Thesis Project Portfolio

Play to Learn: Exploring Student Motivation Through Gamified Math Instruction

(Technical Report)

Assessing EdTech's Viability and Impact on Educational Equity

(STS Research Paper)

An Undergraduate Thesis

Presented to The Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science in Computer Science, School of Engineering

By Breenice Lee

Spring, 2025

Department of Computer Science

Table of Contents

Sociotechnical Synthesis

The state of education currently fails students on two front: first, by widening the gap in education quality for students in underfunded districts; and second, by struggling to maintain student motivation to learn. These issues can be especially difficult to combat in a highly digitized world where attention is constantly contested. Technology holds the potential to potentially address both issues by offering individualized instruction to students in underfunded school systems and facilitating intrinsic motivation to learn through improved engagement practices. Following the Cambrian explosion of educational technology products, developers must continually ask, "Are these tools genuinely transforming education—and for the better?"

My technical capstone addresses the issue of waning attention and motivation in students, specifically in learning mathematical concepts. This was achieved by adapting captivating design elements from popular games to an educational context. *Arctic Flip*, the completed educational game prototype, focused on maintaining user engagement through timed, competitive gameplay. The Mechanics-Dynamics-Aesthetics (MDA) framework guided the integration of addictive games mechanics to foster intrinsic motivation when learning math concepts. Mechanics such as timers, visual-only instructions, and feedback from the computer player were designed to evoke mild stress and competitive emotions from the player to encourage play. Humor was also incorporated into feedback features to help users respond to failure and difficulty in an emotionally healthy way. The game was evaluated using Bloom's Taxonomy and the PICRAT model (Passive, Interactive, Creative - Replacement, Augmentation, Transformation) provides a framework to ensure the game promoted a deep understanding of the content and leveraged technology to enhance rather than replace traditional instruction.

My STS research paper analyzed how educational technology (edtech) tools could be used to alleviate the negative symptoms of a privatized, tax-property based school funding system. This can systematically impose segregation of low-income students from higher quality education, often leading to disproportionate outcomes in life after secondary school. The use of online educational tools were explored as an avenue to bridge the difference in education quality without the need to overcome physical barriers or limit opportunity like traditional lottery shuttle systems. The paper acknowledges that while technology is now essential for participation in many schools, it can be expensive and difficult to implement in rural and low-income areas. As a result, the usage of technology, such as connectivity and hardware requirements, should be minimal and adaptable in order to remain accessible. Actor-Network Theory was applied to map key human and non-human actors involved in integrating online tools into education. The resulting network highlights the critical roles of software developers and policy makers in managing the attention economy's influence on edtech design, especially when aiming to improve or equalize education through web-based solutions.

When considered in concert, the projects demonstrate that the challenges of educational equity and student motivation are deeply interconnected. Addressing them will require iterative efforts to change public perception of educators and realign developer priorities on user-centered design that supports equity and student engagement.