Post-Secondary Student Perceptions of an Emotional AI For Promoting Self-Gratitude in On-line Learning

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For our study, we define "self-gratitude" as a positive emotional response, leading to life satisfaction. This research aimed to evaluate post-secondary students' perceptions of emotionally intelligent robots, designed to improve student's online study and their self-confidence. We designed three middle-fidelity prototypes with varying design requirements, including "Wearable Device", "Portable Device", and "penguin prototype". We conducted an online survey (n=30), and a semi-structured interview (n=8) to assess students' feelings and emotions. The survey results showed that the "Wearable AI" and "Penguin Robot" are more preferable prototypes. The students also thought that the prototypes' features can enhance their study. Overall, users enjoyed anthropomorphic devices that can be fidgeted with. We also found that users desired personalizing features and contextually specific response and expressed some concerns over security and privacy. We conclude that emotional AIs which leverage fidgeting, anthropomorphic design, and provide a personalized experience are best for increasing students' self-confidence and self-gratitude.

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1 INTRODUCTION

During the COVID-19 pandemic, many post-secondary students have had their courses moved online and are now having to tackle online learning in isolation. A 2020 study by Son et al. on the effect of the pandemic on students' mental health found that anxiety and stress are on the rise amongst college students [15]. Moreover, a 2020 study by Blanco et al. found a statistically significant correlation between a student's self-confidence and their academic success [2]. Evidently, boosting students' mental health has benefits beyond just improving students' mental health. Authors such as Robinson, Cottier, and Kavanagh, as well as companies such as Aiko (figure 1) have proposed social robots to improve mental health [12, 13]. However, as of time of writing, there are not any studies that specifically seek to understand student perceptions of emotionally intelligent robots designed to boost self-confidence in academic contexts.

Our aim is to understand post secondary students' perceptions of emotionally intelligent robots specifically designed to encourage self-confidence in educational settings, as that may improve academic success, which may in turn improve mental health overall (with respect to schooling). Fundamentally, we hope to determine whether students are receptive to and comfortable with emotionally intelligent robots. More specifically we hope to identify the specific features and

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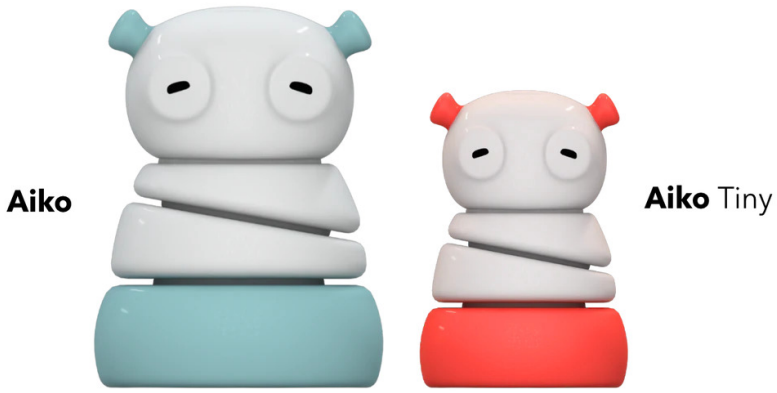

Fig. 1. Aiko AI powered robot by Aisoy

physical attributes users desire in an emotionally intelligent robot. To ensure that participants are basing their answers on a shared understanding, we design 3 prototypes. The first prototype is a wearable bracelet, the second is a pocket sized robot which would sit on your desk in use but is easily portable, the third is a larger, anthropomorphized robot. There are shared features across all the prototypes, such as connecting to students accounts to see their schedule, due dates and grades, as well as features which are unique to the modality, such as the wearable bracelet collecting heart rate data from students to estimate their stress levels.

Our study involved two separate phases: a survey based on Kansei engineering and semi-structured interviews. We designed 3 prototypes of emotionally intelligent robots. Each prototype is based on distinct physical differences so that we might appropriately cover the possibility space for robot designs. We analysed the results of the survey with descriptive statistics to understand participants' emotional response to the three designs and iterate upon the first set of designs. After iterating on the initial three designs we conducted semi-structured interviews to understand post-secondary students' perceptions of emotionally intelligent robots for promoting self-confidence in an educational environment. Our prototypes acted as examples of such devices and provided us with the opportunity to understand how participants perceive the specific features and modalities.

2 LITERATURE REVIEW

2.1 Emotion AI

Socially Assistive Robots (SARs) allow for a more interactive experience and are defined as "robotic technology platforms with audio, visual, and movement capabilities that are being developed to interact with individuals socially while also assisting them with management of their physical and psychological well-being" [5]. SARs are designed to aid the user and coach, motivate, and influence behavior change [5].

The development of SAR's led to a growth of interactive technologies for mental health [4]. For example, Social robots have been tested as a new way of delivering digital treatments, such as psychological, social, and therapeutic programs [12]; and have acted as a life coach [1]. An artificial intelligence-based emotional robot is being marketed to alleviate loneliness, express emotions, and improve communication skills [13]; and psychological well being, mood, and readiness was shown to significantly improve after college students use a social robot coach delivering positive psychology interventions [14].

A study by Yorita et al. in 2018 worked to develop a conversation-based, robot-assisted, stress management framework, which aligns with the emotionally intelligent robot design goals used in this study. This framework that the authors created showed "promising results" in stress management of the participants [17]. It is important to consider research like this, in order to better understand the realistic impacts of our proposed, idealized robots. Another study published in 2020 by Jeong et al. expands on both of the aforementioned studies by creating a positive psychology coach, and having a large number of students use and interact with it [6]. This study showed that there was a "statistically significant improvement in participants' psychological wellbeing, mood, and readiness to change behavior for improved wellbeing" [7]. This study very closely mimics the intention of our own study, and the results are encouraging. Although the aforementioned studies might be similar to perception studies, they do not provide representative information on acceptance and user opinions of these technologies, before or after being acquainted with them.

2.2 Perception Studies

While an exhaustive search of all Human-Computer Interaction and other literature was not conducted, no studies were identified that directly focused on student perceptions of emotionally intelligent robots in online learning environments. However, a number of studies were found regarding perceptions of assistive robots in various, non-educational contexts, and studies on the impacts or designs of self-help robots created for students.

For the purposes of our study, we are interested in the wearable agent sub-field of wearable agent design. Matsunaga and Shiomi in 2021 conducted a study to see if wearing a physical robot changes a user's perception of it. The authors found that wearing a robot produced an improvement in likeability and positive total impression [9], therefore our prototype designs included a wearable design.

We identified a number of perception studies relating to robots which helps show that this is a valid research avenue, however these studies do not directly relate to self-gratitude robots for students. There are two studies related to health care, the first by Johanason et al. from 2020 [8] and the second by Tobis et al. [16] from 2017. The 2019 study focused on social communication between robots and humans, and explored the changes in perception toward the robot as it smiled and used first-name reference. The results showed a great improvement in positive perception toward the robot's personality [8]. The paper by Tobis et al. studied the perceptions of occupational therapy students toward older person care robots. Interestingly, the results showed that the majority of positive perceptions were capability-based (students 'liked' the robot for what it was able to do), while less than half of the students found the robot's social capabilities to positively impact their perceptions [16]. The authors speculate this may be due to students not believing that a robot can replace a caregiver.

The insights from these last two papers helped to motivate our project. On one hand, it appears that social actions from a robot improve likability and promote further positive interactions [8], while on the other hand there can be a tendency to not positively perceive a robot that may 'substitute' a person [16]. These two ideas may play a role and align with the perception students may have toward a emotionally intelligent robot that they could use. Additionally, all the above studies identify a gap in the literature connecting students' perception concerning emotionally intelligent

robots. We hope to fill the gap in literature with a perception study aimed to understand post secondary students' perceptions of emotionally intelligent robots specifically designed to encourage self-confidence and well-being in online school educational settings.

3 METHODOLOGY

3.1 Participant Recruitment

We recruited participants using snowball sampling, a technique through which an initial set of participants are contacted about the study, and then asked to either forward the study invitation to friends/colleagues/etc. who they believe would be suitable for the study, or provide the researchers with prospective participants' contact information. Two mostly distinct groups were contacted. All participants were to be over the age of 18, part of a post-secondary education institution (University or College), and enrolled in online synchronous classes. The participants did not have any cognitive disabilities, and were required to be fluent in English for this study. All participants signed a consent waiver which explained the study, what information we were to collect (see section 3.3), as well as the fact that they could withdraw from the study with no consequences. Interview participants signed an additional concept form.

3.2 Study Design

3.2.1 Materials. Considering the context of an online study, and accompanied by the literature review, we came up with the idea of "Emotionally intelligent robot" to support students during their online study. In order to investigate perceptions of such devices, we developed three idealized medium-fidelity prototypes. These designs are made to function in an ideal way, without considering the technicalities of their physical creation. We produced the initial set of designs via an iterative process where we, as a team, reviewed proposed features. Following the survey (discussed in section 3.2.2), we conducted a redesign phase, during which we changed the descriptions of each prototype to either clarify, change, or add features. Following are finalized descriptions shown to interview participants, alongside the rendered images for each prototype:

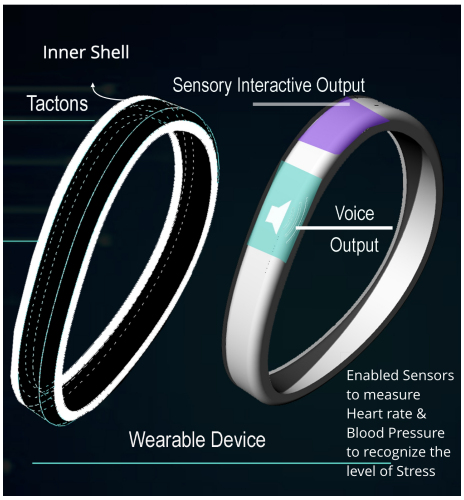

Fig. 2. Conceptual Design 1: Wearable Robot

Initial: The design can easily sync with personal devices (mobile phone or laptop) through online study to create sensory interactive outputs (Voice Cues, Tactons & Texts) based on users' emotions. (Collecting heart rate, temperature, and Blood pressure information to analyze the level of stress.)

Updated: This wearable prototype is designed so that the student can wear the device while engaging in online learning. The outputs include voice responses, haptic tactons, and on-screen text messages. This prototype can estimate users' stress levels by collecting heart rate, temperature, and blood pressure. This prototype can also detect voice cues to help with the wearer's assessment. When it detects that users are stressed it will offer encouraging words via voice or on-screen messages to synced devices. Software of the robot is based on an application on users' phone and will display screen text notifications on user's phone.

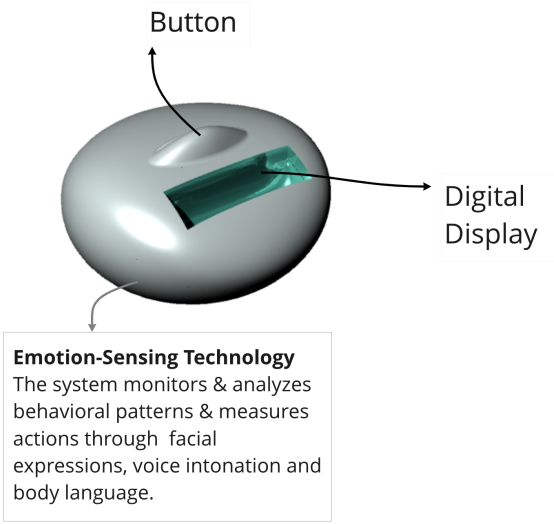

Fig. 3. Conceptual Design 2: Portable Robot

Initial: The design combines monitoring & analysis of facial expressions, voice intonation & body language of the user to produce required outputs in order to create a smooth online learning experience for students. It can easily sync with a personal laptop or mobile device to enhance learning. The device can also receive the student's info about their study progress to create reminders & persuasive notifications. (Output: Voice, Texts, haptics)

Updated: The design combines monitoring & analysis of voice intonation and body language of the user to produce required outputs in order to create a smooth online learning experience for students. It can easily sync with a personal laptop or mobile device to enhance learning. The device can also receive the student's info about their study progress to create reminders & persuasive notifications (Output: Voice, Texts, haptics). When it detects that users are stressed it will offer encouraging words via voice or on-screen messages to synced devices. The form factor of the device is inspired by worry stones so students can fidget with the device during class.

Initial: The design combines speech recognition, sound detection, pose tracking, emotion detection and recognition, image recognition and face detection and recognition of the user, combined within a robot to produce required outputs

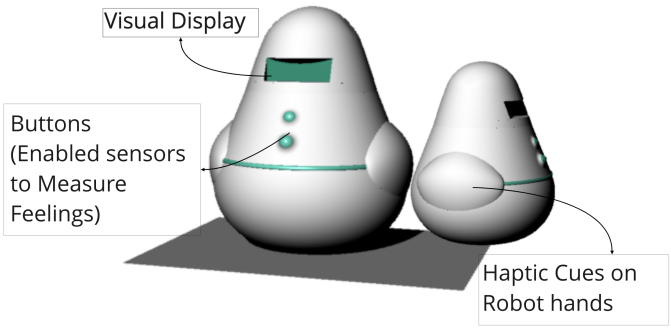

Fig. 4. Conceptual Design 3: Penguin Robot

for creating a smooth online learning experience for students. Software of the robot is based on an application on users phone that they place within the robot. Because the software is portable, the user can benefit from positive outcomes directly from their phone. The device can also receive the students info about their study progress to create reminders and persuasive notifications.

Updated: The design combines speech recognition, sound detection, pose tracking, emotion detection and recognition, image recognition and face detection and recognition of the user, combined within a robot to produce required outputs for creating a smooth online learning experience for students. The software of the robot is based on an application on users' phone that they place within the robot. Because the software is portable, the user can benefit from positive outcomes directly from their phone. The device can also receive the student's info about their study progress to create reminders and persuasive notifications. The robot is bottom heavy so that students can fidget by pushing the robot over and have it return to upright.

3.2.2 Survey Creation. The study consisted of a two part process. The first part was a survey which participants provided information on their thoughts, feelings, and opinions of three conceptual designs. The questions were formulated based on the Kansei Engineering Method, a technique for translating feelings and emotions into design parameters known as sensibility measurements. The survey included ten questions, asking the students about their feelings and emotions to three different medium-fidelity emotionally intelligent robot designs. In Kansei Engineering, the design is investigated based on "Semantic Differential Analysis" [10]. We explored related articles on website design, digital design, etc. to extract related adjectives (Kansei words) for our survey (such as user-friendly, comfortable, usable, etc.) to create the semantic space, as a part of Kansei Engineering methodology. We organized the questionnaire based on this semantic space (Kansei words) in the form of bipolar adjectives (positive, negative adjectives) on a 5 point likert scale. We have included the survey questions in appendix A.

3.2.3 Interview. This interview lasted approximately 30 minutes to 45 minutes, and contained questions regarding the participant's experience with online learning, past experience with emotionally intelligent robots or Artificial intelligent devices, and in-depth questions about the same three conceptual designs as were in the survey. In order to ensure uniform understanding of the three designs, interviewees showed the participants information regarding each of these designs and describe their functionality. This approach also allowed for participants to ask clarifying questions

throughout. Furthermore, the interview included scenarios which address the capabilities of the conceptual designs, and the participants could speculate on their preferences, opinions, and general trust of said emotionally intelligent robots. Lastly, participants filled out a short questionnaire with demographic information. The questionnaire and conceptual design information were provided, as well as the interview guide, scenarios and demographic questionnaire. The interviews were completed over a 3-week period. After completing the interviews, we analyzed the transcripts using a "Reflexive Thematic" analysis approach. We've include the interview guide in appendix B.

3.3 Data Collection

We received (n=30) responses to our survey which we distributed through Qualtrics. From the first part of the study, quantitative survey data was collected, and surveys were hosted and released through Qualtrics. From the second part of the study, a total of (n=8) interviews were conducted over Microsoft Teams, and with participant permission, the audio of the interview was collected and, if present, interviewer notes. This comprised the qualitative data of the study. The audio data was transcribed via Microsoft Teams, or NVivo if the participant preferred, and this transcription was used for qualitative analysis. All data collected was stored securely in encrypted folders, and will be stored for 3 months following the survey release and interview conduction, whereafter all data shall be virtually shredded.

3.4 Data Analysis

We performed descriptive statistics on the results to find insights which informed the aforementioned updates of our conceptual designs. We used a thematic analysis approach to analyse the qualitative interview data. Each researcher was in charge of transcribing their own interviews and collecting appropriate data for coding. The coding process was preceded, by a group coding session, to agree and familiarize each researcher with the type of codes that were most suitable.

We selected thematic coding as it works with qualitative data, can identify similar themes and patterns in the participant responses, and enable us to interpret them. We produced descriptive statistics for the quantitative survey data and demographic questionnaire in order to observe any similar trends that aid in answering the research questions. Results from the demographic survey allowed us to identify any gaps in our sample size and identify any limitations in our study related to skewed sample populations.

4 RESULTS

4.1 Survey Results

We conducted an online survey, containing questions based on Kansei Engineering to measure users' feelings about emotionally intelligent robots. A total number of 30 participants(n=30) took part in the survey. The first question (figure 5) asked participants' consent to take part in the survey. 90% of participants were in the age of (18-24), while 10% were in the age of (25-34), all participants had at least 4 months of online post-secondary study in the past 2 years.

We also asked participants how many hours of online study they have in a week (figure 6), including online classes, online meetings, and the other related online study activities. There were 8 participants that had more than 30 hours of online study, 4 participants had between 20 to 30 hours of study, 15 participants had (10 – 20) hours of online study, and 3 participants were involved in online study for less than 10 hours per week.

We asked the participants how stressed they feel in their online learning environment (figure 7). There were 8 participants that felt "stressed" in their online study, 15 participants felt "somewhat stressed", 4 participants felt

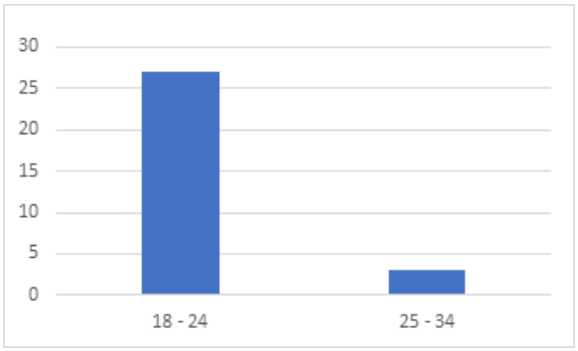

Fig. 5. Participants' age groups (n = 30)

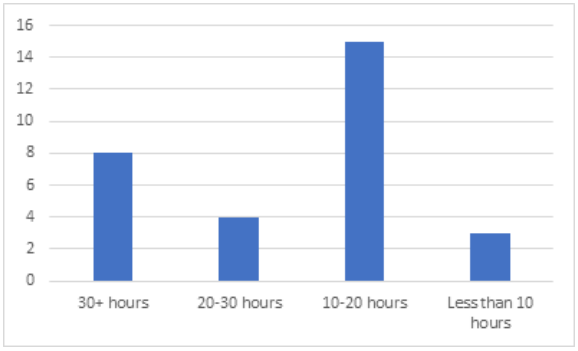

Fig. 6. Hours of online study per week (n = 30)

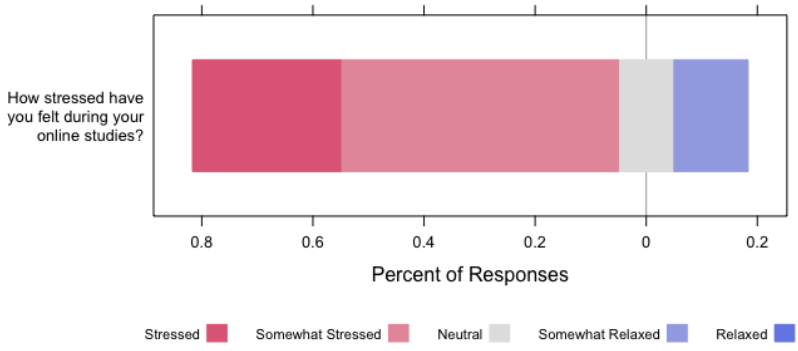

Fig. 7. How stressed participants felt during online studies (n = 30)

"somewhat relaxed", and 3 participants felt "neutral". Therefore, based on the survey's findings, online study was stressful for most of the participants.

The survey provided the participants with information about the designed prototypes. The participants answered some questions about the prototypes' features.

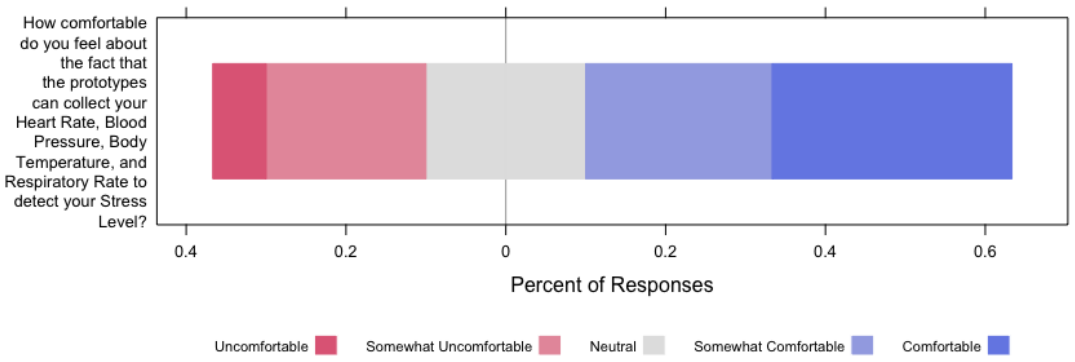

Fig. 8. How comfortable participants were with collection of "Heart Rate", "Blood Pressure", "Body Temperature", and "Respiratory Rate" (n = 30)

We asked the participants how comfortable they feel if the prototypes could collect their "Heart Rate", "Blood Pressure", "Body Temperature", and "Respiratory Rate" to detect their "Stress Level" (figure 8). There were 9 participants that felt comfortable with their "Health Data" being collected , 7 participants were "somewhat Comfortable", 6 participants were "somewhat uncomfortable", 2 participants were uncomfortable, and 6 participants had no specific opinion about it. According to the survey data analysis, 53.3% of the participants felt comfortable about this feature.

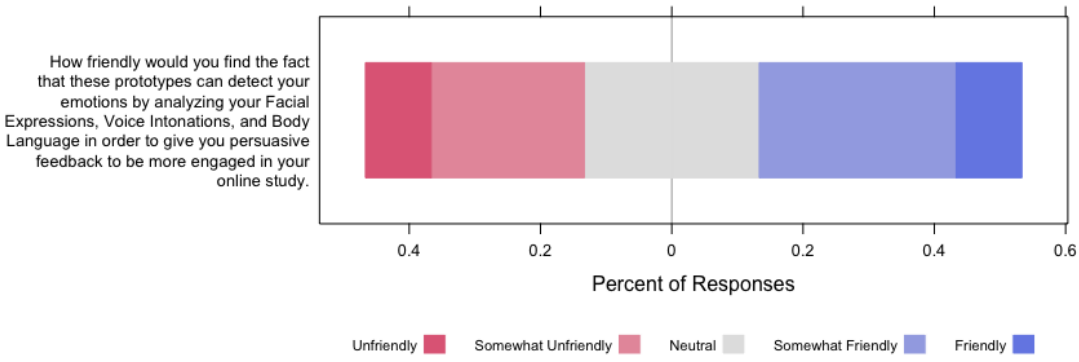

Fig. 9. How friendly participants found analysis of "Facial Expressions", "Voice Intonations", and "Body Language" for "Emotion Detection" (n=30)

Next, the participants were asked how friendly they find the process of detecting their emotions by analyzing their "Facial Expressions", "Voice Intonations", and "Body Language" by the prototypes in order to give them persuasive feedback to be more engaged in their online study (figure 9). 3 participants found this process friendly, 9 participants

thought it would be “somewhat friendly”, 8 participants felt “neutral” about it, 7 participants thought it would be “somewhat unfriendly”, and 3 participants felt the process was “unfriendly”. Based on the achieved data, this feature was acceptable by 66.67% of the participants.

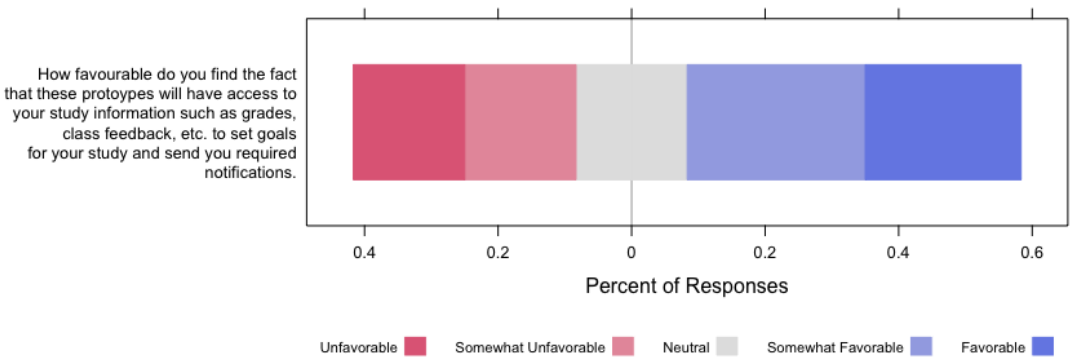

Fig. 10. How favourable participants found that the prototypes have access to the study information such as grades, class feedback, etc. to set goals & send active notification (N = 30)

The other feature investigated in the survey was the ability for the emotionally intelligent robot to have access to the participants’ study information such as grades, class feedback, etc. to set goals for their study and send them required notifications (figure 10). This feature was favorable by 7 participants, 8 participants thought it would be “Somewhat Favorable”, 5 participants found this process “Somewhat Unfavorable”, 5 participants thought it was “Unfavorable”, and 5 participants were “Neutral” about it. According to the data, 66.67% of the participants had no problem, if the prototypes would have access to the participants’ study information such as grades, class feedback, etc.

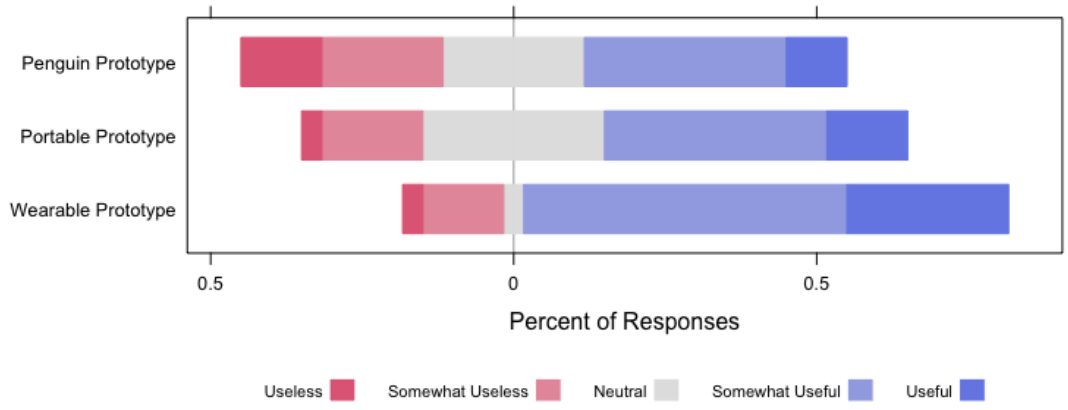

Fig. 11. How useful participants found each prototype for online study (N = 30)

We also asked about the participants' opinions on the usefulness of each prototype in the questionnaire (figure 11). Results showed that 80% of the participants thought the "Wearable Prototype" was "Useful" or "Somewhat Useful", 50% of the participants found "Portable Prototype" "Useful" or "Somewhat Useful", and 43.3% of the participants thought the "Penguin Prototype" was "Useful" or "Somewhat Useful".

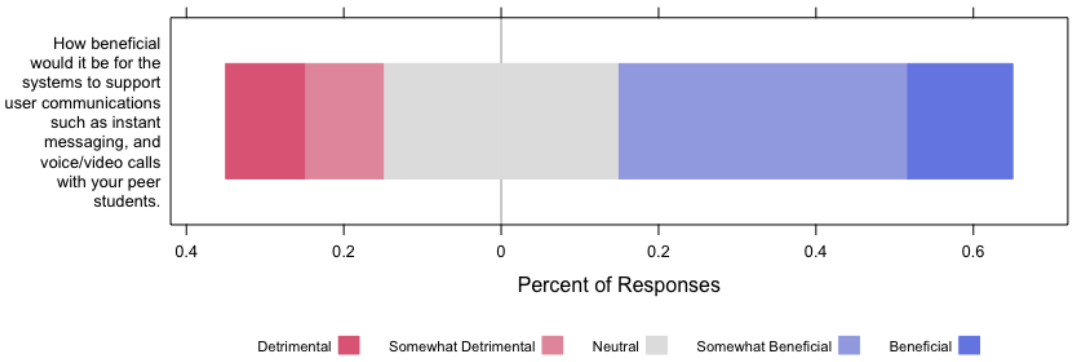

Fig. 12. How beneficial participants found user communications with instant messaging, and voice/video calls with peers (N = 30)

The last evaluated factor was how beneficial it would be for the system to support user communications such as instant messaging, and voice/video calls with peer students (figure 12). In this regard, 15 participants thought this feature would be "Beneficial" or "Somewhat Beneficial", 6 participants found it "Detrimental" or "Somewhat Detrimental", and 9 participants had "Neutral" ideas about this feature.

4.2 Interview Results

We interviewed 8 participants, all of whom were post secondary students (1 college student, 4 undergraduate students, 2 master's students, and 1 PhD student). 3 participants were men and 5 were women, also 5 were ages of 18 - 24 and 3 were 25 - 34.

First we asked some general questions about participants' experiences with online school, A.I assistants, and home robots. All participants had experience with online school, as it was part of the acceptance criteria, and they identified lectures, course work and meetings as their primary online tasks. When we asked participants about their difficulties with online learning, participants mentioned having difficulty staying on top of work, difficulty staying focused, and a general feeling of being disconnected from their instructors and peers. They also expressed frustration over their instructors' failures to adapt their courses for online learning.

Most of our participants described having some experience with home assistants but did not describe having any experience with home robots. Those who had no experience with home assistants said they say no benefit to home assistants or simply have never owned one. Of those who own or have used home assistants some owned multiple and the primary uses were for playing music and conducting simple hands-free tasks like searches. Next we showed participants our 3 prototypes and asked them to identify which features they found most useful, which, if any, made them uncomfortable, and whether they felt there was an overall positive and negative experience.

For the first prototype, the wearable robot (figure 2), participants generally seemed interested in the small form factor and perceived it as less distracting than other prototypes. Participants expressed some discomfort about the

voice messages of the prototype citing fears that they would be annoying or occur at inappropriate times. Overall, the participants felt that the wearable prototype would have a positive overall impact to their online learning and mentioned that it would be useful as a 'study buddy' when doing course work or studying for class.

Overall, participants felt that the second prototype, the portable prototype (figure 3), was just as useful as the wearable prototype. Additionally, they particularly enjoyed that the portable prototype resembled a worry stone and was designed for fidgeting. Some participants expressed discomfort about the body and voice analysis; their primary concerns were about the accuracy or about their privacy. Again most participants felt that the prototype would have an overall positive impact on their online school experience, but some mentioned that this prototype could be distracting.

Our third prototype was the penguin prototype (figure 4). Participants were most excited about the cute design or personality of the robot. They also found putting their phones into the robot to be useful as it would keep them off their phone and help them stay focused on their classes. Again, participants expressed some concerns that this prototype would be distracting and were worried about their privacy. Participants desired the ability to turn off certain features which collected data from users and wished for greater transparency in how data is stored and analyzed. This robot was universally expected to have a positive impact on participants' online leading experiences.

Our first scenario was as follows: *Your self-gratitude Emotional AI has noticed that you are very stressed through your body language, expressed emotions, and busy schedule. In order to help you out, the emotional agent uses a calming voice, and suggests a few ways by which you can relax yourself. It also creates a bunch of visual/voice messages, with the aim to boost your self-esteem, including encouraging statements, and generally trying to "hype you up".* Participants tended to put forward the penguin prototype as the most useful for this scenario citing its cuteness and personality.

Our second scenario was as follows: *You become particularly invested in one of the assignments for your online class. You get somewhat carried away on the assignment and put in more work than you believe was expected in the assignment description. You were very proud of your submission but when you get back the feedback for the assignment you receive a lower mark than expected. The assignment feedback says that your submission is slightly different from the expectations and therefore lost marks.* The portable and penguin prototypes were most common responses for this scenario; the penguin because of its cuteness and personality and the portable because of the fact that you can fidget with it.

Our third scenario was as follows: *You begin feeling nervous or anxious about a presentation coming up in your online zoom class. Your negative self-talk is making your anxiety worse and you wonder if you should make up an excuse to get out of the presentation. You worry what your classmates and professor might think of you if you mess up your presentation and the stress of this becomes overwhelming.* The penguin prototype was the most common response however this scenario garnered the most variety in responses. The reasoning was also varied. Those who suggested the penguin liked its cuteness and personality whereas those who preferred the portable and wearable thought they were less distracting and good for fidgeting.

Finally we asked participants to identify which prototypes they found most useful overall and which they felt most uncomfortable with overall. The wearable and penguin were most frequently mentioned as the most useful prototype. Participants seemed to find the wearable more practical and inconspicuous. They also mentioned that they saw the value of the wearable outside of online learning contexts such as for physical activity tracking. Fans of the penguin prototype felt more connected to it due to its cuteness and perceived personality.

The portable and penguin were also the prototypes with which users were most uncomfortable. They expressed concern about the data collection and possibility for surveillance. Curiously, these responses seem to contradict the responses to the scenarios where users mentioned the wearable the least. Curiously, one participant mentioned disliking the wearable because it was not fashionable.

Overall, the most common trend in the responses about our prototypes was that participants liked the anthropomorphic design of our penguin prototype. This prototype successfully inspired a sense of connectedness with participants.

5 DISCUSSION

5.1 Desire for Personalization

A theme that we observed from our codes is the desire for personalization of the artificial intelligent robot coach. Participants want their AI robot to perform a range of tasks in order to meet their diverse interests and needs and the ability to customize their robot for specific tasks would allow for the robot to be more useful to the individual participant. Some participants were drawn to the idea of having encouraging messages whereas a few participants noted that sometimes encouraging messages can elicit a negative response if they are not context specific *" Because like what if I'm stressed about something and it's unrelated and it sends me like an encouraging response. And I would get annoyed cause it's not even relevant." (P3).* The participants noted that they would want to have the ability to choose between features *"Like you could choose not to have that feature, or you could just choose not to sync it if you didn't like it or you didn't wanna get those." (P3).*

The participant that was originally uncomfortable with encouraging messages became more open to them when the penguin prototype was presented due to it's many features allowing for more context specific responses to user stress *"I like the speech recognition, sound detection, especially pose tracking, emotion detection and all the other listed features. So that's kind of what I found the first one was lacking, right? Like that very customized response where it's really gonna know what's wrong right in that context. And so I think that makes me a little bit less uncomfortable about it than sending me reminders or these messages, right, because it's actually going to be looking at me and seeing, Oh well, she's in this position, she's stressed out for this reason. I can send our contextually specific notification or something? It's actually gonna help, right? Versus it just being kind of like, you know, because empty encouragement isn't good encouragement." (P4).*

A personalized AI emotional robot is more likely to better serve the users needs and lead to positive outcomes, including gratitude. *"I think online learning is difficult. To different degrees to different people. So having that personalized help would be useful because not all types of help are useful to all types of people, so it understands what you need and what specifically stresses you. Then it can give you the best possible aid." (P5).*

5.2 Preference for Cuteness and Personality

We found a theme, that users have a preference for robots which are cute or have personality. The theme was related to "Devices with Personality" The "Penguin Prototype" was described as having character. It appeared that participants demonstrated feeling more connected with the penguin prototype and experienced more positive feelings towards the AI robot. They believed they could interact with the device more effectively. In this regard, one of the participants, (P4) expressed their ideas about "Penguin Prototype", *"It is being cute and like being on your desk for some reason brings me so much joy." (P4).* (P7) explained, *"Penguin Prototype is very cute! I receive more sense of connectedness from the 3rd prototype, because it has some kind of personality!" (P7), "I can practice my presentation with "Penguin Prototype", for me it is like presenting for a person." (P8).*

In general, most of the participants described the penguin prototype cute.

5.3 Fidgeting is a Useful Feature

A feature that appeared after the presentation of the Portable prototype, and was present for the Penguin prototype, was the ability to fidget with the specific device. Fidgeting was explicitly described in the information provided for the latter two prototypes, and it can be understood that that is where participants found out that these devices could be played with. Most participants explicitly pointed out their fascination with the possibility to fidget with each device, and discussed either how they can imagine others taking advantage of this feature, or explain that they would personally enjoy it. There was some distinction between the Portable and Penguin Prototypes, as their means of fidgeting differ; one participant (P2) mentioned their concern with picking up the Portable prototype to fidget with it, as it may fall accidentally, while this is not the case with the penguin prototype. Conversely, P4 explained that they already use a weighted fidget spinner, and as such the portable prototype would feel more familiar *"Fidgeting always helps me focus like having the having something to do with my hands... Especially with online learning like I sit in my chair all the time with my fidget spinner. So something like this would be nice." (P4).*

While the interest expressed by most participants, they did often suggest that others may appreciate the ability to fidget, and it can be assumed that fidgeting is most likely a highly subjective experience, which is another apparent theme from the above results. Furthermore, the ability to fidget does necessarily correlate to reduced stress [11], further implying that it may be a personal destressing habit, rather than an impactful strategy for stressed post-secondary students.

5.4 Ambivalence About Security and Privacy

Another theme that we identified across our transcripts was the split in concerns about security and privacy. Some participants expressed explicit discomfort about the types of information that the robots would collect. We did not say that course instructors would have access to the data collected by the devices but P5 brought up concerns about professor listening to students: *"Yeah, but I guess it's just a little freakier, especially if it were synced to like if you were sending any information to a Prof. Then like, what if you're badmouthing the Prof or the course or something like that? And I'd be more worried about it getting back to them?" (P5).*

In general, participants were most concerned about the speech detection and emotion detection features which relied on audio and visual data collection. Even participants who already owned home assistant devices such as Google Home or Amazon Alexa expressed concerns about how these robots would collect data: *"Well, with Google Home, I know it has like 2 features like 1 where it actually records you and one where it just listens basically. But it deletes right away. So if it was something like that then I wouldn't be as concerned. But if my speech sound detection, post tracking, emotion detection, image recognition face detection, etc. If that was getting stored permanently somewhere like yeah, this device would make me very uncomfortable." (P3).*

In some cases participants contradicting their own concerns about privacy. P5 expressed concerns about the data which would be collected about them and how it would be stored but then also said the following about personalizing the experience with the device: *"I feel like it would give the same response to anyone feeling that same stress. Which is still useful, but maybe it storing data on you and then understanding what you need in a stress sort of stressful situation would be good" (P5).* Curiously, the general concern about audio and visual data collection tended to contradict the fact that survey respondents were most concerned with the collection of biometric data. There was little to no concern about biometric data from interview participants. In fact, some interviewees mentioned that they saw particular use in the biometric data: *''The temperature sensors could be useful. I could see it as being used for like as well as online school.*

If they made it mandatory for all school, you could have temperature checkers for to see if people have fevers." (P6). An additional point that could be made on the topic of monitoring vitals, is the notion that students can self-monitor. In their book titled "The DBT Skills Workbook for Anxiety", doctors A. L. Chapman, K. L. Gratz, and M. T. Tull discuss that individuals with anxiety disorders can benefit from self monitoring, as they can better anticipate their anxiety episodes [3]. Furthermore, self-monitoring can be considered a means to self-gratitude, as the intention would be to reduce stress buildup.

Overall, it seemed that of the participants concerned about privacy or security, audio and visual surveillance was the most concerning element of the prototypes. These concerns were also rife with contradiction both across our participants and even within individual interviews.

6 LIMITATIONS

Due to the fact that we completed the study as part of a one semester course, we were not able to conduct our survey or interviews with large sample size. First, we conducted interviews with eight individuals, which may be considered a small number of participants, and may be hard to generalize our results. Similarly, our we received 30 responses to our survey which was too small to perform meaningful inferential statistics. Lastly, our study was conducted during a time where many current undergraduate students had classes either in-person, or through a hybrid approach, meaning that they may be biased away from thinking about our designs from an at-home-only viewpoint, which also ties into the fact that this study was conducted towards the "end" of the COVID-19 pandemic, rather than at its peak, when students would be actively going through the struggles they described. On one hand this affords participants a more holistic view of their experiences with online learning due to the pandemic. On the other hand, this retrospective view that students used in our interviews may result in them not remembering their exact feelings of stress or anxiety. All of the above points can be addressed or to some degree mitigated in a future, expanded study, in order to yield even more thorough results.

7 CONCLUSION

Our aim for this study was to understand post secondary students' perceptions of emotionally intelligent robots specifically designed to encourage self-confidence in online educational settings. We designed 3 prototypes of emotionally intelligent robots with different features and evaluated students' perception of them through a survey (n=30) based on Kansei engineering and semi-structured interview (n=8). A few common themes were found through the semi-structured interviews. First, personalizing of features and contextually specific responses from the emotional AI robot were desired by participants. Second, participants enjoyed the penguin device as it had anthropomorphic qualities. Third, devices with which users can fidget with are preferable. Lastly, there were security and privacy concerns with the devices that stored personal data. Overall, participants tended to prefer either the wearable or the penguin prototype and anticipate a positive experience with devices. Mechanisms in these emotional AI robots have the potential to increase self-confidence and self-gratitude within students in online learning environments.

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A SURVEY QUESTIONS

(1) How many hours per week are you usually involved in online study? (Including online classes, online meetings, and other related study activities)
   (a) Less than 10 hours
   (b) 10-20 hours
   (c) 20-30 hours
   (d) 30+ hours

(2) How stressed have you felt during your online studies? (Semantic Scale)
   (a) Relaxed
   (b) Somewhat relaxed
   (c) Neutral

(d) Somewhat stressed
(e) Stressed

(3) How do you feel comfortable if the system collects the information of your "Heart Rate", "Blood Pressure", "Body Temperature", and "Respiratory Rate" to detect your "Stress Level"? (Likert)
(a) Comfortable
(b) Somewhat Comfortable
(c) Neutral
(d) Somewhat Uncomfortable
(e) Uncomfortable

(4) The system will try to detect your emotions by analyzing your "Facial Expressions", "Voice Intonations", and "Body Language" to give you persuasive feedbacks to be more engaged in your online study. How do you find this process?
(a) Friendly
(b) Somewhat Friendly
(c) Neutral
(d) Somewhat Unfriendly
(e) Unfriendly

(5) The system will have access to your study information such as grades, class feedback, etc. to set goals for your study and send you required notifications. How do you think about these interventions?
(a) Favorable
(b) Somewhat Favorable
(c) Neutral
(d) Somewhat unfavorable
(e) Unfavorable

(6) How useful do you see the "conceptual design 1" being applied for online study?
(a) Useful
(b) Somewhat Useful
(c) Neutral
(d) Somewhat useless
(e) Useless

(7) How useful do you see the "conceptual design 2" being applied for online study?
(a) Useful
(b) Somewhat Useful
(c) Neutral
(d) Somewhat useless
(e) Useless

(8) The system will support user communications. The students can interact with other peers through instant messages, voice/video calls. How beneficial do you think this feature is?
(a) Very Beneficial
(b) Beneficial
(c) Neutral

(d) Somewhat Beneficial
(e) Not Beneficial

(9) Do you have any additional questions, comments, or concerns about this project?
(10) Would you be interested in participating in a similar interview related to this topic? Please reach out to Zahra at zahraalizadehelizei@cmail.carleton.ca.

B INTERVIEW GUIDE

B.1 Introduction

We are conducting interviews about post-secondary students' perceptions of artificially intelligent robots for promoting self-confidence. We will ask you about your opinions and experience related to the topic. If you accidentally disclose any identifying information in the interview we will remove it from the transcripts.

There are no right or wrong answers–everything you say is useful to us learning about students' perceptions of intelligent robots. We encourage you to be open about your experiences and thoughts. If you are uncomfortable answering a question, let us know, and we can skip that particular question. The interview will be audio recorded so we can analyze the data later. The interview recording and transcriptions will be anonymized. Do you have any questions before we begin? May I start recording?

B.2 Question Guide

B.2.1 Part 0: Introductory Question.

(1) What are you studying? Can you tell us about your typical day while attending school?

B.2.2 Part 1: General Questions.

(1) Can you tell us about your experience with robots (such as Jibo or Aido) or artificial intelligent systems (such as Amazon Alexa or Google Home)?
(a) If you do not have experience with either of these, why not?
(2) Have you experienced any difficulties with online learning?
(3) Do you have any strategies you use to build self-confidence particularly while attending online courses?

B.2.3 Part 2: Prototype Questions. For each prototype, the interviewer will present the image and description to participants, offer to read the description, and ask if participants have any questions.

Part 2.1: Wearable Robot This wearable prototype is designed so that the student can wear the device while engaging in online learning. The outputs include voice responses, haptic tactons, and on screen text messages. This prototype can estimate users' stress levels by collecting heart rate, temperature, and blood pressure. This prototype can also detect voice cues to help with the wearer's assessment. When it detects that users are stressed it will offer encouraging words via voice or on screen messages to synced devices. Software of the robot is based on an application on users phone and will display screen text notifications on users phone.

(1) Are there aspects of this prototype which sound particularly useful to you?
(a) Why are these features useful?
(2) Are there aspects of this prototype which make you particularly uncomfortable?
(a) Why do these features make you uncomfortable?
(3) Overall, how do you feel this robot would affect your experience in online learning?

(a) Do you think it would have a positive or negative impact?

Part 2.2: Portable Robot The design combines monitoring & analysis of voice intonation and body language of the user to produce required outputs in order to create a smooth online learning experience for students. It can easily sync with a personal laptop or mobile device to enhance learning. The device can also receive the student's info about their study progress to create reminders & persuasive notifications (Output: Voice, Texts, haptics). When it detects that users are stressed it will offer encouraging words via voice or on screen messages to synced devices. The form factor of the device is inspired by worry stones so students can fidget with the device during class.

(1) Are there aspects of this prototype which sound particularly useful to you?
   (a) Why are these features useful?
(2) Are there aspects of this prototype which make you particularly uncomfortable?
   (a) Why do these features make you uncomfortable?
(3) Overall, how do you feel this robot would affect your experience in online learning?
   (a) Do you think it would have a positive or negative impact?

Part 2.3: Penguin Robot The design combines speech recognition, sound detection, pose tracking, emotion detection and recognition, image recognition and face detection and recognition of the user, combined within a robot to produce required outputs for creating a smooth online learning experience for students. Software of the robot is based on an application on users phone that they place within the robot. Because the software is portable, the user can benefit from positive outcomes directly from their phone. The device can also receive the students info about their study progress to create reminders and persuasive notifications. The robot is bottom heavy so that students can fidget by pushing the robot over and have it return to upright.

(1) Are there aspects of this prototype which sound particularly useful to you?
   (a) Why are these features useful?
(2) Are there aspects of this prototype which make you particularly uncomfortable?
   (a) Why do these features make you uncomfortable?
(3) Overall, how do you feel this robot would affect your experience in online learning?
   (a) Do you think it would have a positive or negative impact?

B.2.4 Scenarios.

(1) Your self-gratitude Emotional AI has noticed that you are very stressed through your body language, expressed emotions, and busy schedule. In order to help you out, the emotional agent uses a calming voice, and suggests a few ways by which you can relax yourself. It also creates a bunch of visual/voice messages, with the aim to boost your self-esteem, including encouraging statements, and generally trying to "hype you up".
   (a) What are your thoughts on this personalized interaction between person and device?
   (b) Out of the three designs shown to you earlier, do you think any would be more effective in de-stressing you in this scenario? And why?

   You become particularly invested in one of the assignments for your online class. You get somewhat carried away on the assignment and put in more work than you believe was expected in the assignment description. You were very proud of your submission but when you get back the feedback for the assignment you receive a lower mark than expected. The assignment feedback says that your submission is slightly different from the expectations and therefore lost marks.

(a) Which of the prototypes do you feel would be most effective at improving your self confidence in this scenario? Why?

You begin feeling nervous or anxious about a presentation coming up in your online zoom class. Your negative self-talk is making your anxiety worse and you wonder if you should make up an excuse to get out of the presentation. You worry what your classmates and professor might think of you if you mess up your presentation and the stress of this becomes overwhelming.

(a) Which of the prototypes do you feel would be most effective at lowering your anxiety and improving your self-confidence in this scenario? Why?

B.2.5 Part 4: Prototype Follow Up.

(a) Which of these prototypes did you feel was most useful?
(b) Were there aspects about the prototype(s) that you feel stood out? Why?
(c) Which of these prototypes were you least comfortable with?
(d) Were there aspects about the prototype(s) that you felt were particularly inappropriate? Why?
(e) Do you have additional comments or questions that we did not cover?
(f) Are there any points or opinions that you would like us to highlight in our report?

B.2.6 Part 5: Followup Demographic Survey .

(1) What is your age?
  (a) 18-24
  (b) 25-34
  (c) 35-44
  (d) 45-54
  (e) 55-64
  (f) 65-74
  (g) 75-84
  (h) 85 or older
(2) Which of the following most accurately describes you?
  (a) Non-binary
  (b) Female
  (c) Male
  (d) Prefer to self describe
  (e) Prefer not to say
(3) How much of your current post-secondary education has been online.
  (a) Less than half
  (b) About half
  (c) More than half
(4) What degree are you currently pursuing? (i.e. Undergraduate, Master's, PhD)