Project Title: The 'Touching Creativity': a proof of concept project.

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Executive Summary

Virtual reality (VR) is becoming an increasingly popular tool to stimulate learning in new and varied ways. However, often VR landscapes use is limited to two sensory channels e.g. sight and sound. This limitation creates barriers to learning for sight impaired students. The Open University (OU) has a history of designing accessible teaching and learning materials for all. However it was recognised, by the project leader, that OU sight impaired design students are limited to interacting with hands-on learning materials via a single sense e.g. sound.

This project hypotheses that through the inclusion of haptic VR learning tools, OU students with sight impairments, can be facilitated to better access of VR teaching tools. Thereby through this project the OU would be able to facilitate a wider sensory access to appropriate teaching and learning VR materials, and maintain a 'student first' approach.

Aims and scope of your project

- The aim of this project was to design a proof of concept APP proposal which would increase the use of VR haptic tooling which would extend 'applied learning' to a wider student audience.

- The goal of the project was to initially raise awareness of the affordances of haptics to a distance learning institute, and to disseminate findings from the proof of concept which would be used internally and presented externally at the Esteem 2018 conference.

Activities

- Inclusive and accessible principles and frameworks were at the heart of this project, thereby the project took the structure of a two tiered (T) approach:
    - T1) Pilot formative testing with design academics, observations and qualitative results were captured to further develop the haptic APP.
    - T2) Further developing the haptic APP to be more accessibly linked to sight impaired student's needs and assistances, as well as retaining access for non-disabled design students.
- Planned activities undertaken were:
    - T1 – planned trials with design (stem) Academics testing and trialling the haptic device with the designed interface application.
    - T2 – Developed APP tested by 20x design students working with the OU (n=10) fully sighted and (n=10) Non-sighted-Visually Impaired (NS-VI).
- The changes made were not at the aims or objectives level of the project, but more in the creative process of the testing elements and changes in materials. For example, the 3D scanned model element of the project, initially the model was expected to be designed by each student individually and sent to the 3D scanner company that would result in all of the 20 prototype models needing to be scanned and transferred to haptic space. However due to time restrictions and student access to a consistent quality of modelling materials, it became apparent that a more pragmatic approach would be for the project lead to design a single 3D model, which would be 3D scanned and transferred to 3D haptic space. This became a much easier and more manageable approach. Other changes were made to bring the testing protocols in to an accessible quality, and to maintain consistency throughout.
- Data evidence gathered was recorded via a recording device as well as testing notes taken throughout. The recording went across the prototype assembly trials by both groups, in both manual and virtual haptic modes.
    - Qualitative evidence was gathered from recordings and questionnaires,
    - Quantitative outcomes were gathered from output from the haptic APP, together with digital times and collision records.

Findings

When comparing the performance results between FS and NS-VI participants, we observed that in the manual prototype (MP) task versus virtual prototype (VP) mode, all participants had a similar performance reflected by the duration and nCollision parameters. That said, graphical findings showed that while statistical significance in difference was not achieved, there was a marked difference in the variation of duration and nCollision between MP and VP. This variation is thought to be due to the learning curve for using the haptic device, and future work can consider additional exposure sessions, while observing the variation.

As there was an insignificant difference shown between groups, between MP and VP, reflected by both duration and nCollision, then we can agree with the hypothesis that haptic VP has enabled both groups (N-VI&FS) enough to level the playing field, through the prototype shape assembly task. Further to this, all participants have assembled the prototype well within the accepted industry norm (5mins), and with limited difficulty, as shown through the collision (error) results.

- Particular successes from this project are shown as largely qualitative, due to the quantitative output being well within the normality spectrum offering a level result by both groups. In some cases there are non-measured narrative successes which are encouraging and offer a true human centred 'story' output from this project. Qualitative results were verbal narrative feedback given by each participants during the shape assembly testing period, and written feedback via Lickert questionnaires post trial.
    - The qualitative successes are:
        - From NVIVO (V10) themes were create and from those themes it was found that 100% of the participants stated that they either felt the trial was **interesting** or the device and accompanying app was **easy to use**.
        - *NS feedback was of particular interest - Participant NS9 [7] stated:*

        It was satisfying accomplishing something which I had thought impossible/very difficult in a relatively easy manner.

        He went on to say:

        Moving from a mental picture to actually creating a prototype was satisfying. Without the interface I can't conceive how the task could be accomplished on my own. Only [sic] other alternative would have been a sighted assistant to do all the work.
    - *There was also a shared agreement (NS/FS) of how easy it was to use the haptic de-vice and interface interaction by both groups [7]. However one participant NS8 [8] indicated an innate need to use both hands to interact with the 3D objects he stated:*
      It was also somewhat confusing at the cognitive level, that while holding the pen in the right hand and clearly feeling a virtual wall, the left hand did not feel anything.

- **Outside of the qualitative and quantitative findings** several NS-VI participants have communicated that after this trial, they felt confident enough to do other testing with other OU researchers working with NS-VI students as participants. One particular NS female held such negative opinions about her traveller capabilities, and her own view of her skills etc, that she never imagined she would be able to offer anything of any worth. Since this trial the same student has now become a more confident traveller and attended student union events across the OU campus.
- This project offered all kinds of challenges of time management of colleagues and the authors own time management in the role as project lead. This was anticipated as the project held such a variety of disciplined strands and a high level of accountability to inclusive design principles. However the colleagues who collaborated with the project, were ready to offer guidance and pointers to support the projects progression and to keep the project on track.
- The other issues were handling students signing up, although this was done through OU internal processes, it was a struggle to access students with sight impairments quickly and easily.
- Externally this projects success will hopefully lead to the paper being disseminated within Eurohaptics 2018 and Esteem 2018. Internally the impact could be seen as this trial proved there is an interest from student groups and academic staff for the inclusion of haptic technology or haptic augmented tooling in to applied discipline modules at the OU. The way this is taken forward will hopefully change, to fit more mobile forms of haptic feedback device or APPs. The impact is more channelled to the fact that there is a need, rather than the actual haptic device used.

Impact

a) Student experience

- Students who were invited to the project had no previous knowledge of haptics, the specific device used, nor the concept of how haptics worked in the virtual realm. Thereby students were introduced to new fields of design interaction and prototype assembly. Many of the students have since followed up their interest in haptics. One specific case of a NS participant (now a PhD student) reading haptics (Air Haptics) and was inspired by the particular process and device and stated he would like to include the shape assembly project as a literature review in the future.
- The longer term impact revealing the effect on students' retention etc… will be measured after more testing with mobile haptic devices or gesture haptics.

b) Teaching

- The legacy this project has left with academic teaching staff has been interesting. From the three volunteer design ALs selected to work with the BETA version of the shape assembly, all of them have been inspired to read further on haptics in education. They all were interested and stated they were inspired about the OU investing in research for design TEL.
- Externally this project has led to the project lead adding to an external blog through University Hertfordshire (UH). It has also been placed in the project leads PhD thesis, as a main trial of haptic testing. Papers have been submitted to external haptic conference.

List of deliverables

- Esteem conference 2016
http://prezi.com/gvc3k6g4i1gz/?utm_campaign=share&utm_medium=copy
- University Hertfordshire blog http://discoverhaptics.com/haptics-in-education-digital-touch-at-a-distance/ HERTS BLOG
- The OU Design Group Blog http://www.open.ac.uk/blogs/design/?p=35
- L.Bowers (2017) "Touching creativity; an inquiry of haptic tooling to support design practice, within a distance learning curriculum." submitted to Open Learning: The Journal of Open and Distance Learning.
- L.Bowers, N.SBraithwaite, R.Hayle, F.Amirabdollahian, A.Jefferies Haptic Prototype Assembly Tool for Non-Sighted, Visually Impaired and Fully Sighted Design Students, Studying at a Distance. Eurohaptics 2018 (unpublished submitted Jan 2018)

References

N.-S. P. 9, Interviewee, Shape Assembly Test. [Interview]. Friday November 2017.

NS8, Interviewee, Shape Assembly Test. [Interview]. Thursday November 2017.

F. 5, Interviewee, Shape Assembly Test. [Interview]. Wednesday November 2017.

Statement of ethical review

Reference number HREC/2016/2276

Appendices

- Eurohaptics paper , submitted for publication April 18th 2018 Eurohaptic Conference
- Esteem Abstract, submitted for Esteem, April 24th 2018.

Final report document was submitted to esteem@open.ac.uk 29th Jan 2018.