Development of Educational Technology Using Co-Design

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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

Oftentimes, engineers work on projects that may be outside of their scope of expertise. They have the technical background, but not the proper experience to address wide, abstract problems. This idea pertains to my capstone team's work as we are working on a project that is a mix of education and technology, however our backgrounds are primarily in technology. Our goal is to develop educational technology that will improve financial literacy in American students using virtual assistant technology. Technology does not simply make teaching easier and devices are not a replacement for teaching for every student (Harris, 2016). This push for technology to bridge educational gaps may clash without the proper expertise from both backgrounds requiring collaboration. To develop an effective tool, it is important to explore what is good educational technology and the process of developing it.

The usage of educational technology has grown tremendously in the American education system. It is predicated that by 2025, the demand for this technology will have more than doubled and cost about $42.5 billion - about an 87% increase compared to 2021 (Writer, B. B. S., 2021). Some have attributed the growth to the push for more individualized learning opportunities as opposed to the current rigid state of the education system (GovTech, 2021). Despite the rise in both spending and usage, a large portion of Americans continue to struggle with what some might consider important life skills such as financial literacy. In 2021, 56% percent of adults considered their financial knowledge as an A or B level, while 16% gave a D or F level (NFCC Wells Fargo, 2021). Compared to 2018, the A or B level confidence rose by 1%

(NFCC, 2018). In terms of teenagers, about 74% reported a lack of confidence (Greenlight). This large percentage of lack of confidence in financial literacy can be negatively impactful on one's ability to make financial decisions, thus affecting their personal life. This contradiction between high growth in educational technology compared to the low growth in financial literacy confidence is surprising as one would expect a linear relationship between the two .

Developing effective educational technology is important, but there exists a void in building good educational technology, so I intend to explore how to address this. Using the process of codesign, my STS research will investigate what is good educational technology, and how engineers and external experts collaboratively work together to effectively complete projects.

Defining Good Educational Technology

With the recent Coronavirus pandemic, more than 1,300 schools were forced to switch to online teaching methods which can be seen as a huge technological jump (Smalley, 2020). While technology can be a powerful tool when it comes to learning, it is valuable to evaluate what is educational technology and what factors make educational technology good. Educational technology can be defined as technology that utilizes available resources, human and material, provides a solution to an educational problem, and aims to "improve …education by getting maximum … output with the minimum input" (Mangal, S. K., 2009). An additional definition of educational technology is technology "that assists in the communication of knowledge, and its development and exchange" (Lathan, J., 2019). Good educational technology should target the appropriate audience. Research has shown that if the education is targeted to meet a student's learning level, it can be very effective in improving student learning (J-PAL North America, 2019). To summarize, technology that uses existing resources to solve an educational problem by improving the transfer of knowledge, while targeting the audience is good educational technology. It is not simply an audio-visual tool nor a computer-tool, but rather a tool that integrates these ideas in an effective system.

Defining Codesign

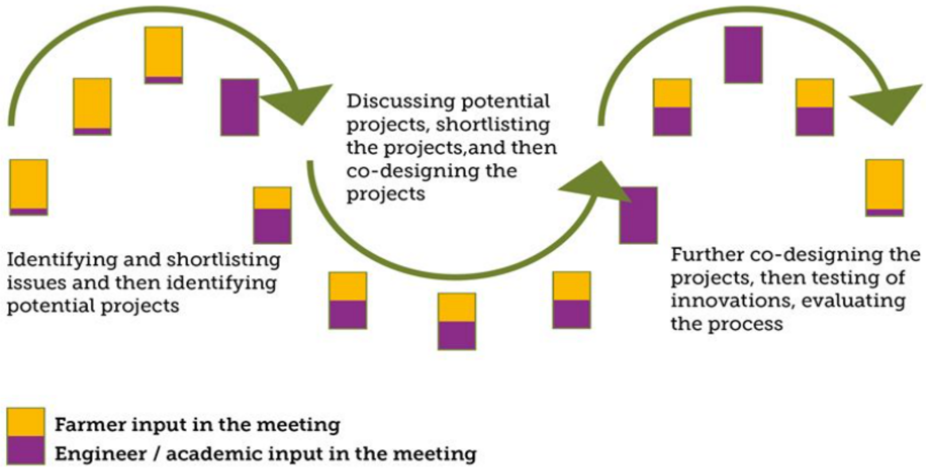
Educational technology itself can be broken into two sectors: education and technology. The two fields themselves are distinct, and those who work in those fields generally do not overlap as well. However, like the term "educational technology" suggests, imagine experts in education and experts in technology collaboratively working together. Intuitively, it makes sense that the experts together can create good educational technology. For technology that aims to innovate instructional models, simply gathering feedback from educational experts is not enough (Arnett, 2016). To determine the dynamic of how different groups of experts can work together, the process of codesign will be explored.

Codesign can be described as the process of engaging people with differing skills, knowledge, resources, and interests in a project (Edmunds, 2013). An example of codesign can be seen in the joint efforts between the University of California, Berkeley's Community Assessment of Renewable Energy and Sustainability program and the Pinoleville Pomo Nation to develop housing that is sustainable and culturally appropriate for tribal citizens. It was believed that the housing could continue to uphold the tribe's cultural values and social norms, while improving upon it. "The codesign process pursued in this project, described in more detail below, is intended to engage an array of stakeholders and actors with different knowledge, skills, and experiences, as well as different resources, sources of power and prestige, and interests in the project. The intention of the project was that tribal government would determine when and how the actors would work together and to what ends.” Due to the lack of information of what housing would meet cultural and sustainable norms for the Pinoleville Pomo Nation, the process of codesign was used. The key setup in the group’s dynamic is that the tribe was considered the housing experts, while the engineers and architects are the ones who will carry out the vision with some added suggestions. It’s important to understand that when using a co-design type of relationship, one must account for the different groups in mind, the power/tension between the groups, and the situation itself.

Codesign in Case Studies Beyond Education

Codesign can be seen in the collaborative effort between engineers and physicians to develop solutions to medical problems. “Approaches that combine the fundamental aspects of engineering with medicine are likely to yield a wealth of new directions for research and development” (Crawford, 2007). In this model, the two groups come together for brainstorming sessions to address interdisciplinary research problems stemming from a medical need (Crawford, 2007). The physicians discuss existing medical issues that could be solved with technology, and the engineers think of technology that could solve these issues. Using this model, the team has improved the precision of a spectroscopic tool, developed a noninvasive blood hemoglobin monitor, and has been working on a tool to determine the age of bruises. Without this collaboration, physicians would not have the technical background to develop these solutions, while engineers would not have the medical background to address these problems. A setup such as this would be beneficial to engineer projects including my team's. Instead of the team asking teachers for input on lesson plans and the tool overall, if we work as equals, then we can learn about issues they've experienced with teaching kids and adjust for this.

Two groups who at first are very different, but together can accomplish great things in technology are engineers and farmers. The IKnowFood project was "one of the first large-scale academic research projects to integrate a farmer-led approach into its methodology". (Innovative Farmers, 2021) Farmers from the Scottish borders and Yorkshire joined engineers from the University of Manchester to address pain points farmers faced in agriculture. The goal of the co-design experiment was to develop a range of tools that would make farming systems easier. The two groups met ten times during the duration of the project, and were involved the entire time. The level of involvement from both parties during each meeting can be seen in the below figure.



Both parties shared experiences of agricultural innovation, and then farmers specifically discussed issues they experienced in agriculture. The pain points were ranked by relevance, importance, and solvability, and after discussing them in depth, certain points to address were prioritized. Engineers supported tech designs and did several interactions of developing and testing. With each iteration, two questions were consistently raised: why do you farm and what are your positive and negative experiences of agricultural technology? The results of the persistent questions and collaboration yielded four new technologies: two apps and two new tools that maximized the farmers experience with technologies and reduced pain points.

With the recent coronavirus pandemic, people were forced to adapt to a new way of remote living. Despite it being challenging times, new methods of collaboration and resourceful ideas were a byproduct. The recent University of Virginia University Hospital Expansion plan is a prime example of successful innovations arising from pressured times through the process of co-design. The University of Virginia Hospital Expansion plan was a six year plan intended to add almost 450,000 square feet of new construction, and renovate part of the existing hospital (Woody J, 2021). The design team was required to be on site during the duration of the project. However, due to the Coronavirus pandemic, virtual reality was incorporated during the design development process, which allowed physicians, staff and the design team to preview the proposed designs. This collaboration was met with positive feedback as the participants got to visualize the design through the Oculus headset and critique the design proposal. One surgeon specifically commented on the size of one of the speciality rooms where procedures would be performed. Another commented on the visibility of exam rooms from a nurse's perspective. The construction firm agreed that "virtual galleries and virtual sites tours are now an integral part of the new normal", likely due to the saving of countless hours planning site visits and performing safety training. Without the performance of codesign and gathering key parties' insights, the design team would not have met the full needs of the key users and likely would have faced delays due to the pandemic.

Application of Codesign in the Realm of Education

Schools look for ways to support learning through technology, however, they find existing technology often does not support the actual needs of teachers (Arnett, 2016). After reviewing various cases in which engineers and experts interact within one team, one can apply this methodology to create the technology that does support the needs of teachers. In looking at the collaboration between engineers and physicians, physicians discussed medical issues they faced and engineers pitched ideas that might solve them. A setup such as this would be beneficial to educational technology projects. Instead of the engineers asking educational experts for feedback on built technology, engineers may benefit from addressing root needs by asking about issues prior to actually creating the technology. In the next case between engineers and farmers, one can see the effectiveness of the continuous involvement from both parties. Level of involvement varied over the course of the project, but summing up that of each expert from the graph, one would notice the contributions are about equal. In regards to engineers working with educational experts, engineers and educational experts should contribute equally and be involved throughout the entire project. Repeated iterations will ensure continuous improvement on new technologies. In the last case, engineers and hospital personnel worked on the design of the new building together and their personal experience saved the design team hours. In regards to collaboration in edutech, engineers and education experts should actively work on the design of educational technology together to streamline the design process.

Evaluation of Senior Project

After reviewing what good edutech is and exploring the interactions amongst engineers and different experts, much of what has been discussed can be applied to my senior project. My team and I are engineers that were assigned a project in education, specifically finance. The project involved building a virtual voice assistant that served to improve financial literacy in American students from kindergarten through twelfth grade. However, a hindrance in the project was our lack of expertise in education. Our team intended to consult experts in education, but did not have enough time to do so. The result of this was a prototype that was more universal than personal to students, which limits the effectiveness for teaching students. Several improvements could have been made to the final prototype if the process of codesign was utilized.

Case studies suggest that our team and experts in education should have been involved throughout the entire duration of the process from the design phase to implementation. Total contributions to the project should be made equally from both parties as opposed to a heavy involvement from my team. Lastly, before beginning the design process, my team should have identified key needs/issues that experts in education are facing to ensure the technology we developed would address those. If these steps were taken, the educational technology built would have been improved all around.

Conclusion

It is apparent that educational technology will continue to grow in spending and usage in the United States. However, the effectiveness has not been proven after looking at Americans' financial literacy level in the past few years. The relationship between spending/usage of educational technology should be proportional to that of Americans' learning financial literacy comfort. In order to address this relationship, the process of codesign has been evaluated in several case studies evaluating designers working with groups ranging from physicians to farmers. Codesign has shown promising results in various scenarios and it is evident that it can be applied in an educational setting. Equal, continuous contributions from both engineers and educational experts throughout the entire project is key to effective collaboration. However, before beginning, it is important for engineers to identify the key needs/issues educational experts are facing. With successful implementation of this dynamic, educational experts and engineers can explore working together to develop good educational technology that addresses the needs of the users properly.

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