Formative assessment of inquiry skills for Responsible Research and Innovation using 3D Virtual Reality Glasses and Face Recognition

Conference or Workshop Item

Formative assessment of inquiry skills for Responsible Research and Innovation using 3D Virtual Reality Glasses and Face Recognition

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Abstract. This paper examines the experience and views of learners on technological innovations with a novel pedagogical model to enhance formative online assessment of Responsible Research and Innovation (RRI) skills with e-authentication. The authors developed the OER "virtual classroom" app based on the famous "Bletchley Park" and also an activity for learners exploring this museum in pairs with individual assessment. Participants practiced RRI skills and shared their views about their VR experience in an e-assessment activity with e-authentication through the TeSLA face recognition system. Participants were students from the UK and Brazil. Our research questions include whether the 3DVRG activities in pairs in the same physical environment support peer-learning with assessment-in-context. Findings revealed that activities that enabled physical interactions in pairs enriched the virtual interactions in the museum. The combination of authentic scenario, interactive tasks and assessment-in-context helped learners acquire new information and connect with existing knowledge. These interactions enhanced the immersive learning experience, particularly for those who did not experienced sickness with 3DVRG. Three types of interactions with the virtual space, their peer and the topic respectively enabled the virtual, social and cognitive presence.

Keywords: Key words: 3D Virtual Reality, authentic scenarios, interactive tasks in pairs and assessment-in-context, RRI, face recognition

Introduction

This study considers the importance of effective and inclusive approaches for engaging students with technologies that can help them to acquire knowledge, develop skills and extend their learn-to-learn strategies in online learning environments. Due to the fast development of technology, open access and authoring tools, educators and learners have far more educational resources than ever before. However, there is the

lack of effective and inclusive approaches to foster scientific literacy (Hodson, 2015[1]), such as inquiry skills for Responsible Research and Innovation - RRI (Table 1)

Inquiry skills for RRI	Description
Devise questions **(?)**	refers to a socio-scientific issue
Communicate Ideas (💡)	presents (informed) ideas related to the issue
Critique claims **(-)**	highlights counter-argument that refutes an idea
Justify opinions **(+)**	explain opinions linked to knowledge, facts or data
Examine consequences **(+/-)**	shows benefits or risks for society or environment
Interrogate Sources (💭)	shows details about reliable evidence

Table 1 - inquiry skills for RRI OKADA (2016[2])

To address this gap, this study investigates immersive learning with easy-to-use VR technologies that include authentic scenarios, peer-to-peer interaction and assessment-in-context (Okada, 2016[2]). This study considers the proposition that learners and educators must be prepared to make sense of real-world issues, scientific developments and technological innovations related to the past, present and future (Ryan 2015[3]). This qualitative pilot study based on Responsible Research and Innovation (RRI) approach (EC, 2014[4]) examines the experience and views of learners about technological innovations such as 3D Virtual Reality Glasses (3DVRG) and e-authentication systems to enhance peer-learning and assessment in context. RRI which was coined by the European Commission to highlight the importance of a "*transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view on the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products in order to allow a proper embedding of scientific and technological advances in our society*" (Von Schomberg, 2011:1[5])

Although VR literature has been published since the 1960s (Artaud, 1958[6]), studies with immersive glasses only emerged at the end of the 1990s with the first widespread commercial releases of consumer headsets. However, there has been few examples of empirical research developed about the effective use of virtual reality for educational purposes (Whitelock et al., 1996[7]). Immersive learning practices (Goetz et al, 2014[8]) have been emerging recently with cheaper immersive glasses and free Virtual Reality resources for mobile devices and authoring systems such as the Unity 3D. The VR experience enables people who can't be physically in specific learning places (e.g. museums) experience and learn together as if they were actually there.

This qualitative study focuses on the app "virtual classroom" created in the Unity 3D with 360-degree photos and videoclips of the famous "Bletchley Park" created by the authors and the TeSLA e-authentication instruments for voice and face recognition. TeSLA is an Adaptive Trust-based e-Assessment System that combines biometric, textual analysis and security instruments, which is funded by the European Commission

The museum Bletchley Park, located in the town of Bletchley in England was selected for our study due to its relevant socio-cultural history, which attracts the interest of many learners across the globe, particularly those who watched the film "The Imitation Game". Bletchley park was once a secret military installation in which the German codes were decrypted during the Second World War, a project coordinated by Alan Turing who developed the first computer known as "Turing Machine".

Methodology

The research questions focused on examining the use of virtual reality resources to enhance peer-learning with assessment-in-context. Our research questions were:

1. How do peers interact with each other and with the 3DVRG?
2. Do these interactions enhance peer-learning and assessment-in-context of inquiry skills for RRI?
3. What are the key recommendations for teaching staff and technology teams interested in virtual reality and e-authentication assessment systems?

This pilot study was developed based on qualitative exploratory approach including various types of data, such as: pre-pilot and post-pilot questionnaires, video recording of the experience, and observations to reflect on the outcomes with all participants.

Four pairs of students from the area of Computing and Educational Technology were invited from the Open University-UK, Estácio de Sá University and from the Virtual University UNISUL in Brazil as well as two facilitators. Each pair comprised students from the same university and each student used immersive glasses (3DVRG) with an Android smartphone and the Virtual classroom app (available in Google Play Store) to visit the Bletchley Museum simultaneously. They completed seven activities:

1. Watch a short video about the aims of this study on virtual reality with 3D immersive glasses and assessment-in-context with e-authentication.
2. Fill out the participation consent about the project to authorise open anonymised data.
3. Read the orientations about the usage of the glasses and the installation of VR app, including how to adjust the lens and how to navigate in the app.
4. Answer the pre-questionnaire for sharing their interests, views and experiences (Laptop with access to TeSLA system).
5. Use 3DRVG to visit the Bletchley museum at their study or working place (e.g.at home or university). Participants could sit down or stand up, turn around, move their head up or down, talk naturally about the room, sensations, memories, questions and surprises. For this purpose, they should be together in the same virtual room, interacting and helping each other.
6. Complete the assessment-in-context activity by using the same app to answer a few questions about technology, art history and culture related to the Bletchley park museum and socio scientific and ethical issues about code breaking, security and privacy.
7. Fill out the post-questionnaire to reflect and share their views about peer learning, assessment-in-context and e-authentication. (Laptop with access to TeSLA system).

The data was analysed considering different types of interactions grouped on three categories: virtual, social and cognitive. It observed peers, roles, duration, description, feelings, shared information, pre-knowledge, questions and comments. In addition, data from the pre-pilot questionnaire were examined in terms of learning interests, preferences on assessment resources and reasons for visiting the Bletchley Park museum. Data from the post- pilot questionnaire was used for triangulation to identify

their reflections about peer-learning, assessment-in-context during the Virtual Reality experience and views on e-authentication.

Findings

The results of this qualitative exploratory pilot study revealed that the immersive experience with 3DVRG can enhance (and be enhanced by) peer-learning, assessment-in-content and features inherent in Virtual Reality such as engagement, interaction and visual realism (Rosenblum & Cross, 1997[9]).

In this study, the data revealed that a sense of immersion was created through visual interaction in the virtual environment and also via the verbal interaction with their real peer.

The snapshot below (snapshot 1) illustrates that participants were engaged with the virtual environment due to their freedom to move, spin, observe and visualize their surroundings according to their interests. They shared positive and negative sensations and technical comments that emerged from the use of 3DVRG. Although the students in Snapshot 1 found that the experience was not pleasant, they were engaged also with the topic and willing to interact more with the objects of the environment, read more information and see more interactive components (Wu, Lui, Wang & Zhao, 2015[10]).

Snapshot 1: VIRTUAL PRESENCE

Visiting fellow: For me it wasn't a very pleasant sensation, it is not very comfortable, I feel a bit dizzy in this 3D reality.
PhD student: It looks like a picture, static.
Visiting fellow: Yes.
PhD student: It is a still photo. And because of it, is static, so is boring; it ends up being a bit boring because is static, if it was more dynamic, if you could move around the room, it would be closer to the real life.
Visiting fellow: Or maybe, like for example in this... if we could, when we are close to these pictures on the wall, if we stared at them and could make it closer so we could be able to read it maybe it would better too.
PhD student: Yes. As well as if the people that are standing could move.
PhD student: I found a thing which approximates and decreases at least on these glasses. I can pull forward or back places, but it doesn't pull much, it doesn't go much.
PhD student: It also causes a dizziness sensation if you move too much.
Visiting fellow: Yeah, Humm, if you move too much. For me specially if you move too much down, look down, or spin around too much gives me a dizziness sensation.

Data shows various interactions that enabled social presence activating participants' curiosity on the social-historical cultural context through the feeling of being together (Let's go,Wait,..We are in,...). Participants shared questions (Is him

Turing?, Is it actually him?, Have you ever watched the movie The Imitation Game?) comments (I did, it's very good, I recommend to watch the film again... on the cinema) including their interests and previous knowledge (There are some replicas of the Enigma... the original... it's there in the museum) . They also talked about issues that they faced (Can we walk forward here?) and new features to improve their experience with the 3DVRG (Were you able to approximate anything?).

Snapshot 2: SOCIAL PRESENCE

PhD student:	Do you want to go to another room?
Visiting fellow:	Let's go. Wait, the "next" button is here, right?!
PhD student:	Yeah, just fix your eyes on it… there.
Visiting fellow:	We are in!
PhD student:	There, the man is here. Is him Turing? Is it actually him?
Visiting fellow:	Yeah, that's him. Have you ever watched the movie The Imitation Game?
Visiting fellow:	I did, it's very good, I recommend watching the film again… on the cinema.
PhD student:	There are some replicas of the Enigma, but on the original one, actually original that was used for the film; It was used for the film and it's there in the museum.
PhD student:	Can we walk forward here? I'm just sideways. If I stand up and walk forwards, I will go forwards?
Visiting fellow:	Did you go forwards?
PhD student:	No, you just stand in the same place.
Visiting fellow:	Yeah, in this room that we are, I am trying to fix my eye in some places, but it's not approximating. Were you able to approximate anything?

In this study, it was evident that the interaction in peers (Gwee,2003[11]) had an important role in activating previous knowledge (at the university, we learn, Turing machine is the origin of everything, right) to connect it with visual information from the virtual space (The most interesting thing to see is the size right?! From the machine, which was needed to process all this)? This enabled learners to connect knowledge on social- cultural historical context through visual and verbal interactions about objects, space and people from the past). Participants' social, virtual and cognitive experiences supported their successful learning outcomes. Assessment-in-context through questions connected to their experience helped them consolidate their learning experience and reflections about the technological innovations from the past comparing to the present (What objects Alan Turing had in his office?... that's obvious, right? What cultural object of the time was used, mainly by women?... Sewing machine, I know this is the answer).

Snapshot 3: COGNITIVE PRESENCE

Visiting fellow:	At the university, we learn, Turing machine is the origin of everything, right?
Visiting fellow:	The most interesting thing to see is the size, right?! From the machine, which was needed to process all this.
PhD student:	It is considered the first computer.

Visiting fellow: Yes, yes. In college we learn, Turing machine is the beginning of everything, right.
Visiting fellow: What objects did Alan Turing have in his office?
PhD student: Mobile phone, computer, ha-ha. Honestly, that's obvious, right?! Typewriter and phone, someone received a message here on the cell phone, here vibrated.
Visiting fellow: Yeah, it's mine, it must be my class.
PhD student: Now for the next question. What object of the culture of the time was used, especially by women (hee-hee) This one the feminists will not like it!
Visiting fellow: Do not go!
PhD student: Sewing machine, I know this is the answer.

It was possible to observe from the extracts above important indicators of the interaction that facilitated an immersive experience when participants recalled previous knowledge to make sense and connect their experience in a different period of time and location offered by the Bletchley Park museum. This connection between visual information, reflection in pairs and previous experiences supported their performance through the assessment-in-context.

In terms of supporting teaching staff with the use of 3DVRG for peer-learning, the data provided some insights into creating pedagogical activities which might support peer-learning:

- Guide participants to explore together the same virtual room to expand social, virtual and cognitive interactions.
- Identify and find ways to solve problems, such as check if they were visiting the same place, and if not, how they could find each other
- Describe rooms, objects, features, familiar and unfamiliar sensations to identify what was already observed or not.
- Relate their virtual experience with current facts or past events as well as connecting previous knowledge with their visual information.
- Encourage peers to share question, relevant aspects, topics, doubts, techniques to create opportunity to acquire new knowledge, hook curiosity, develop inquiry, co-learn and co-assess together.
- Share observations and feedback during the process to extend their experience and views considering different peer's opinions and experiences
- Assess the acquired knowledge and the process of learning as well as evaluate the whole experience including the immersive resources

In relation to the aspects highlighted by the participants for technical teams and technology developers of virtual reality apps, the recommendations are:

- Include extra links to text that might help them to read information and expand cognitive interactions
- Allow them to experience the approximation with objects and people in the virtual space (zoom in and Zoom out) to enrich their virtual interactions within the environment
- Enable participants to go forward and backward, with [start, exit] next and return options to navigate in the space with more flexibility as well as

strengthening the social interaction arising from being together in the same area.
- Include a mini-map to facilitate an overview of the place, for planning the navigation and encouraging different experiences through virtual, social, and cognitive presence.
- Include a video clip to expand interactive areas to highlight topics and expand their immersive experience
- update the App by enhance the locations or objects that are special with sound and video) to offer different experiences and possibilities for participants.
- Include extra information for novice students about virtual reality and an option to sit down and use a 3D VR with a tablet instead of glasses.

In relation to the authenticated evaluation, although it was not possible to use the TeSLA face and voice recognition instruments in this pilot, the pairs of students discussed the possibilities based on the project TeSLA video clip (TeSLA Project, 2018[12]) and the current environment. Previous studies about TeSLA examined students' acceptance of e-authentication (Okada et a., 2018[13]). The participants' views and comments were:

- VR technologies and assessment with e-authentication might facilitate users' identification by naturally sharing their faces and voices during their immersive experiences without having to login using passwords
- the recognition of students' voices and faces might enable adaptive and personalized learning with Virtual Reality.
- Authentication and new ways of assessment through voice and face recognition might enable new ways of co-learning by moving from the traditional exams and written assignments to more engaging and immersive assessment-in-context connected to peer-learning experiences.

In terms of participants comments from the post-questionnaire about Face Recognition, there was a diversity of opinions. Students shared various issues.

Theme: Technical persistence

Initially I had problems with the face recognition tool because the system was not in Chrome browser. After changing it, I did not have any technical problem.

Theme: Trust

I found the whole process longer than traditional assessment without e- authentication, however, I do believe that the face recognition will increase trust of participants with online assessment. Students who are committed to study will benefit with the e-authentication system.

Theme: Quality of e-assessment

To ensure quality of the e-assessment activities, I think that various tools should be integrated (e.g. voice and face recognition as well as plagiarism and forensic analysis).

Theme: Disabled students with special needs

Disabled students might have problems in the face recognition system and might need extract support from the TeSLA team.

Discussion and Conclusion

This study revealed possibilities and recommendations on how students in pairs interact with the 3DVRG to enhance immersive learning. The results showed the value of virtual, social and cognitive interactions mediated by VR artefacts, peer-interaction and assessment-in-context with Face recognition. Students did not have significant difficulties and they received prompt support for their technical issues about e-authentication.

The study investigated experiential activities (Le et. al., 2015[14]) through 3DVRG between pairs that interact virtually with the artefacts, socially through verbal dialog mediated by technologies and cognitively with the studied object and visual information. This initial exploratory study offers educators- instructors, tutors, course-designers and learner the possibility of using Virtual Reality with pedagogical activities in pairs including contextualized assessment (Kearney, 2013[15]) with authentication.

It also provides important guidelines for technologists interested in creating apps about real remote places with 360° pictures and videos. The limitation of this exploratory study was a small number of participants. However, our next step is a mixed method study with more institutions in the area of computing and data science, as Bletchley Park provides authentic and engaging learning scenarios.

Display Items

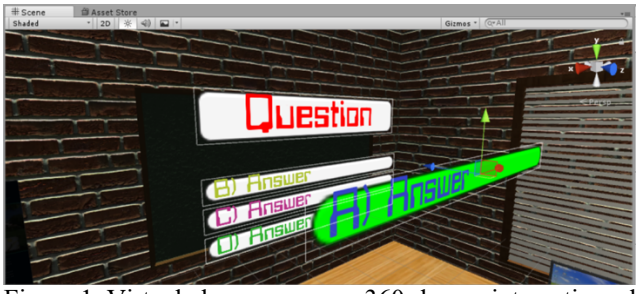

Figure 1. Virtual classroom app - 360-degree interactive white board


Figure2. 360 photo of the Bletchley museum

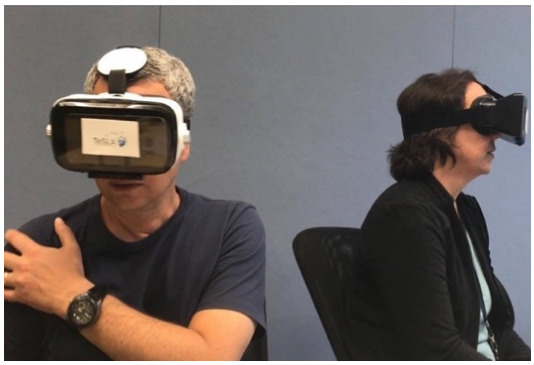

Figure 3. Peer students' participants from the UK and Brazil

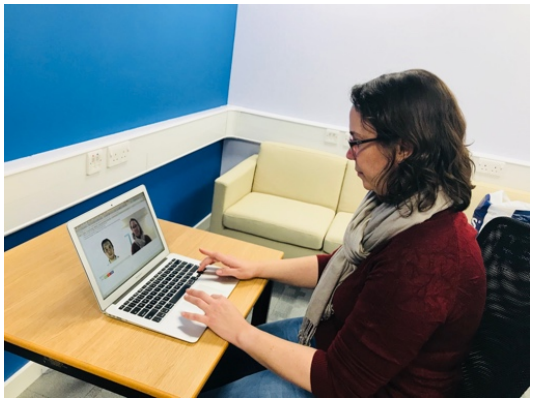

Figure 4. TeSLA Project – Adaptive trust e-assessment system tesla-project.eu/

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