Diverse Goals but One Heart with Mixed Reality in Information Systems

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The use of Mixed Reality (MR) in Information Systems learning and teaching pedagogies is becoming more widely accepted as providing a reflection of possible realities. The aim of using MR in learning design is to extend the student experience by helping them not only to 'see the unseen' through the capacity of MR but also to visualise and interact with complex and abstract concepts. This study expands on the current literature by applying design science to use, survey and evaluate Microsoft HoloLens, a MR device, in an Information Systems classroom. The significance of this study is the use of MR in an Information Systems class to understand and learn the technology and provide an authentic learning experience to prepare the students for technological disruption and the future of work. Student survey responses were positive, with high student satisfaction in the classroom, demonstrating critical and creative engagement with the technological limitations and challenges with the user experience. This paper concludes with suggestions of specific pedagogical models that could be used in Information Systems education.

Keywords: Mixed reality; Information Systems; design science

Background

Mixed Reality (MR) is an emerging technology and is a budding form of experience (Milgram & Kishina, 1994). MR overlays 2D and 3D objects into the real world (Azuma et al., 2001). The user can view the real world through a handheld or head mounted device (Harborth, 2017). Microsoft HoloLens is an example of a MR device. MR applications are used in various fields like health (Stretton et al., 2018), business (Soliman et al., 2018) and education (Alexander et al., 2019; Leonard & Fitzgerald, 2018). MR offers the chance to reshape clinical simulation spaces for learning and teaching in healthcare higher education (Magana, 2014). A MR system is defined by Azuma et al., (2001, pp. 34) as one that "combines real and virtual objects in a real environment; runs interactively and in real time; and registers (aligns) real and virtual objects with each other".

Today Augmented Reality (AR) refers to the overlay of data onto the visible world, while MR refers to the display of virtual objects over the real-world background. With MR, an overlay of virtual objects over the real visible world, enhance our sensory-motor engagement with the world (Lindgren et al., 2016). A systematic literature review by Harborth (2017), highlights a shortage of MR related work in Information Systems and outlines many promising areas for future work. In a recent study MR was used to help students learn the anatomy of the human body mediastinum and it was found to strengthen the students' self-efficacy and motivation, improved learning, and provided a good learning experience (Nørgaard et al., 2018). The differences between VR and MR in learning design was highlighted by Hugues, Fuchs, & Nannipieri, (2011) and they emphasised that there is a strong argument available to set aside the technical similarities of the technologies and to treat them separately (Hugues, Fuchs, & Nannipieri, 2011). In many respects, the affordances of virtual reality have been well explored in the literature on the educational use of video games (Waddington, 2015). However, the immersive nature of more advanced VR technologies does appear to enhance these effects (Clark, Tanner-Smith, & Killingsworth, 2016; Martín-Gutiérrez et al., 2017).

Visualizing various data both big and small in a real and physical environment is the next promising area in this MR related research. The first promising area in visualizing is a system with immersive analytic features of MR developed by Mahfoud et al., (2018). Przybilla et al., (2018) used design thinking and proposed a human-centric approach for documenting chronic wounds using augmented reality smart glass application. Studies in health-related areas include, exploring on interactions with the neuropsychologist's avatar in virtual locations using a VR social network (Bernard et al., 2018) and, creation of a hybrid augmented experience merging physical and virtual worlds for immersive e-therapy (Gorini et al., 2008). Given the maturity and availability of MR technology, the adoption of MR applications to support the Information Systems education process is a realistic application scenario within the context of digital disruption. Hence, the aim of this study is to design, trial and evaluate the use of a MR device - Microsoft HoloLens, as a teaching tool in Information Systems classrooms.

Methodology

Design science is a promising research paradigm in Information Systems education (Gregor & Hevner, 2013; Laurillard, 2013) and it is used to answer a research question by building socio-technical artefacts (Myers & Venable, 2014). The key principle of design science research is the identification and understanding of a design problem, and its solutions are developed in the construction of an artefact. In teaching, Laurillard states that design science provides a framework for improving learning and teaching contexts when introducing and evaluating an emerging technology in the classroom (2013). For this study, the design problem is the use of MR technology to provide an authentic learning experience in an Information Systems class to support students to learn, and to support teachers to evaluate the technology.

The solution to the design problem in this study is to evaluate Microsoft HoloLens in an Information Systems class as an artefact. Microsoft HoloLens was used by 180 students studying an undergraduate and a postgraduate unit about Information Systems in Organisations. Six HoloLens devices were used in ten different workshop classes to review the concepts taught. Each workshop consisted of approximately twenty students. Four tutors were involved in the orientation of the use of HoloLens in class. The lesson plan was prepared and shared with the tutors as given in Table 1. Tutors were also familiarised with the lesson plan and the HoloLens. Three members from the education team were also involved in helping the 180 students use the HoloLens in class for the first time. Table 1gives a demonstration of the lesson plan to introduce HoloLens in class.

Table 1: Lesson Plan used to introduce HoloLens in class

Time	Stage of Lesson	Details
5 minutes	HoloLens orientation	Watch HoloLens Orientation Video and demonstration.
5 minutes	Introduction to the task for the class	Discuss the question to solve and how to work in groups.
5 minutes	Group formation	Groups are formed with a maximum of four students in a group.
30 minutes	Initialization with HoloLens	Each student in a group can start using HoloLens and familiarize themselves in using HoloLens and communicating with their team members.
30 minutes	Design with HoloLens	Students choose the question to work on and work towards designing their solution in HoloLens.
30 minutes	Present the solution	Students present their findings with HoloLens.
10 minutes	Survey	Students answer the survey.
5 minutes	Conclusion	The session is concluded with a summary of lessons learnt.

Figure 1. Use of HoloLens in class.

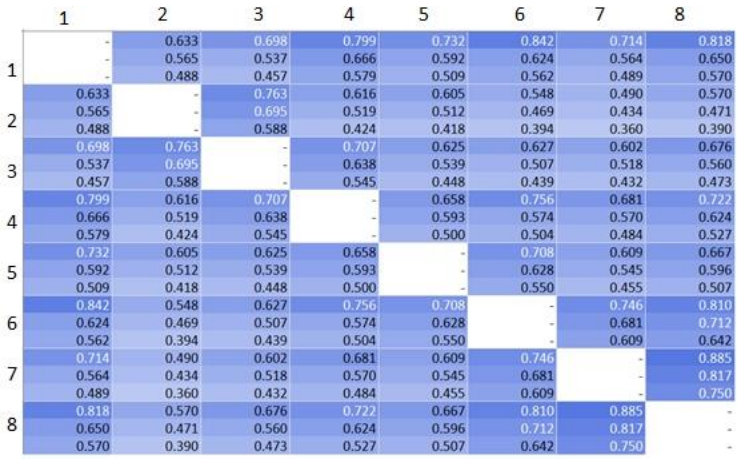
HoloTour application gives a view to explore the beauty and history of Rome or to uncover the hidden secrets of Machu Picchu. HoloStudio is a HoloLens app that allows developers to create holograms of your own design and turn them into physical objects with 3D print compatibility. After an initial orientation to MR and the various applications of the technology, students formed groups of four. HoloLens was circulated between each of the group members for them to experience one of the available Apps. Students then discussed the opportunities and capabilities of the immersive tourism HoloTour App and the 3D hologram creation HoloStudio App. Based on a previously chosen industry or business area for analysis, students were asked to consider how MR and these types of Apps might transform the future and associated opportunities for their chosen industry or business area. At the end of the class, students were asked to participate in a short survey to ascertain their views on the user experience and critique the affordances of the technology. This doubled as a formative learning moment to inform their final assignments which required students to analyse the impact of innovative technologies and the effect of change on their chosen industry/business. At the end of the session, students were asked to rate their experience. The findings from the survey are presented in the next section.

Findings

The results from the survey conducted is given in Table 2. The highest scored question was “This App would make learning more interesting” which scored 89% agreement. The question that scored second was “It was enjoyable to use” with a mean on 84%. Students were very frank in telling that it was not easy to use as it scored low with a mean of 72%. The correlation matrix of the eight questions are plotted in Figure 2.

Table 2. Survey questions and the average score

No.	Variable	Mean	SD
1	It was enjoyable to use.	8.4	2.1
2	It was easy to use	7.2	2.2
3	It worked well	8.0	1.9
4	This App helped me understand the main idea.	8.0	2.1
5	I found it helpful to be able to walk around the object/s.	8.1	2.3
6	This App would make learning more interesting	8.9	2.0
7	This App would help me learn better than normal classroom activities.	8.1	2.5
8	I would like teachers to use this App in the classroom	8.3	2.5



	1	2	3	4	5	6	7	8
1	-	0.633	0.698	0.799	0.732	0.842	0.714	0.818
	-	0.565	0.537	0.666	0.592	0.624	0.564	0.650
	-	0.488	0.457	0.579	0.509	0.562	0.489	0.570
2	0.633	-	0.763	0.616	0.605	0.548	0.490	0.570
	0.565	-	0.695	0.519	0.512	0.469	0.434	0.471
	0.488	-	0.588	0.424	0.418	0.394	0.360	0.390
3	0.698	0.763	-	0.707	0.625	0.627	0.602	0.676
	0.537	0.695	-	0.638	0.539	0.507	0.518	0.560
	0.457	0.588	-	0.545	0.448	0.439	0.432	0.473
4	0.799	0.616	0.707	-	0.658	0.756	0.681	0.722
	0.666	0.519	0.638	-	0.593	0.574	0.570	0.624
	0.579	0.424	0.545	-	0.500	0.504	0.484	0.527
5	0.732	0.605	0.625	0.658	-	0.708	0.609	0.667
	0.592	0.512	0.539	0.593	-	0.628	0.545	0.596
	0.509	0.418	0.448	0.500	-	0.550	0.455	0.507
6	0.842	0.548	0.627	0.756	0.708	-	0.746	0.810
	0.624	0.469	0.507	0.574	0.628	-	0.681	0.712
	0.562	0.394	0.439	0.504	0.550	-	0.609	0.642
7	0.714	0.490	0.602	0.681	0.609	0.746	-	0.885
	0.564	0.434	0.518	0.570	0.545	0.681	-	0.817
	0.489	0.360	0.432	0.484	0.455	0.609	-	0.750
8	0.818	0.570	0.676	0.722	0.667	0.810	0.885	-
	0.650	0.471	0.560	0.624	0.596	0.712	0.817	-
	0.570	0.390	0.473	0.527	0.507	0.642	0.750	-

Figure 2. Correlation matrix

Among the positive aspects of HoloLens, the promising future of MR technology was evident in the students' answers to the open-ended questions regarding the best and worst aspects of the HoloLens Apps and what could be added or changed. Students indicated that HoloLens and MR technology are the future of "next generation digital native dependency" and that these technologies are "new, exciting, innovative, engaging and responsive". The students were confident about the interface experience and the human computer interaction component of the HoloLens. "It was amazing to experience a place away from the classroom, and also be taken back to historical periods and move around and view the place as if you were there" and "Amazing user experience" are examples of quotes related to human computer interaction. The feedback also highlighted that HoloLens enhanced student learning and experience as stated in the following quotes: "Best way for students to learn something new"; and "Excellent for teaching in class". These responses, perhaps not surprisingly, highlight the benefit of the innovative learning experience for students, as well as aspects of the user experience of the technology itself.

Students also highlighted some negative aspects of HoloLens. "Hard to use at the beginning"; and "Not easy to use," clearly indicated some of the difficulties using the technology. The same point was also highlighted in the answers to the survey question: "It was easy to use". These responses indicate that students analysed the user experience while being immersed in the experience. This sense of user empathy is an essential element for the future of work and the design and development of Information Systems solutions. Some students were also not comfortable with the eye view, especially if they wore glasses. Some examples that highlighted viewing issues included "Users can't use it without glasses"; "it could possibly hurt people's eyes"; "eye strain"; and "it was difficult to see at times". There were also issues related to the view and the controls listed as "screen was too small" and "it was very hard to use the controls".

To the final question about suggested improvements, some student responses indicated a limited view of the potential of MR. Comments about the gamification elements such as "Make it like PS VR Game" and "NBA games", while other student responses indicated that they are thinking about the potential future of the nexus between Information Systems, MR and human interaction/empathy. Some examples for the same are listed as "more options and more computer human interactions" and "more interactive communication".

Conclusion

Diverse student goals and objectives can be explored using MR in the classroom as it provides a positive environment for creative and critical inquiry and technological exploration. HoloLens is an example of digital disruption in the way students see the unseen and experience a transformative technology that facilitates learning while simultaneously producing immersive classes that are engaging and entertaining for the student. While MR is resurfacing from previously discussed theoretical frameworks to actual implementations that are set to disrupt business and society alike, further investment in MR in Information Systems education is clearly warranted, as shown in this study.

This study presents the trial and findings of the evaluation of using Microsoft HoloLens as a teaching tool in Information Systems classes. The findings of this study shed light about how MR is succeeding in bringing the outside world into the classroom by making learning collaborative and interactive. The new learning experience with MR provided students with the opportunity to exercise authentic, critical and creative inquiry which was

demonstrated by students' comments on both opportunities and limitations of the technology. Student comments also demonstrated that authentic experiential learning led to professional practice thinking about their potential future. The students also brought their learning experience with HoloLens in their final assessment. For example, one assessment presented how to use HoloLens in the watch repair industry. Another set of students proposed a personal trainer using HoloLens.

One of the main limitations for this study is the cost of HoloLens. The current version of HoloLens costs USD4500.00. Hence, we were limited to using 6 HoloLens in workshop classes. The applications are also expensive so we used freely available applications like "HoloTour". In future, we aim to develop applications for the next phase of the study as it not only helps us to use it but will also involve students specializing in programming to the develop application. There is a need to work towards improving accessibility and comfort with other 'needs', for example, students who are wearing glasses, as reflected in the survey. As the technology is not easy to use, there is a need to include more time for the students to be familiar with the use of technology.

Information Systems research on the use of MR technologies for education is really in its infancy. The new version of Microsoft HoloLens that was released in February 2019 worked with companies like PTC Vuforia solutions, Philips and Bentley to give a transformative MR experiences for industrial customers. These are leading examples of how work can change. This study points to a different set of affordances, and the early research in this area is overwhelmingly positive about its effects on learning, motivation and providing students with authentic learning experiences.

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