

Increased motivations to practice class content beyond the level that is required is necessary for deep learning, which the The National Research Council (NRC) describes as "the process through which a person becomes capable of taking what was learned in one situation and

applying it to new situations" (Nisbet, 2014). This ensures that it is less likely to fall behind again by instilling self-motivation behavior to challenge themselves.

STS Topic

In order to gather the right foundational information and ask the correct questions when designing an educational tool, my STS topic will begin with a system analysis of effective open educational resources (OERs), to develop a deeper insight into what OER qualities help students effectively learn new topics beyond regurgitating memorized lecture material. This will provide a foundation for a thorough discourse on exploring OERs as a potential tool to equalize education. This involves analyzing the effectiveness of educational tools like ST Math, IXL, and Reflex Math, given their extensive use in public classrooms. Their widespread adoption provides a stable dataset—diverse, high-volume, and collected over a significant period—enabling a thorough evaluation of their impact.

OERs extend access to personalized education for students, where district funding may not reach. The issue then lies with distilling how OERs present learning as a fun activity to do outside of mandated class hours. Gaining a better understanding of what motivates students to spend additional time and voluntarily take on challenging tasks on the OERs can be utilized to pull struggling students without access to private supplemental education ahead.

Due to the irrefutable role technology has already played to mental health over the past few decades, evaluation of existing educational technology will be analyzed in conjunction with related factors of social isolation and tech addiction. The impact of digital addiction will be narrowed down to video game addiction in order to assess the core components of how technology captivates user's attention and controls users' motivations.

During the COVID-19 pandemic, when many students felt isolated and lost motivation to learn in the absence of a human instructor, an alarming 84% of public schools reported negative trends of student behavior. The reported behavior was related to “classroom disruptions from student misconduct (56 percent), rowdiness outside of the classroom (48 percent), acts of disrespect towards teachers and staff (48 percent), and prohibited use of electronic devices (42 percent)” (National Center for Education Statistics, 2022). This decline in student socialization related skills can negatively impact academic ability, specifically in test-anxiety management, confidence to learn new concepts, and happiness from receiving positive feedback (Valiente et al., 2020). This highlights educational institutions’ extended responsibility to develop students’ socialization skills along with academic skills.

The rise in video game addiction can be attributed to two main factors: “Needs for mastering game mechanics” and “Needs for relationship” (Xu et al., 2012). This often causes players to neglect normal daily functions including relationships with their peers, either furthering an existing isolation issue or creating new ones, keeping the user from building socialization skills. This builds on top of the social isolation trend that began during Covid-19 distance learning, highlighting the dire need to address student’s socialization.

Both mental afflictions of declining social behavior and tech addiction in students can be connected to prolonged isolation from peers whom students would typically engage in social interaction within a school setting. When implementing OERs into educational settings, especially when utilizing the addictive qualities of video games that can inspire the grit and self-initiated efforts of a successful student, it is vital to incorporate initiatives to nurture socialization skills along with academic knowledge.

Conclusion

Understanding the core mechanics of digital games and their potential to lead to addiction and isolation can help us redirect their impact for positive outcomes. Leveraging this knowledge to apply to more desirable portions of life like education can make these addictive mechanics a valuable tool for lifelong learning. By designing an effective OER that can maintain attention and fosters motivation to tackle challenges, it can serve as a tool to deliver personalized education to underfunded districts, potentially mitigating the negative effects of segregated education. My technical project seeks to inspire genuine enjoyment of learning, much like the joy experienced when playing your favorite game by adopting immersive gaming into online educational tools.

My STS research paper intends to evaluate the effectiveness of OERs in the context of ongoing education latency and addressing the challenges of social isolation and tech addiction. The paper will delve into the discourse of the potential for OERs to address the challenges of a socioeconomically divided education system. The potential of OERs will be supplemented by a systems analysis of successful OERs, highlighting common educational approaches and practices. This should inspire developers to create online products that leverage the alluring qualities of technical applications for a higher purpose, such as personal development.

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