DM3107 Major Research Project

To what extent is the growth of immersive design beneficial in educational settings?

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Introduction:

This report investigates immersive design and how it is implemented into the education sector. Immersive design can be described as the process of designing things using immersive technology (Spacey, 2017). Immersive technology refers to any technology which serves to extend or replace versions of reality. This includes developments such as Virtual Reality (VR) and Augmented Reality (AR). Immersive design has been chosen as the topic of interest for this essay due to its rapid growth in recent years. By 2027, the global VR and AR market is predicted to generate $165.3billion USD in revenue (Market Research Company Focuses On Providing Valuable Insights On Various Industries, 2021). This highlights the relevance of immersive design in today's global economy, therefore it will be interesting to investigate how this may benefit education and training in particular. Furthermore, as part of their sustainability goals, the United Nations emphasises the need for quality education to stimulate socioeconomic mobility and provide a more sustainable future for all (Education - United Nations Sustainable Development, 2021). Immersive design could therefore provide a solution to this, however the impacts of this technology need to be researched further.

The aim of this report is to evaluate the effectiveness of immersive design in educational settings. This includes applications of AR and VR technology in schools and workplace training. In order to achieve this, objectives have been set. These include:

- To identify the different applications of immersive design in education.
- To identify the benefits and limitations of using immersive design as an educational resource.
- To understand whether traditional learning theories can be applied to immersive design.
- To identify how immersive design will evolve in the future.

Literature Review:

Introduction:

Immersive technology began emerging in the 19th century, when Charles Wheatstone (1838) invented the Stereoscope, a device which allowed users to view an image from two slightly different perspectives in each eye, creating the illusion of a three-dimensional (3D) projection (Thompson, 2017). Since then, immersive design has evolved drastically and is increasingly being incorporated into everyday applications including educational resources. In a survey of 8,288 teachers (NewSchools, Gallup, Inc., 2019), 65% claimed to use digital learning tools on a daily basis. The trend towards integrating technology into education has been escalated due to the COVID-19 pandemic, which contributed to over 1.2 billion children being out of the classroom following school closures (Li, Lalani, 2019). Immersive design is also growing in popularity for conducting workplace training, with 26% of businesses using VR or AR to train its employees (Gilbert, 2021). Studies have shown that 87% of the global workforce are disengaged with their organisation (O'Boyle, 2016). The trend towards immersive training applications could therefore be an attempt to engage the workforce more, to increase productivity. The shift to a more virtual approach to learning has impacted individuals differently.

Application of immersive design in schools:

Studies have found that using immersive technology is an effective learning method. For example, Lieu et al (2020) noted how VR encourages students to actively participate with the virtual simulations, resulting in higher levels of academic achievement than pupils who were taught using more traditional teaching methods. This trend could also be a consequence of reduced distractions from a classroom setting, by being fully immersed in the learning experience. Furthermore, researchers at the University of Maryland (UMD) (Are virtual reality and augmented reality the future of education?, 2018) supported the idea that pupils learn better with immersive technology, in an experiment using the ‘memory palace’ method. This is a method which has been used since ancient times, involving individuals storing images in an imaginary physical location, which is suggested to make them easier to recall (Remembering More of Everything: The Memory Palace, n.d.). The experiment by UMD consisted of participants being split into two groups and viewing images of celebrities, which had been placed in an imaginary location, following the memory palace format. Whilst one group did this using a desktop computer, the other group wore a VR headset. Participants were then asked to recall which celebrity had been located in the different areas of the scene. The results showed that those who wore the VR headsets had an 8.8% higher recall accuracy than those using the desktop computer. This could be because they were able to fully explore the scene as if

they were actually there, making it more memorable and therefore highlighting the benefits of using immersive teaching resources for retaining information.

Barton (n.d) identified the exploration of physical locations as one of the core uses of immersive technology. Whilst she refers to this idea in regards to travel agents using VR to advertise holiday destinations, it can also be applied to exploring historical locations, to make history lessons a more immersive experience, by making students feel like they are actually in particular historical locations. For example, Harvard University has made use of technological advancements and archeological records to develop the Giza Project (Digital Giza | About the Giza Project, n.d.), a collection of 3D models of the pyramids of Giza, which students are able to explore using VR, alongside digital reconstructions of historic artifacts. Through immersive applications such as the Giza Project, individuals are able to gain a more in-depth understanding of these historical sites, by gaining access to hard to reach areas and having the freedom to explore, in contrast to reading through a textbook (Guillette, 2019).

It has been suggested that using immersive technology in schools may have some legal and ethical issues (Hawkinson and Klaphake, 2020). In particular, the increasing use of these technologies can threaten privacy regulations, due to the large amounts of data they require. For example, VR headsets track the motion, head movements, eye movements and vocal commands of the user. Several policies aim to protect children, such as the children's online privacy protection act, however regulations may need to become stricter to accommodate the increasing use of technology by young people. Safety concerns have also been brought up (Dunleavy, Dede and Mitchell, 2008), where being too immersed in VR and AR simulations can cause students to not consider their real life surroundings, particularly when being used in outdoor spaces. For example, there have been incidents involving people jumping in front of traffic whilst using AR applications such as Pokemon Go (BBC News, 2016). There is however arguably a low risk of this occurring in educational settings, as they tend to take place in controlled environments, where the user is supervised. Furthermore, immersive technology has been found to pose risks to the wellbeing of children. In particular, a study by Kaimara, Oikonomou and Deliyannis (2021) identified cybersickness, obesity, radiation and sleep disorders as common concerns about children’s development. They refer to cybersickness as nausea, disorientation and oculomotor issues occurring as a result of experiencing virtual environments through mediums such as VR headsets, large screens and curved screens, and has been found to occur more during use of VR games than regular 2D or 3D games. Melatonin is a sleep hormone which has been found to be more sensitive to light in children than in adults. This means that exposure to bright screens at night can result in children experiencing sleep disorders, where the melatonin becomes less concentrated. Sleep disorders have been shown to negatively impact academic achievement. Gaultney (2010) found that those who reported having no sleep disorders had a higher GPA than those who reported having at least one sleep disorder. This suggests that despite immersive design benefiting students positively in regards to helping them retain information more easily, when consumed in large amounts or late at night, it can damage their academic performance.

Application of immersive design in medical training:

Another way which immersive technology can be applied for educational purposes is for training medical professionals. Using VR, medical students can experience 360° CGI reconstructions of the human anatomy in detail and interact with realistic replications of common surgical procedures (Virtual Reality in Healthcare, 2021). A benefit of this is that VR simulations provide a more realistic experience than animal modes, videos and e-learning due to the intricacies that can be projected using 3D graphics (Li et al, 2017). Furthermore, VR allows trainees to gain an understanding of handling instruments and body structures in a controlled, risk-free environment, resulting in increased surgery speed and lower levels of accidents. Despite this, the use of VR in medical training also poses some limitations. For example, the development and implementation of VR is expensive, due to the hardware and software required (Baniasadi, Ayyoubzadeh and Mohammadzadeh, 2020). Studies have found that the initial cost of implementing a VR training exercise is $327.78 per participant, in comparison to $229.79 for the live alternative (Farra et al., 2019). Over time however, the cost per participant of VR training reduces, whilst remaining fixed for live training. This is because the high initial costs of implementing VR can be spread over a higher number of participants over time. This contrasts with the recurring costs of training through live exercises, such as using up hospital space and taking staff away from their duties to serve as trainers. As well as educating medical students, VR can also be an effective method for helping patients improve their understanding of medical treatments before undergoing them, which therefore improves their overall satisfaction (Virtual Reality in Healthcare, 2021). Some patients however may be reluctant to use VR (Baniasadi, Ayyoubzadeh and Mohammadzadeh, 2020), particularly older people, who are generally less familiar with the application of modern technology. 87% of people over the age of 75 have never been online (No isolation, 2021), therefore the idea of being fully immersed in VR may seem off putting.

Application of immersive design in astronaut training:

Astronauts require extensive training to equip them with the technical knowledge and ability to perform complex tasks in space (Trukhanov, 2021). Due to the high costs and risks involved, it is impractical to train astronauts in space (McGowin, Fiore and Oden, 2021).Traditional astronaut training has therefore been located in classrooms and swimming pools (Baughman, 2019), however more recently, space agencies have made use of the opportunities which immersive design can offer to improve training practises. For example, VR simulations allow astronauts to experience realistic situations, through the way they can interact (Bosch Bruguera et al, 2019). Bosch Bruguera et al

discussed how immersion has been improved through the use of features such as hand tracking, placement of joysticks and wide field of view; all of which enable a more realistic training simulation. Furthermore, the way VR simulates disorientation, motion and zero gravity (Logan, 1998) has shown to increase the sense of realism. Spatial disorientation tends to occur as a result of the lack of gravity in space has been suggested to impact the safety of astronauts (Liu et al., 2016). Studies have shown that training astronauts in these environments can therefore reduce the effects of motion sickness and spatial disorientation during spaceflight (Harm, Stroud and Klaus, 2005), by preparing them so that they are used to these conditions. In particular, this study highlights a 53% reduction in nausea symptoms. Furthermore, through immersive methods, astronauts from around the world are able to train in the same virtual environments, whilst geographically separated, allowing them to work together to prepare for upcoming missions (Trukhanov, 2021). This however depends on the facilities available at these locations. Whilst immersive technology has been proven to increase the effectiveness of astronaut training, recommendations have been made on how it can be developed further. For example, Bosch Bruguera et al (2019) noted how training scenarios could be made more realistic by incorporating multi-user simulation, eye tracking, haptic feedback and system failure simulation. All of which they considered achievable as technology develops and more advanced hardware and software becomes available.

Applying learning theory to immersive design:

When evaluating the effects of immersive design on education, traditional learning theories need to be considered, to gain a better understanding of the way that individuals process information. Traditionally, learning strategies have been heavily text based and dialogic, however the introduction of more immersive virtual approaches allow for more complex learning experiences and empowerment through increased user interactivity (De Freitas et al., 2009). McGowin, Fiore and Oden (2021) discussed the theoretical considerations for implementing immersive design into education to identify whether VR and AR are viable learning methods. They use the term ‘learning affordances’ to describe uses of technology which stimulate sensory or cognitive experiences which help support learning. For example they outlined how abstract ideas need to be converted into experiences. VR achieves this by placing the user into a virtual space, where they are able to interact with concepts. This helps support the idea that individuals learn better by actively doing something, rather than just observing it. Furthermore, they mention the idea of how learning can be achieved by exploring manipulations of reality, where it is not physically possible to interact with something. They reference the example of the user exploring the human body on a micro-level as a cell, using VR. In particular, this learning theory is evident in medical training scenarios, where students use VR to explore the human body in great detail (as stated previously). Dunleavy, Dede and Mitchell (2008) use a similar idea in their study, where they aimed to identify how AR interactions aid or hinder learning. They found that whilst students were highly engaged by the interactivity and collaborative nature of the

simulations, hardware and software issues caused counterproductivity and demotivation. This is due to more time being spent trying to resolve technical issues, than actually learning.

Summary:

To summarise, immersive design provides a more engaging experience for users than traditional training methods, due to the more interactive nature of it. This is beneficial for education where Individuals tend to process information better by actively participating rather than just reading out of a textbook (McGowin, Fiore and Oden, 2021). Other benefits include lowering the risk of certain training activities, by completing them virtually. Whilst initial costs of implementation may be high, over time may save costs in other areas (Farra et al., 2019). For example, hiring individuals to lead training activities, or the costs of fixing mistakes caused by inadequate training. As immersive technology continues to increase in popularity and becomes more accessible, the costs of hardware may also decline (Pettinger, 2019). The general consensus understood from secondary research suggests that immersive design can benefit educational practices, however there are improvements that can be made as technology progresses. Despite this, there are also limitations which need to be considered such as the risk of cybersickness (Kaimara, Oikonomou and Deliyannis, 2021) as well as the opportunity cost of technical issues wasting time (Dunleavy, Dede and Mitchell, 2008). When referring to the United Nations goal for quality education for all (Education - United Nations Sustainable Development, 2021), the findings in this report highlight the potential benefits of using immersive design for improving education. However, due to the costs of implementing the technologies and training those to use it, immersive educational resources may be harder to deliver in lower income countries.

Methodology:

The sources included in this literature review have been found using academic databases such as Google Scholar (n.d.) and OneSearch (n.d.). This helped provide reassurance that the information being referenced was well researched and credible, where it was written by industry professionals. Using academic databases also allowed for a more direct research method, where searches could be refined to the more relevant sources. Where relevant scholarly sources couldn't be found, blogs and articles written by those in the industry were used. Since immersive design is a fairly recent development, particularly in the education sector, it meant that there weren't as many academic sources available, however online blogs provided more information on current trends. Whilst this meant that a wider range of information could be gathered, considerations had to be made as to how valid the sources were. This is because online content is often produced for a specific purpose, such as to sell a product or deliver an argument, which could therefore skew the information. Further research into the sources therefore had to be conducted to ensure that the intentions of the text were authentic.

In order to fully answer the thesis question, primary research will be conducted, to support the secondary findings. This will be through the distribution of a questionnaire. This method has been chosen as it allows for both quantitative and qualitative data to be collected. Furthermore, questionnaires are more flexible for the respondent, where they can complete them in their own time, meaning that there is likely to be a higher response rate and answers are likely to be more in depth. This will increase the representativeness and validity of the findings. Participants may feel more comfortable giving truthful answers if kept anonymous, which will further increase the validity. Potential limitations of this method may include difficulties understanding the questions. Due to the nature of questionnaires generally being completed remotely (for example via the internet), participants will not be able to ask questions or receive clarification, which could result in them answering incorrectly. To minimise this occurring, questions will therefore need to be worded in a way which is easy to interpret. The purpose of the research will be to gain an in-depth understanding of people's experiences and opinions of immersive design, education and immersive design in education, to help respond to the aim of this essay. The questionnaire will be distributed to a wide range of people including educators, those in education and those in work

roles which require regular training. This will generate data regarding the uses of immersive design in different areas/levels of education.

Time Management:

To ensure that a sufficient amount of data is collected, participants will be given three weeks to respond to the questionnaire. The intention of this is to increase the response rate, by allowing individuals more time to complete the questions. A following week will then be dedicated to interpreting this data and presenting the research findings, in the form of tables and charts. Once the analysis has been completed, a written discussion can be produced in relation to the thesis statement.

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