VR subtitles for the hearing impaired in a virtual classroom

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Abstract—**The VR classroom has become a popular way to immerse students in the learning experience while covid was around. Unfortunately for some users this form of learning is more of a hassle rather than an immersive experience. We will specifically be covering hearing impaired users of a virtual classroom but many issues with accessibility exist in this area of teaching. For hard of hearing users it is difficult to use this feature as understanding fellow classmates as well as the teacher is difficult for them when all they can see is each others avatars. Our solution to this problem was to convert the audio into readable subtitles for the user. Through our research we applied the game UI design knowledge and applied it to these subtitles. This allows us to have user customization on the subtitles which improves the user for each separate user based on their subtitle preferences. The customization is limited too color and size but there is plenty of room for additions to the customization. Throughout this entire process we have developed a good mock up of what our final product would be as we had difficulties incorporating the speech to text.**

I. Introduction

Our Project is a subtitle user interface that was designed for use in the VR classroom but could be used in office meetings, and virtual chat rooms like VR Chat. The intended audience for this interface was hard-of-hearing users but could also be used by users who lack the audio aspect of a virtual classroom through faulty or broken hearing equipment. The concept for this project is to give a solution to the fact that hard-of-hearing users lose immersion in the VR classroom because they cannot hear as well as the other users thus not being able to learn or participate as much as others. Our ultimate goal was to mimic the real classroom experience in our virtual one so users could be as immersed as possible and stay focused while learning. Since they lack the audio aspect of the virtual classroom we have had to do thorough research on the best way for hard-of-hearing users to retain information and have applied what we learned to the interface. Our subtitle user interface aims to provide a good user experience by adding settings and interesting feature to our subtitles like different colours, font sizes, and the ability to see subtitles above the head of whoever is talking.

II. Methods

For our methods to conduct this project we had many iterations of it till we got to our final product. The first example we created was a simple implementation of subtitles (see **Fig. 1**). In this picture there is a complex menu but as we do not have a picture of our old project but the very first version was just the subtitles simulating the teacher talking to the students. This version just described was the one that was we used to play test with in class. From that test we got a lot of useful feedback that led to us creating our second official prototype. In our first session we were able convert the feedback into graph able data that helped guide our process for the second iteration. That play allowed us to create a graph for the SUS (see **Fig. 2**), PQ (see **Fig. 3**), and NASA TLX (see **Fig. 4**). All of those graphs gave us a lot of great feedback on the current state of our first prototype. Each of them showed us that we had a good concept for our project but a lot of work needed to be done to give a good user experience. As we were not able to test with hearing impaired students we were unable to get any data from our target audience but we felt the changes from this data would still be applicable for our target audience. Following the data collected we then added a complex menu which gave the customization functionality intended for our users (see **Fig. 1**). This updated menu allowed the user to change the color and size of subtitles. We still faced some user experience issues as while we had good user settings we seemed to forget to tailor mechanics for our hard of hearing users. While the subtitle customization was useful the question of who was talking became an issue. While hearing people would hear from the 3D audio, hard of hearing users would not be able too. This became another problem we wanted to solve and was included in our final iteration of the prototype. Finally the last iteration of our project included a mock up of another student (see **Fig. 5**). This fake classmate simulated how the user would be able to see who was talking as well as what they are saying. We included subtitles above the head of the student which followed the same setting the user edited in the menu. Which included personalized settings as well as mechanics that accomodated hard of hearing users to immerse

them as best as possible in the classroom.

III. Results

Our subtitle user interface has proven that subtitles in VR classrooms will be a viable way for immersing hard-of-hearing users. For our subtitle user interface, we have subtitles in front of the user on their desk that should appear when the teacher is talking to the class. We have added settings to the subtitles to enhance the user experience. One of the settings is color changing for the text by using sliders to change the red green blue scale(see **Fig. 1**). This can help the user by allowing them to change the color freely to meet their need, whether they are color-blind or the subtitles are blending into the surrounding areas. Another setting is size change based on a slider from zero to one (see **Fig. 1**). This can help the user by allowing the user to shrink the text if it is blocking the way of something or enlarge the text if they think the text size is too small. Having both of these settings adds a lot to the user experience of our subtitles. We have also created a menu to keep all of the settings in an easy-to-access area(see **Fig. 1**). This menu allows the user to turn off and on the settings at will with the press of a button. This adds to the user experience because it allows the user to have their virtual desk even less cluttered and allows them to see anything behind the menu. A feature we added was adding subtitles above the heads of other students (see **Fig. 5**). This feature allows the user to know who is talking to them instead of only seeing text appear in front of them. This is helpful to the user because the user should not get confused by who is talking to them as well as not clutter the space in front of the user with all other users' subtitles. Another feature we added was the ability for the user to choose their seat within the VR classroom. This is a small addition to the virtual world but is another step closer towards increasing the immersion a user feels, which is one of the core goals we aim to achieve with this project.

IV. Discussion and Conclusion

While creating the subtitle user interface for virtual classrooms we have learned that adding multiple sounds for speech-to-text does not work well and can glitch out with free-to-use software. From this, we conclude that if we were to make this again we would need to purchase better software for text-to-speech. We have also learned a lot about creating user interfaces for VR. There are advantages and disadvantages as to how the user interface is presented. For example, making the user interface stationary does not allow the user to always see the user interface. Making the user interface follow the user's head can cause motion sickness if not implemented properly. We learned about how users might react within a VR world. We have also learned how to conduct proper testing using tools such as the SUS score, Nasa TLX, PQ, and body-storming. With this knowledge of these testing methods, we can properly test any project we make in the future. From our research as well as creating our subtitles user interface we can conclude that adding subtitles to VR worlds for the hard of hearing is a

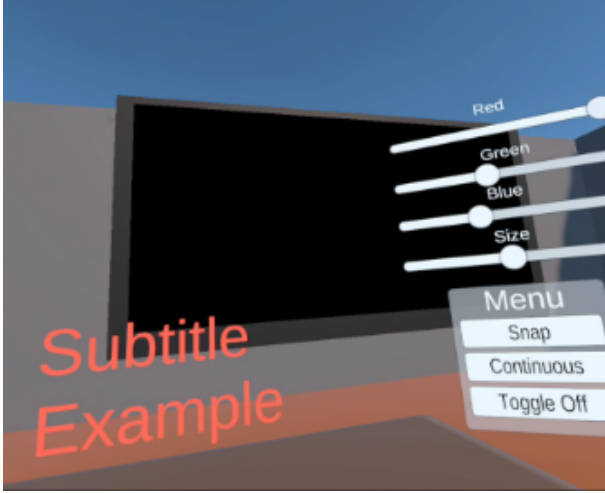viable way to keep these users immersed and focused within the VR world.

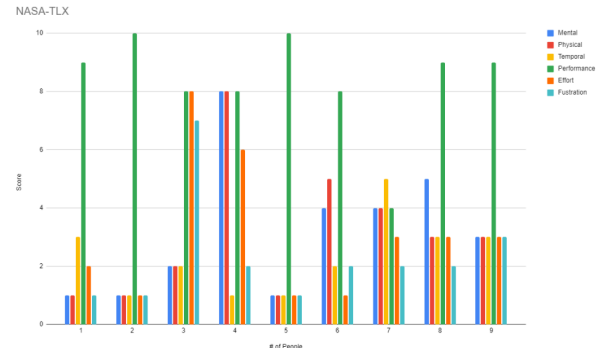# V. REFERENCES

Fig. 4. NASA TLX graph

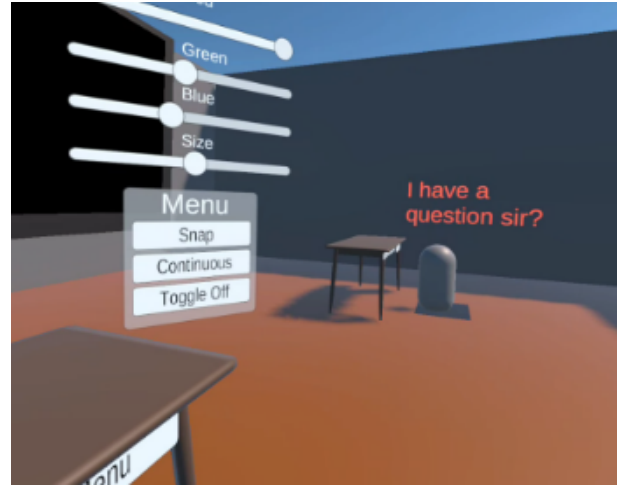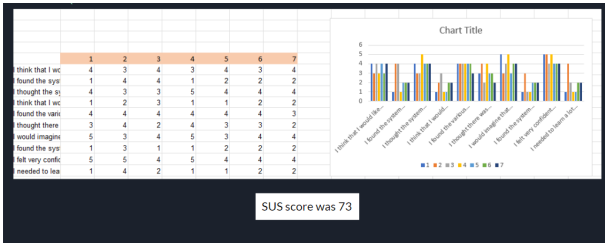Fig. 1. Example of subtitles

Fig. 5. Example of student

Fig. 2. SUS graph and number

Fig. 3. PQ scale

A. [1] A. Tamayo and F. Chaume, "Subtitling for d/deaf and hard-of-hearing children: Current practices and new possibilities to enhance language development," MDPI, 30-Jun-2017. [Online]. Available: https://www.mdpi.com/2076-3425/7/7/75. [Accessed: 29-Jan-2023].

B. [2] J.-O. Yoon and H. Choi, "The effects of captions on deaf students' contents ... - DCMP," 21-Jun-2010. [Online]. Available: https://dcmp.org/learn/static-assets/nadh274.pdf. [Accessed: 29-Jan-2023].

C. [3] N. Talavan, "Using subtitles for the deaf and hard of hearing as an innovative ...," Research Gate, 13-Mar-2019. [Online]. Available: https://www.researchgate.net/publication/334422955_Using_subtitles_for_the_deaf_and_hard_of_hearing_as_an_innovative_pedagogical_tool_in_the_language_class. [Accessed: 29-Jan-2023].