

Thesis Project Portfolio

Educational Game Console for Teamwork and Reading Comprehension

(Technical Report)

Uncovering Insights to Improve the Development of Hearing Aids for Musicians and Music Listeners

(STS Research Paper)

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Table of Contents

Sociotechnical Synthesis

Educational Game Console for Teamwork and Reading Comprehension

Uncovering Insights to Improve the Development of Hearing Aids for Musicians and Music Listeners

Prospectus

Sociotechnical Synthesis (Executive Summary)

User-Centered Design for Hearing Aids and Educational Games

My STS research on music-enhanced hearing aids is driven by my concerns about hearing loss, especially since music has always been a creative outlet for me and many others. However, more people are consistently listening to music at very high volumes, so I was curious about how hearing aids process music, particularly since many aren't aware of their capabilities. Through my research on hearing aids' ability to process music, I found that users often felt frustrated. Some shared that they once enjoyed music but could no longer engage with it in the same way, while others described it as mere noise, lacking clarity and meaning. Thus, my STS research focuses on improving hearing aids for musicians and casual music listeners by gaining a better understanding of the barriers that hinder effective collaboration among key stakeholders, such as hearing-impaired users, audiologists, and manufacturers. My technical project addresses a different challenge, which is addressing children's learning loss and lack of social connections after being isolated during the COVID-19 pandemic. Inspired by my own struggles with reading comprehension as a child, I noticed that while there were many engaging educational games for improving math skills, there were very few designed to enhance reading comprehension. Despite the differences in my STS and technical projects, both highlight how product design can be improved by considering the user experiences, feedback, and needs of end users. Focusing on user-centered design and effective stakeholder collaboration is essential for understanding user needs, refining products based on feedback, and promoting cooperation among stakeholders to create designs that lead to more satisfied users.

The technical project of my thesis produced an educational multiplayer game console designed to enhance third-grade students' reading comprehension and social skills. The console features a 10.1-inch screen, two joystick controllers, and a Raspberry Pi 4 to run a custom-made multiplayer, reading comprehension game. The console is housed in a child-friendly, durable enclosure inspired by BMO from *Adventure Time* to appeal to kids. The game focuses on improving reading comprehension through story-based levels with associated questions that are similar to ones seen in the Virginia Standards of Learning (SOL) exams. Students will have to work together to overcome obstacles and answer reading comprehension questions, and this multiplayer format promotes teamwork and social interaction to help students rebuild communication skills that were lost during the pandemic. Additionally, the game incorporates a hint system and removes the scoreboard to reduce performance anxiety for students who may not enjoy competitive games or struggle with test-taking, ensuring a positive and stress-free learning experience. This project can serve as a framework for creating educational games that are challenging enough to push 3rd grade students to improve their reading comprehension skills and entertaining enough to keep them engaged in playing. It also helps them practice their teamwork skills, making the experience both fun and educational.

In my STS research, I applied Schwarz-Plaschg's framework on analogies by comparing specialized sport prosthetics (SP) for para-athletes with music-enhanced hearing aids for musicians, uncovering three key insights that can help improve collaboration in the development of music-enhanced hearing aids. First, there is a stigma surrounding hearing aids due to insufficient and inaccurate media representation, which often associates these devices with aging and frailty, discouraging their use. Second, financial barriers restrict access to essential services, making it challenging for individuals to afford necessary devices and hearing exams. Third, a

lack of inclusivity within healthcare environments hinders effective communication between hearing-impaired patients and healthcare providers. Addressing these challenges is critical to empowering users to adopt hearing aids, access necessary devices and hearing exams, and effectively communicate their concerns about music processing with healthcare providers. Ultimately, this research seeks to uncover insights to help enhance user satisfaction with hearing aid music processing capabilities, improve quality of life, and support individuals in pursuing their musical passions.

My technical project highlights the need for a user-centered design approach to support learners who may struggle with traditional, widely used educational games. From an ethical standpoint, this aligns with Arnold Pacey's concept of prioritizing last first, which emphasizes focusing on the basic needs of unconventional and overlooked communities first. This principle applies to both educational games for learners with testing anxiety and to hearing aids for users facing affordability constraints, who experience a decline in quality of life due to their inability to properly enjoy music. Additionally, during my STS oral presentation, I learned how to use analogies to anticipate outcomes, learn from past mistakes, and identify the 'missing dimension' in sociotechnical systems by analyzing their historical contexts. For example, prosthetics for para-athletes gained recognition after WWII, the 9/11 attacks, and the Paralympics, while hearing aids remain less visible and stigmatized as being associated with old age, discouraging their use despite the growing need. This contrast highlights why hearing aid users are often more reluctant to use their devices compared to para-athletes using SP, emphasizing the ethical responsibility of exploring the historical contexts of sociotechnical systems and using analogies to understand where the constraints stem from, such as the social and cultural barriers faced by hearing aid users.