THE FUTURE OF VIRTUAL REALITY IN EDUCATION: HISTORY, TRENDS AND TECHNOLOGIES

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Abstract

Virtual reality depends on two human perceptions, sight and sound. VR has been applied in various sectors such as education, medicine, aviation, tourism, and video games. Leisure and entertainment have shown the highest buzzing interest. Since VR introduction it has had several challenges such as expensive hardware, poor ergonomics, and difficulty in creating contents irrespective of the sector. Rapid adoption of mobile devices among other trending technological innovations adopted by the society has greatly improved access to VR. Investment increment by several companies such as Facebook, Apple, Samsung, HTC, Magic leap among others will bolster improved VR accessibility in coming years. A notable project by Google is the Google expedition that has interacted with Educational institutions yielding better accessibility to virtual technologies and rapidly change formal education. Changing the dynamics of formal education will be possible with improved accessibility to virtual technologies and teaching in the physical classroom with the aid of virtual environments: Virtual Laboratory, field trips among others.

Keywords: Educational VR contents, Virtual reality, Virtual technology.

1 INTRODUCTION

The title Virtual reality was first utilized and predates the 1960s, although its origin can be traced to the 19th Century when panoramic murals began to appear, the first 360-degree art. One century later, the Sensorama, in order to create an immersive VR, it required that it engaged all five senses via a device (mechanical). This system simulated close to a real life experience involving in all sensory experience of driving a motor cycle embedded with 3D, digital film with audio, sense of smell, and the feeling of motion, in addition to the wind sensation. VR rapidly evolved in several protocols closely simulating reality. With innovation and technological advancement, ICT and VR are closely, intertwined as a result of ever increasing computing capability and adaptive human interface. The result of this, is that VR will continue to evolve in various approach.

For the past decades, there were major difficulties in using Head Mounted devices (HMDs) or related technologies, for instance, these technological devices were not popular and were usually too expensive. Also, their features were such that they could often cause a feeling of aversion to users due to inconsistency between the coordination of the head and the corresponding change in the scene. Oculus Rift, a commercial product offers a good virtual simulation at an affordable price while there are other affordable products still under investigation, as such making use of such systems are more feasible in the fields of education and training. Additionally, technology now offer systems that are equipped with low latency and precise tracking movement that ensure better usage and achieve Visceral reaction.

In general virtual reality, is extensively used in the fields of education and training due to its potentials that is stimulating interactivity and motivation. Furthermore, it offers an ideal process to approach, study and acquire new knowledge for participants who prefer a visual, auditory or kina-esthetic learning style.

2 VIRTUAL TECHNOLOGIES DEPICTION CLASSIFICATION

Virtual Reality (VR) is based on a concept that refers to a whole computer generated 3D simulation with the aid of computer systems utilizing graphical setups. In order to achieve a realistic immersive experience is dependent on a capable of hardware and software such as dedicated glasses, VR helmets, motion sensors and 3D applications. In contrast augmented reality refers to generating virtual elements on a real environment such as text and other multimedia contents, the
characteristics of these elements are usually 3D which require interaction from the user. Heish & Lin (2011) predicted the possibility AR user interaction will on a high. VR & AR has become a current subject such that they have been found to be useful in the area internet technologies. Also the potential for VR/AR has enabled it become applicable in all other sectors such as medicine, marketing, engineering etc. unlike in the past where it was restricted to aviation industry.

Rosenblum & Cross (1997) identified Immersion, Interaction and Visual Realism as major factors that are associated VR.

Immersion is a perception of being physically present in a non-existent world, this perception is created by surrounding the user in images, sound or other stimuli that’s prompts user’s interaction (Wu, Lui, Wang & Zhao, 2015) e.g. virtual glasses, gloves with sensors, HMDs and surround sound. Visual realism simulates the physical presence regarding the user in a virtual environment, which have two components which are geometric realism (GR) and illumination realism (IR) which simulates both real objects and lightening of the model. Björk & Holopainen (2004) indicated that simulating a physical presence in a non-existent environment can be classified as generally as motoric, cognitive, and emotional. Benford, Greenhalgh, Reynard, Brown & Koleva (1998) also stated that VR creates an immersive spatial experience when the user detects discrepancies in the virtual environment e.g. a player in a video game, to counter against this, a real time interaction is necessary (Riva, 2006) to get instant feedback of their position and sensation. The feedback can be exploited via input and output devices (visual, Aura and haptic). In order to create a perfect virtual environment, hardware and software should be able to render detailed and realistic virtual scenarios, and need to handle geometry, texture, and physical models to be considered real.

In contrast Augmented reality (AR) is an extension of VR that mixes real environments with objects created in a virtual environment; in this regard, there is a thin line between AR and VR as illustrated by Milgram & Kishino (1994) which delineates a scale between a real environment and a virtual environment (Fig. 1); Benford Et al (1998) suggests that the perception of the user should be categorized into artificiality and transportation (Figure 1). Zhou, Duh & Billinghurst (2008) also implied that AR is capable of interacting with virtual objects and physical objects but not limited, to real-time computer imagery overlaying onto physical objects in precise positions. Höllerer & Feiner (2004) emphasized the ability of AR interaction of virtual objects with physical objects AR creates new means of human-computer interaction (Ludwig & Reimann, 2005)

![Figure 1: Reality-virtuality continuum](Source: Milgram & Kishino, 1994)

3 METHODOLOGIES

Kerawalla, Luckin, Seljeflot, & Woolard (2006) Stated that students are likely to feel more committed and motivated via the use of virtual technologies, thus emphasizing the potential VR technologies. Chen & Tsai (2012) suggest that via virtual technologies, new methods for teaching and learning will
be illuminated. Virtual technologies in education has led to several case studies investigations (Harris & Reid, 2005; Martin-Gutierrez, Saorin, Contero, Alcaniz, Perez-Lopez, & Ortega, 2010; Di Serio, Ibañez & Kloos, 2013), nonetheless most research focus on specific experience and subjects. Therefore integration of VR/AR is crucial for effective instructional designs is well comprehended (Dun-leavy, Dede, & Mitchell, 2009), owing to the fact that educational processes have not yet found conventional procedures of integrating these technologies.

However, traditional learning environments have been resistant to integration of educational innovations, teachers tend to be resistant to adoption of new technologies for the fear of leaving his/her comfort zone because it will involve time to relearn, unlearn and the cost of implementation and maintenance. In spite of, the rapid advancement of technology such as smartphones and tablets etc. eventually VR technologies will become more economical for tertiary institutions and pupils. It is crucial that we identify the pros and cons of VR in an academic setting.

4 PROS OF ADOPTING VIRTUAL TECHNOLOGIES IN EDUCATION

Various scientific literature have identified pros of VT in education as outlined in the table below;

<table>
<thead>
<tr>
<th>Authors</th>
<th>Outlined Advantage</th>
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<tbody>
<tr>
<td>Kaufmann, Steinbugl, Dünser, Gluck (2005)</td>
<td>Improved Students’ social and collaborative skills</td>
</tr>
<tr>
<td>Feng, Duh, &amp; Billinghurst (2008)</td>
<td>Improved students Psychomotor and cognitive skills</td>
</tr>
<tr>
<td>Harris &amp; Reid (2005)</td>
<td></td>
</tr>
<tr>
<td>Di Serio Et al (2013)</td>
<td></td>
</tr>
<tr>
<td>Martin-Gutiérrez &amp; Meneses (2014)</td>
<td></td>
</tr>
<tr>
<td>Bacca, Baldiris, Fabregat, Graf, &amp; Kinshuk, 2014</td>
<td></td>
</tr>
<tr>
<td>Holley, Hobbs, &amp; Menown, 2016</td>
<td></td>
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</table>

The outlined pros of VR/AR technologies can be compared to Computer Assisted Instruction (CAI), because both are simulated. The development of cognitive skills, positive attitudes, student’s empowerment effect, instructional capabilities and other instructional methods have been attributed to the success of CAI. (Chow 1998; Zacharia, 2003) Ferry et al (2004) suggests that real life experience can be represented by simulations. The interpretations of results, forecast, exploration of new domain and designing experiments have been made conceivable (Steinburg, 2000)

In the same way, positive attitude and motivation have been found among students to use VR technologies for earning processes (Mikropoulos, Chalkidis, Katsikis, & Emvalotis, 1998). Additionally, VR captures student attention by engaging them, it is exciting and challenging to manipulate and create objects in the virtual world. Also precision, visualizing of objects and processes are all inclusive in VR which may be impossible in the real world, but in VR it is possible. Winn (2002) suggested by following a constructive approach, students are exposed to abstract ideas by using models that can be interacted with and it also makes it easier for them to acquire knowledge.

Therefore, VR technologies promotes decision making via interaction with environments, permitting independent exploration, comprehending new concept, creating new experiences and learning by active student participation. In addition, Kotranza, Lind, Pugh, & Lok (2009) determined that real-time interaction authorities visualizing results promptly, hence students are able to take decisions based on these results to reach their learning goals, improving their learning performance and cognitive skills but it is also possible to interact collaboratively, virtual environments tend to boost interaction and teamwork among students. These advantages promote better students’ participation by engaging immersive experience, eliminating distractions, and creating positive attitudes when students have quality feedback to reach their learning objectives. VR/AR best standpoint is that, it provides a first person experience. This concept aligns with Dales’ learning cone (Dale, 1969), stating that a well-designed virtual experience is nearer to a direct purposeful impact experience than just educational television or exhibits.
Furthermore, in technological developments, VR technologies are forerunners as a result of these advances of these technologies, it has become more accessible, today disabled students have the opportunity of participating in virtual experiences (Lange, et al., 2010), notwithstanding these advances benefits regular students by creating more accessible experiences (e.g. by using their mobile devices, or by accessing to virtual spaces when enrolled in distance-taught courses).

In summary there are four advantages of using virtual technologies:

- Virtual technologies provides immersive experience, where the student feels like a character while studying three dimensional model objects that encourages participation, motivating and by large enhances their learning experience.
- Virtual technologies allows interaction with virtual objects and collaboration with other students because VR technologies employs a constructivist approach of learning. Thus, students can investigate experiment and obtain feedback, that results in improved learning experience.
- As a result of recent technological advancement, VT are now accessible and affordable, technologies such as smart phones, tablets and video game devices have improved VR/AR accessibility. As a result of this, complex devices are no longer required, shared VR contents can be accessed via online platforms like Netflix, YouTube etc. Thus, making it easier for both disabled and regular students to interact and collaborate to achieve a learning objective.
- Virtual technologies allow more interaction than conventional learning materials. By using VR/AR, students feel immersed while interacting with concepts, objects and processes by using headsets, tactile gloves, and motion sensors. This immersion permits to experiment environments with realistic objects that could not be accessible otherwise.

5 VIRTUAL REALITY MARKET/ INVESTMENTS

According to Digi Capital (2016) report, AR/VR has had as many as $686million in investment, the second quarter of 2016 saw VR increase by $1.2 billion dollars. The same report also a $120 billion dollars surge by 2020.

However, the investment in 2016 on VR, about 50% was allocated to HMDS, 60% to Magic Leap to the tune of $800 million dollars, a major player in the VR industry. It is estimated among the four major players in the VR industry as of 2016 they share a business volume of about $9 trillion dollars in sum total; Magic Leap with the highest slice of $ 4.5 billion dollars, followed by Oculus Rift at $ 2 billion dollars, Blippar at $1.5 billion dollars and Mind Maze at $ 1billion dollars. Currently Magic leap is now face fierce competition from new comers; Facebook, Google or Microsoft which added special features to VR glasses. Magic leap success has been on how they pretend to project digital light fields into the user’s eyes.

Definitely, the leading sectors in VR/AR in 2016 were hardware, video services/solution, video games, marketing, consumer application, distribution tech and Peripheral devices. Analyst suggest that sales of virtual reality helmets will rise swiftly in 2016; it is projected that a million units could be sold. The future of VR in terms of investment is very bright, movie directors such Steven Spielberg in the movie “ready player one go” have been fascinated by the potential in essence of VR.

6 VIRTUAL LEARNING INSTANCES

Nowadays, virtual technologies are not limited to just classrooms, various levels of interaction and immersion is made possible by technological advancement that allow varying alternatives. The ‘second life’ (www://secondlife) is one example of virtual worlds (VW) that may be used, otherwise adopted to teach pupils in various profession such as medicine, health and safety (Boulos, Hetherington, & Wheeler, 2007). And construction safety (Le, Pedro, & Park, 2014). VWs works by permitting the user by creating a virtual flexible learning environments and thus making it possible to use services such as sharing a desktop (PC), displaying presentations, attending video conference, drawing on whiteboard and file sharing etc. as illustrated in figure 2. These platforms (VW) are accessible via a computer desktop VR, the advancement and affordability in VR technologies such as HMDs enable better immersive experience. Therefore incorporation of 3D VR into virtual learning environment is feasible, just like in the VR cinema as illustrated in figure 3.
However, immersion and interactivity desire high viewing degree, which makes it possible for students to proceed, interact with elements in a virtual environment like in the real life, with the aid of affordable and ease to use body motion sensors. Looking ahead, students can ideally interact with virtual objects without requiring any sort of controller.

7 INSTANCES OF VR/AR IN EDUCATION

There are several applications of VR/AR in academic environments that have been revealed by literature some of which have been highlighted as illustrated in the table below:

<table>
<thead>
<tr>
<th>Authors</th>
<th>Implementations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jarmon, Traphagan, Mayrath, &amp; Trivedi (2009)</td>
<td>Illustrated utilizing 3D Virtual Worlds in VR to teach</td>
</tr>
<tr>
<td>McKerlich, Riis, Anderson, &amp; Eastman (2011)</td>
<td></td>
</tr>
<tr>
<td>Kuei-Shu, Jinn-Feng, Hung-Yuan, &amp; TsungHan( 2016)</td>
<td>Detailed simulation of driving a vehicle in VR</td>
</tr>
<tr>
<td>Gutiérrez, Domínguez, &amp; González (2015)</td>
<td>Using Virtual technologies to train spatial skills</td>
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</tbody>
</table>

The subsequent projects, experiences, and software developments representatives, among others have been found to be associated with educational environments as illustrated in the table below:

<table>
<thead>
<tr>
<th>Project</th>
<th>Developer</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aumentary Project</td>
<td>Labhuman (<a href="http://www.labhuman.com">http://www.labhuman.com</a>)</td>
<td>Spain (University of Valencia)</td>
</tr>
<tr>
<td>Build AR Project</td>
<td>HITLabNZ (<a href="https://www.hitlabnz.org/">https://www.hitlabnz.org/</a>)</td>
<td>New Zealand (University of Canterbury)</td>
</tr>
</tbody>
</table>

Both projects main objective is to assimilate AR in classrooms via creating tools to build an AR application in education:

<table>
<thead>
<tr>
<th>Applications</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aurasma (2011) (<a href="http://www.aurasma.com">http://www.aurasma.com</a></td>
<td>Created by the software company Autonomy, it is exploited by various learning strategies.</td>
</tr>
<tr>
<td>Science Center to go (SCTG)</td>
<td>It allowed manipulation and experimentation with virtual elements to augment scientific education. (Connolly &amp; Hoskins, 2014)</td>
</tr>
<tr>
<td>Magicbook (2001)</td>
<td>It visualizes virtual contents like 3D objects, animations or videos via a computer webcam or a mobile device on a text. (Billinghurst, Kato, &amp; Poupyrev, 2001)</td>
</tr>
</tbody>
</table>
8 CONSTRAINTS OF VR TECHNOLOGIES IN EDUCATION

Buckingham & Rodriguez (2013) indicated that recent advancement in technologies has enabled massive data exchange via social media, smart phones, PC and technological devices which have changed the way communication is conducted. Today upcoming students have been exposed to technologies, but this does not mean that they adept in utilizing these technologies in an academic setting.

Margaryan, Littlejohn, & Vojt (2011) also suggested that current technologies may not require pedagogical innovations as Virtual Learning Environments (VLEs) always gives room for affordance of pedagogy to maximize enlightenment merit. Fowler (2015) indicated by engaging academic staff to actively participate in creating virtual academic settings to achieve the merit of enlightenment.

9 CONCLUSION

The next decade will see VR/AR steadily evolve and become a popular technology for public consumption as well as educational environment (Ezawa, 2016). Overtime VR/AR experience were expensive and restricted to Aviation and nuclear power plant, it is important to note; power, capability of latest devices and intensive developments of virtual technologies, VR content accessibility are factors that contribute to VR/AR standardization. This definitely leads to accelerated access and cheaper VR/AR technologies.

Also, the next few years will see integration of VR/AR become easier, revolutionize the way individual communicate following the footprint of its predecessor, the internet and smartphones. As time progresses low cost headset will be more powerful, cheap and accessible thus enhancing mobile devices. Most academic setting, beginning from elementary school to tertiary institution, should be able to create immersive experience by allowing users control elements or process such that it a standard for educational practices.

However, facilitating learning requires taking advantage of virtual technologies but ultimately the way in which the technology is utilized will influence the learning outcomes. VR/AR technologies can be used by docile users to retrieve knowledge, execute instructions more like in traditional labs but VR’s edge is immersion and interaction achieved via cheap HMDs and body motion sensors. The impact of this, is that students can now have first person experience, take decisions after obtaining feedbacks, analysis and reflection leading to enlightenment. Notwithstanding students will be able to create, share knowledge by simulating in a VR environment.

In spite of the advancement in VR technologies, there is a limitation of how VR/AR is used in an academic setting which may not be dependent on the technology but the manner in which these technologies are utilized to impact individuals. Ultimately VR learning experience should look beyond knowledge acquisition but to implement constructivist approach in an academic setting to obtain quality benefits in learning.

REFERENCES


