New Strategies to Increase Engagement and Decrease Dropout in Mental Health

Interventions

**Analyzing and Implementing Codesign Benefits and Challenges to Conversational Agent
Feasibility Study**

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 Your Major

By

Disha Patel

November 3, 2021

Annabel Lynch, Aparna Ramanan, Rob Schwartz

ADVISORS

Sean Ferguson, Department of Engineering and Society

Laura Barnes, Department of Systems & Information Engineering

Introduction

There evidently has been and currently exists a mental health crisis in America, sourcing from a huge range of age groups and backgrounds. Approximately half the U.S. population experiences serious mental health problems during their lifetime, including 29% with an anxiety disorder, yet more than two thirds will not receive treatment ("U.S. Department of Health and Human Services", n.d.). With this level of mental illness burden, it is clear that treating people one-on-one in a clinical setting will never meet the existing needs.

My capstone project group is working to research and design innovative techniques to embed in digital mental health interventions, specifically the use of a virtual conversational agent. The team is collaborating with members of MindTrails, an existing UVa digital program to reduce anxiety through a cognitive bias intervention method, to create a conversational agent that replaces a human coach during a session. MindTrails is created through the Program for Anxiety, Cognition, and Treatment (PACT) Lab in the Psychology department. The goal of the conversational agent is to provide feasible and useful insights to keep users engaged in MindTrails and minimize attrition rates throughout the study.

My STS research will directly relate to the technical work being done in my capstone project as there is certain overlap between the technical aspects and frameworks discussed in class. As previously mentioned, my team is working directly with members of the Psychology department to engineer an effective conversational agent. With this crucial collaboration process I will focus on analyzing features from the codesign framework being implemented in my capstone project to assess what is effectively being done versus not. To successfully make this analysis, I will investigate existing cases and projects in which codesign methodologies are being implemented and what successes or challenges can be applied to improve my capstone work.

Technical Topic

As previously discussed, mental health is a topic that is very important and prevalent in the world today, especially as we as a nation face issues like the COVID-19 pandemic, Black Lives Matter movement, and divides in the political climate (Panchal et al., 2021). In efforts to minimize the toll being taken from events like the ones listed, the increase of mental health interventions are crucial. However, given the high magnitude of mental health seeking patients, digital mental health (DMH) measures must come into play.

Digital mental health strategies have significantly increased and played a huge role in providing care for those who are unable to do so in person. However, attrition is a problem for users who desire to complete mental health interventions but find that they are not able to do so (Bremer, et al., 2020). This is a problem in all behavior-change technologies, including MindTrails. As a capstone group, we will work on creating a way to keep users engaged in MindTrails. Human coaches were initially used in MindTrails to increase engagement among participants. Due to availability issues, alternative engagement methods have been researched by our team. A conclusion reached was the potential solution of a conversational agent - an automated agent that can respond to closed or open-ended responses from the user at predetermined or open times. A digital conversational agent during MindTrails is beneficial as it will allow for non-human interactions which is preferred by those with social anxiety, consistent service at any hour of the day, user familiarity to chatbots creates ease of use, exposure to unfamiliar people can be avoided (exposure can trigger anxious feelings and the fear of being judged), and a digital agent is cheaper to run due to reduction of MindTrails staff.

My capstone group's main goals in its efforts with MindTrails is to research existing virtual conversational agents and their features to design the best chatbot so that users stay active

in their MindTrails sessions. We will use a software called Juji to design our agent based on what effective designs currently exist. The first step is to get to know what feature options already exist and how they can be implemented in our design. From researching existing chatbot technologies like Woebot, Vitalk, and Atena (Beilharz, et al., 2021), the main features of a conversational agent that we must consider in our design include:

- Embodied vs. Non-Embodied
    - An embodied CA has an icon or character with emotions. Based on how the interactions are perceived, the character's personality and facial expressions change
    - A non-embodied CA lacks these features and has a static icon
- Domain Free vs. Domain Specific
    - Some CA's can participate/engage in any domain. Interactions are prompted by the user and can regard a variety of topics
    - Domain specific CA's operate in a single speciality such as medicine, retail/customer service, education, etc.
- Free vs. Rule-Based Responses
    - Free responses allow the user to type open or free text. There may be character limits on responses, but the user has personal freedoms on what to write.
    - In rule-based, there is a basic chatbot which responds based on a decision tree. Interactions are programmed by call-to-actions.

Like I mentioned, my team is planning on working with the Juji software to design our conversational agent. Given the opportunities within Juji, we have decided that the design of our agent will be non-embodied, domain-specific, and rule-based. This will make the design process

quicker and easier for us so that we can run a study with the final product to assess how engaging the agent actually will be in MindTrails. A study will be conducted to assess the feasibility of leveraging conversational agents in order to increase engagement in social anxiety interventions. The layout of the study includes the following:

1. Participants work through one training session of MindTrails
2. Following the session, participants will be interviewed regarding their experience using MindTrails
3. Interview will then transition to potential interest in working with a conversational agent (created in Juji software) during a future MindTrails session
4. Participants will use and gain experience with the Juji agent
5. Another interview following the Juji experience will ask participants on how they felt about Juji and if it will help to stay engaged during the next MindTrails session

My job as of now is to continue research and begin implementing key takeaways from the Juji software to present to the MindTrails team. The goal is to be able to assess the feasibility of a conversational agent versus a human coach in an intervention like MindTrails by providing insights on the technicalities and purpose behind the study. Hopefully, a transition from a human coach to a digital conversational agent will result in equal or less attrition from the study.

STS Topic

Now that there is a general understanding of what the technical work being done in my capstone looks like, it is important to begin considering what methodologies being implemented in the project are effective versus not. Specifically, I will be using previously published material to substantiate an evaluative framework that can be applied to my capstone project. This includes

reflection and analysis of what collaborative design looks like in the work that I am doing as well as determining areas for improvement within my project to maintain a successful codesign process. Through this research, I will be able to make recommendations for bettering the collaborative work being done in my capstone project, but I also hope that the lessons learned from this research can be applied to future engineering students working through collaborative design and the experiential learning curriculum.

First, it is important to understand what the codesign framework is and what a successful codesign process looks like. Though the main focus of codesign includes collaborative work, there is much more to consider to fully grasp what makes the framework so impactful. A project between a group of engineers working to build culturally inspired, sustainable housing for the Pinoleville Pomo Nation (PPN) uses a codesign process to gain a better understanding of the needs of the people who will live there. The effective codesign aspect of this project intends 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" (Edmunds, et. al, 2013). In my capstone project, there exists a codesign relationship between our group of engineers and members from the Psychology department that work for MindTrails. The issue that lies without this collaboration is the inability to appropriately design a conversational agent so that it is engaging and feasible for participants. We as engineers are able to control the software that produces the responses from the agent, but the knowledge from another stakeholder (psychology department) is crucial in assuring the verbiage of the chatbot responses will be impactful to the user. This is being done as my team consistently meets with the Psychology department working with MindTrails and gains input based on what experiences and background knowledge they have.

Earlier in the technical portion, a brief study design layout was discussed in terms of how the feasibility of a conversational agent will be investigated and executed. One crucial step is interviewing the participant (with a generalized form of anxiety) to get their feedback before and after using the designed conversational agent. A successful codesign project involves working with the elderly population to develop concepts for health care services. One main codesign technique used in this study was directly interviewing the main stakeholder group (elderly population) to gain a better understanding of their existing knowledge and views. "Through co-design, we engaged in an ongoing dialogue with the elderly people that participated, which enabled us to jointly develop, verify and further develop ideas and themes, which helped us to generate valuable and validated concepts— more valuable and validated than concepts that would have been developed without interacting with users" (Steen, et al., 2011). This study clearly shows the positive impacts of using interviewing in the codesign process to gain a better understanding of the affected groups of the study. In the case of my capstone project, this exact method is being used to understand what reactions participants have since they will be the primary group using the final technology design. Though there is interaction and collaboration being done within the team of engineers and members of the psychology department, there is still no way to know exactly how participants react to new technologies like the conversational agent without getting direct feedback.

While getting to know how beneficial techniques of codesign in existing studies can be pinpointed in my capstone project, it is equally important to be aware of potential challenges that exist in the framework. One of the challenges for codesign facilitators is responding to pressures related to resource and time constraints that could compromise the process (Moll, et al., 2020). This obstacle exists in my capstone work as there are time and resource limitations in the process

of creating and testing the feasibility of a conversational agent. Time is a huge factor that creates pressure in two ways -- the overall timeline pressure of the technical work (only until Spring 2022) and the time constraints of each codesign group, possibly preventing regular collaborative meetings. Resources are also limitations, specifically in a health related study like MindTrails due to existing rules like HIPAA that prevent thorough analysis of the study. These are challenges that may not be able to be fully solved, but understanding that they are present can help minimize the negative impacts from them.

Through the study of existing codesign cases and the benefits and challenges presented within them, it is safe to say that the framework of codesign is very important - most of the examples that are found are rare, but they are wonderful. The key takeaways from my research on codesign have aligned very closely with my technical work requiring joint teamwork with other stakeholders like members of the Psychology department running MindTrails.

Next Steps

Since I have analyzed my existing capstone project in relation to the framework of codesign, it is now possible to consider next steps of the technical work and how my STS research can be applied. As previously explained, next steps include designing the conversational agent using the Juji software, and running and implementing a feasibility study to understand how the design will or will not keep users engaged. After gaining extensive knowledge of codesign techniques and their impacts, I will be able to figure out how to best work with involved groups of the technical project. However, even after the codesign research done in the STS portion of my paper, there still exists some questions in how to work with the specific stakeholders of my project -- psychology student participants with generalized or social anxiety,

and the psychology team assisting with the MindTrails aspect of the project. With this being said, I hope to look into particular cases in which there is codesign in the healthcare world between workers in the field and engineers. One specific case study that I have found that I hope to look further into is a codesigned group pregnancy care for refugee background women (Riggs, et al., 2021). This ties into the healthcare aspect of my technical work as well as integrating ideas with a vulnerable group (similar to the participants suffering from some sort of generalized anxiety in my capstone study).

References

Beilharz, F., Sukunesan, S., Rossell, S. L., Kulkarni, J., & Sharp, G. (2021, June 16). *Development of a positive body image chatbot (kit) with young people and parents/carers: Qualitative Focus Group Study*. Journal of Medical Internet Research. Retrieved November 3, 2021, from https://www.jmir.org/2021/6/e27807/.

Bremer, V., Chow, P. I., Funk, B., Thorndike, F. P., & Ritterband, L. M. (2020, October 28). *Developing a process for the analysis of user journeys and the prediction of dropout in Digital Health Interventions: Machine Learning Approach*. Journal of Medical Internet Research. Retrieved November 3, 2021, from https://www.jmir.org/2020/10/e17738.

Edmunds, D. S., Shelby, R., James, A., Steele, L., Baker, M., Perez, Y. V., & TallBear, K. (2013). Tribal Housing, codesign, and cultural sovereignty. *Science, Technology, & Human Values*, *38*(6), 801–828. https://doi.org/10.1177/0162243913490812

Moll, S., Wyndham-West, M., Mulvale, G., Park, S., Buettgen, A., Phoenix, M., Fleisig, R., & Bruce, E. (2020, November 1). *Are you really doing 'codesign'? critical reflections when working with vulnerable populations*. BMJ Open. Retrieved November 3, 2021, from https://bmjopen.bmj.com/content/10/11/e038339.

Panchal, N., Kamal, R., Cox, C., & Garfield, R. (2021, February 20). *The implications of COVID-19 for mental health and substance use*. The Implications of COVID-19 for Mental Health and Substance Use. Retrieved November 3, 2021, from https://www.kff.org/coronavirus-covid-19/issue-brief/the-implications-of-covid-19-for-mental-health-and-substance-use/#:~:text=The%20KFF%20Health%20Tracking%20Poll,eating%2C%20increases%20in%20alcohol%20consumption.

Riggs, E., Yelland, J., Mensah, F. K., Gold, L., Szwarc, J., Kaplan, I., Small, R., Middleton, P., Krastev, A., McDonald, E., East, C., Homer, C., Nesvadba, N., Biggs, L., Braithwaite, J., & Brown, S. J. (2021, July 1). *Group pregnancy care for refugee background women: A codesigned, Multimethod Evaluation Protocol applying a community engagement framework and an interrupted time series design*. BMJ Open. Retrieved November 3, 2021, from https://bmjopen.bmj.com/content/11/7/e048271.full.

Steen, M., Manschot, M., & De Koning, N. (2011, August 15). *Benefits of co-design in Service Design projects*. International Journal of Dsign. Retrieved November 3, 2021, from http://www.ijdesign.org/index.php/IJDesign/article/view/890/346.

U.S. Department of Health and Human Services. (n.d.). *NIMH " mental illness*. National Institute of Mental Health. Retrieved November 3, 2021, from https://www.nimh.nih.gov/health/statistics/mental-illness#part_2539.