GOOGLE GLASS AS A LEARNING TOOL: SHARING EVALUATION RESULTS FOR THE ROLE OF OPTICAL HEAD MOUNTED DISPLAYS IN EDUCATION

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ABSTRACT

This paper provides an overview of the findings from an evaluation of the role of Google Glass in education over the past three years. The authors have experimented with Optical Head Mounted Displays as a support tool for various learning activities over the past few years. The study described in the paper commenced back in 2014 and continued despite the fact that the development of the Google Glass technology was paused and then shifted towards enterprise clientele. This was a result of our confidence that the future of learning interfaces is aligned to the proliferation of augmented reality and the fact that the Google Glass interface offers an ideal tool for learners due to its light structure and seamless wearing experience. The paper discusses how Google Glass has been used for a range of learning activities and describes the learners' experiences from using the device. The main contribution of the paper is in the form of measuring the success of the specific interface by sharing the results of three years of evaluations. The evaluation results are further analysed taking under consideration a number of profiling techniques of the learners involved including their personality type and learning style.

KEYWORDS

Learning tools, E-learning, Optical Head Mounted Displays, Google Glass, Interface Evaluation, Learning Interfaces

1. INTRODUCTION

This paper discusses the role of Optical Head Mounted Displays (OHMDs) in an educational context. The paper initially describes how the authors engaged in the use of Google Glass as a learning tool for providing student feedback but also offering a technology utilising augmented reality, guiding students in the synthesis of learning portfolios. The work carried out is placed within the context of relevant literature, and the arrangements needed for setting up the necessary infrastructure are discussed in detail. The paper concludes with a presentation of a thorough evaluation with more than 300 participants over two years, focusing on the technology's usability, as well as its suitability for certain learning tasks.

2. BACKGROUND

Our work with OHMDs started more than five years ago when commissioned to participate in the investigation of a project using Google Glass for an international pharmaceutical organisation. The scope of the project was to remote train or guide users in troubleshooting machinery. The concept found a useful application in a number of learning activities as the Google Glass offered an opportunity to provide feedback to students, mentor academics, monitor student activity and also offer a tool to display real time evaluation from students participating in lectures and lab sessions. In this paper we will discuss a number of uses of Google Glass in our research and we will focus on how participating students evaluated the interface for the purpose of their specific learning activity.

There is evidence in the relevant literature of the usefulness of OHMD. Their main strength is their ability to produce and support augmented reality applications. This concept is associated with the integration of information with a live video or even the user's surrounding environment in real time format. One of the key uses of the Google Glass for our research was its capability to merge new information into an existing image. An example of one of the first commercial applications of augmented reality technology is the analysis systems used in televised football games for post match analysis (Kaufmann et al, 2007). OHMD are not designed to provide workstations; therefore, traditional input devices such as keyboards do not support the concept of smart glasses as a wearable device (Scheffel et al, 2012). This was not a limitation for our work, as we focused primarily on the integration of content into pictures taken with the Google Glass, as well as the exchange of pictures with messages between users. For example lecturers could view students' voting on different aspects of their lecture (e.g. pace being too fast, slides being boring), while students were able to receive pictures showing examples of what they have done wrong during their presentations. At the same time students were able to use the Google Glass to take photographs of specific part of their work including social network interfaces as instructed by their tutors in a series of messages displayed through the OHMD.

One of the main capabilities of OHMD is to be able to provide users with a readable, effective interface that can be an information source whilst not distracting there attention from reality. This wearable technology provides users and developers with the opportunity to exploit a new method of computer interaction and enhancing the users level of control over a system. This was the main attraction to our study, as it allowed students to use their computers, while wearing the Google Glass and browsing through a series of instructions displayed. A brief training session was required for the participants to grasp the use of the OHMD interface, which usually lasted less than a couple of minutes. OHMD can provide educators, trainers and professionals with the ability to train, assist and support workplace or classroom learning (Schweizer, 2012). Using OHMD for interactions with students and transmit real-time updates should provide improvements in terms of student performance, learning enhancement and participation in learning activities. Students are not willing to ask questions during seminars with a large number of attendees and thus would miss out on gaining valuable training and education (Kuhn et al, 2015). As we will see later in the paper, the vast majority of the students found the use of this technology not only a rewarding experience but also a useful tool enhancing the way they received feedback for their learning.

There is a lot of literature on the role of OHMD in education. Johnson et al (2011) discuss the many applications of augmented reality in education, focusing on how interactive experiences are likely to appeal to digital native learners. As Bacca et al (2014) identified there are a number of issues that may affect the learning process including "difficulty in maintaining superimposed information" and "paying too much attention to virtual information". There is evidence in relevant literature that the use of augmented reality technology increases willingness to participate, as students feel more engaged and able to participate (Almeida et al, 2014). Montero et al (2013) used the technology to enhance and support communication within presentations and lectures. As Tang (2014) states, Google Glass is generally used to capture pictures, record videos and provide feedback to the individuals. Pardo and Siemens (2014) also report that an early indication of student progress can allow the opportunity for prompt intervention from teachers and a personalisation of teaching, which would benefit all three mentioned stakeholders.

3. GOOGLE GLASS AS A LEARNING TOOL

As mentioned so far, there is evidence of the usefulness of OHMD in education and in particular on the way augmented reality can assist students in a number of learning activities. In our research we did not wish to provide yet another application displaying useful information associated with artefacts that students would handle or a virtual assistant providing information relevant to specific items learners would interact with. Instead we used Google Glass in tow main ways. First we used the display for providing step-by-step guidance to students while they collected evidence of their work for their learning portfolios. The role of the OHM was to provide the information that would otherwise be in the form of guidance sheet or a set of guidelines provided through the e-learning platform. The second use of the Google Glass was for providing feedback to students on their presentations. A series of photographs were taken during the student presentations and informative vignettes were provided to show whether the students did well or not in

relation to the content of their presentation, as well as their posture and delivery style. The later part of this paper shares the findings from the evaluation of both uses of Google Glass as an educational tool.

This research study involved two undergraduate modules (i) a first year module covering foundation topics of business information systems and (ii) a third year module covering strategic management in information systems. Both modules used social networks as part of the learning process. Facebook was used in both modules, while the second module involved the use LinkedIn and Twitter. Participants conducted four activity types:

- Reading, social media content relating to specific tasks.
- Writing on social media as required by their coursework.
- Showing, sections of their group report they have created.
- Browsing, though various social media features and explaining their use.

The first task was designed with emphasis on identifying learners' ability to multi-task effectively, as they had to follow the instructions offered on Google Glass, and in parallel to read content from the social media they used for their module. The second task required them to type their contribution to the social media interface they were directed by the Google Glass guide. The third task requested learners to take a photograph of specific sections they created as part of their group report. Finally the learners were requested to provide an explanation for various features and contributions they had in the social media pages used for their module. The scope of the learning activity was to assess whether the experience of using an OHMD has an impact to a range of learning activities and interface tasks.

Figure 1. Lab setting for providing feedback to students

As shown in figure 1, the lab setting for the use of Google Glass for feedback provision is rather simple. The student delivers the presentation, while an instructor observes the sessions taking photographs and adding vignettes from a list of pre-designed feedback messages. A second instructor ensures that there are additional photographs of the student's presentation, as Google Glass is limited in the number of photographs that can be taken due to its battery life, over-heating and speed of capture. A camcorder is also used for providing video recordings to students. These recordings are used for tagging certain delivery messages, as an additional feedback mechanism. The concept of this setting is to provide an additional feedback mechanism to the student taking advantage of the Google Glass ability to create vignettes on captured photographs. This use of augmented reality can be further enhanced if the presenter wears an OHMD that displays in real time the transmitted feedback. Alternatively the feedback messages can be received via a smart phone, table or PC.

Figure 2 shows the lab setting for students using Google Glass while performing the four tasks identified earlier in the paper. To the left there is a photograph showing the student positioned in front of a computer, while wearing the Google Glass. After the training is completed the student begins his/her navigation through the screens displayed on the Google Glass and performs the required tasks. The picture on the right shows the student's view of the task that must be performed and also the picture of the social media interface that must be read as instructed. Some of the simple messages displayed on the Google Glass guidelines include the following:

- Task 1 – Show 3-4 features you have used on your page. Take a photograph of these features.
- Task 2 – Read a post of one of your visitors. Take a photograph of the post.
- Task 3 – Go on the report structure for Element 3 (note: part of the module's coursework). Show which sections you are planning to do. Take a photograph of the report structure.

The video recording of the session is required for additional checks to avoid plagiarism (i.e. students showing others' work as theirs) but also as another way to provide students with their experience of the OHMD interface. The video is also used for assessing difficulties in using the OHMD interface and analysing average times for performing the different tasks.

Figure 2. Lab setting for observing students using Google Glass

Figure 3 shows the feedback students receive following their presentation. There is a range of criteria used for assessing the content and delivery of the presentation. In the examples included we can see positive and negative feedback associated with the content of the specific slides, as well as the body language and posture of the presenter at the moment the photograph was taken. These pictures are overall well received by students as they offer 'rich' feedback and more specific guidance on what has gone wrong and areas for further improvement. We will see in the next section of the paper how students evaluated their experience using Google Glass for these tasks, as well as the usefulness of using the specific OHMD for getting feedback on their presentations.

Figure 3. Feedback provided to students via Google Glass

4. EVALUATION RESULTS FOR THE ROLE OF OPTICAL HEAD MOUNTED DISPLAYS IN EDUCATION

Following the completion of both activities using the Google Glass, the research study involved a detailed evaluation on the use of the particular interface. The scope was to assess whether OHMD is suitable for the specific task. The survey conducted included seven questions. The first three questions were focused on the use of Google Glass and in particular, they focused on comfort, navigability and simplicity or ease of use. The second part of the survey included four questions, corresponding to the four tasks students had to complete while wearing the Google Glass, namely (i) browsing, (ii) reading, (iii) writing, (iv) showing.

The survey was in the form of affirmative statements and participants had to use a 10-point scale to indicate whether they disagreed with each statement (i.e. 1 out of 10) or agreed (i.e. 10 out of 10). Before we analyse the responses to the specific questions, it is important to discuss the overall satisfaction of using the technology. As shown in figure 5, the vast majority of the students tend to find the technology very useful. This result is from an earlier study that took place in 2015-16, during a period we were trying to identify whether the positive reaction to the technology is actually associated with the usefulness of its functionality and its ability to play a significant role in learning enhancement. As with all innovative uses of technology, there is likely to be a positive bias towards using such technologies in comparison to more traditional learning environments. It is important to state that at no point incentives were provided for student participants of the study. The task was based on volunteers in both modules. The initial pilot study involved 92 participants of whom 27 were females and 65 males, while 30% of the students were enrolled on the Business Information Systems in Practice (year one) module and 70% were enrolled on the Strategic Management and Information Systems (year three) module.

The overall satisfaction for using the technology was quite high for both modules (74.1% for the final year module and 71.43% for the first year module). However there were different patterns when we see responses according to gender for both modules. It appears that first year female students were the least enthusiastic in using the technology. Nevertheless, female students of the final module seemed to be the most positive in relation to the overall experience of using OHMD in their learning. Despite the fluctuations observed we were able to reflect on the fact that the positive reactions ranged from 65% to 76%, which led to further pilot studies and more evaluations.

As mentioned earlier, the questionnaire consisted of seven questions, where students need to provide a score from 1 (low) to 10 (high) in agreement to the following statements:

(1) The Google Glass was comfortable to wear.
(2) The Google Glass was easy to navigate.
(3) The Google Glass was simple to use.
(4) Ease of use while browsing on the screen.
(5) Ease of use while reading from the screen.
(6) Ease of use while showing content on the screen.
(7) Ease of use while writing on the screen.

The results from both modules were impressive over a two-year period. The cohorts covered were 2016-17 and 2017-18, involving 90 students from year 1 and 276 students from year 3. The average responses across all seven questions were quite similar for both modules with 71.4% and 71.9% for the first and third year modules respectively. The simplicity of the device scored higher for both modules. The most challenging activity was to read from the screen while wearing the Google Glass, as voted from students of both modules.

Our study was not limited on simply assessing the views of our students on the seven questions but also make associations between the students' views on the use of OHMD for supporting their learning and the profiles of the participating students. All students of the two modules undertake a series of profiling exercises at the beginning of their studies. These profiling surveys are concerned (i) management style (Adize's model is used), (ii) team roles (based on Belbin's roles), (iii) personality profiles (using MBTI types) and (iv) learning styles (based on the VARK classification). It is really important to be able to assess whether the views of students are affected by their profiles. This would allow us to make some assumptions on the way these and similar technologies are likely to be received by learners with similar profiles in the future.

Figure 4. Evaluation responses on Google Glass effectiveness and suitability for the task

As shown in figure 5, there are different responses when we take under consideration the team roles of the participants. According to Belbin we have nine different role profiles in a team. As our students were all studying the same computing topic, we did not take under consideration the 'Specialist' role of Belbin's model. However, when classifying the student responses according to the eight remaining profiles 'Completer Finisher', 'Coordinator', 'Implementer', 'Monitor Evaluator', 'Plant', 'Resource Investigator', 'Shaper', and 'Team Worker' we can observe certain patterns. It is evident that 'Plants' seemto provide the lowest scores in most of the four tasks performed with the help of Google Glass. On the other hand 'Implementers' and 'Monitor Evaluators' seem to find the use of Google Glass quite positive when performing the majority of the tasks. 'Coordinators' were the ones who found that Google Glass were comfortable to wear and easy to navigate more than anybody else, while Shapers were the ones whou found it easier to use.

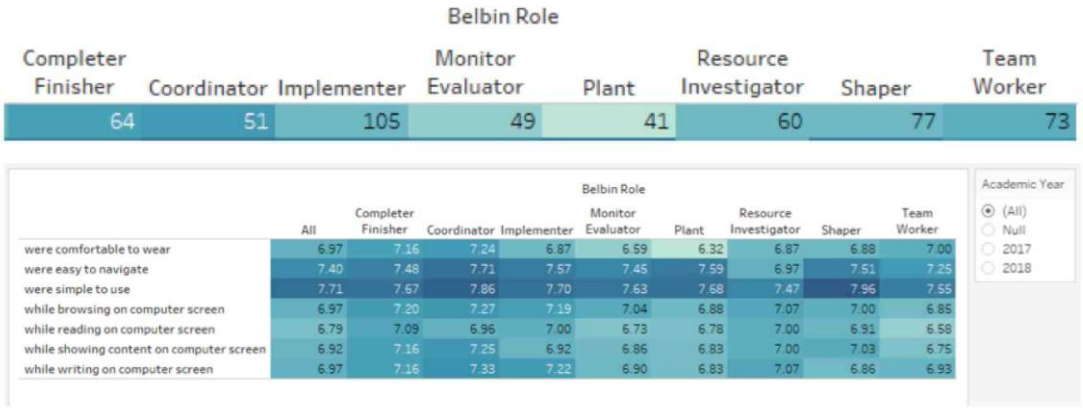

Figure 5. Evaluation responses on Google Glass classified according to Belbin profiles

Figure 6. Evaluation responses on Google Glass classified according to MBTI profiles

Similarly interesting findings are provided when reviewing the evaluations categorised according to personality profiles as identified using the MBTI type indicator. Virtuosos, also known as ISTP profiles (Introversion-Sensing-Thinking-Perception) and 'Protagonists' also known as ENFJ (Extraversion-Intuition-Feeling-Judgment) seem to be the types that were really impressed with the technology and found it easy to use and helpful across most tasks. On the other end of the spectrum, the 'Debater' type also known as ENTP (Extraversion-Intuition-Thinking-Perception) are the ones with the most negative response for comfort, ease of use and ability to read while wearing the Google Glass. It is important to note that due to the large number of types included in the MBTI typology, some types have a rather small number of representative students. When observing more common types we see 'Mediators' known as INFP (Introversion-Intuition-Feeling-Perception) being more positive across most questions while 'Commanders' known as ENTJ (Extraversion-Intuition-Thinking-Judgment) provide more negative responses.

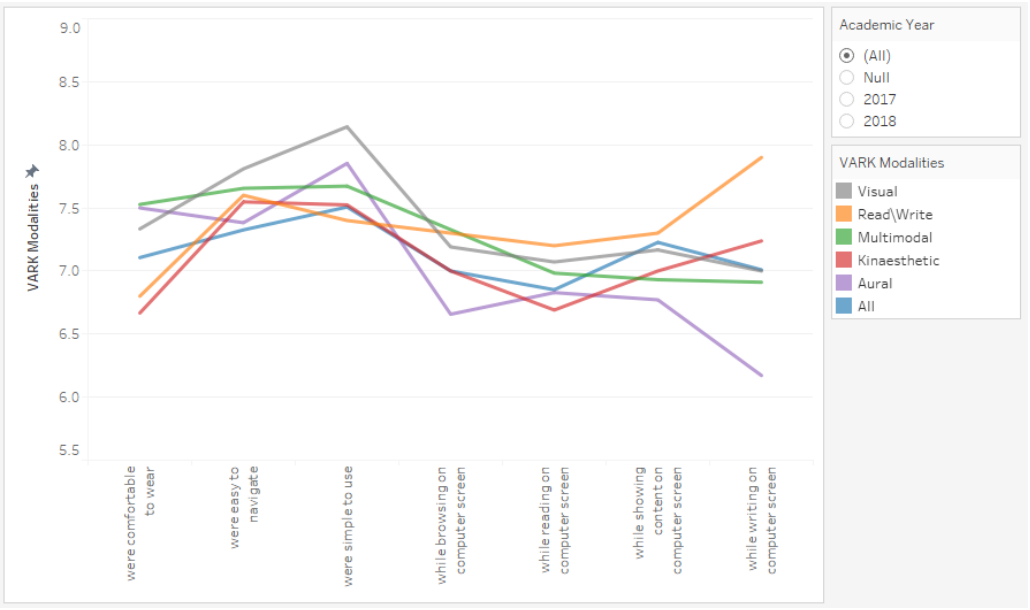

Figure 7. Evaluation responses on Google Glass classified according to VARK profiles

Finally, as shown in figure 7, the VARK classification that distinguishes learners according to their preference to learn as (i) visuals, (ii) aural, (iii) read/write, or (iv) kinaesthetic shows similar response patterns on usability aspects between visual and aural types. Read-write and kinaesthetic profiles tend to provide similar responses on the way Google Glass facilitates the different learning tasks.

5. CONCLUSION

This paper discussed the use of Google Glass as a learning tool and in particular its use for providing feedback, as well as offering guidelines for constructing learning portfolios. The paper's main contribution is by suggesting a lab setting for using OHMD in educational contexts, as well as sharing detailed findings from an extensive evaluation of the technology over a period of two years with more than 300 participants in two undergraduate models. The paper also provides a classification of evaluation responses against different typologies used for participant profiling.

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