Possible Adoption Options of Virtual and Augmented Reality Technologies in Open Universities during the Covid-19 Era.

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The paper explores the use of Virtual and Augmented Reality (VAR) in response to the COVID-19 Pandemic, that is, the role VAR can play during the Covid-19 crisis and beyond, for business continuity. VAR solutions are needed to help maintain continuity in teaching and learning following disruption caused by COVID-19 by allowing learners to continue to benefit similar physical teaching and learning experience by applying VAR solutions. The paper therefore reviews various solutions suitable for adoption in Open Universities.

Keywords— Virtual Reality, Augmented Reality, Open Education, Open University, Covid-19

1. Introduction

Technological innovations have assumed a vital role in teaching and learning. Educational institutions gain a competitive edge by how fast they adopt new teaching and learning technologies. Such innovations include Virtual and Augmented Reality (VAR). COVID-19 which was first reported in December 2019 has disrupted business continuity in teaching and learning, this is because the usual physical interactions have been discouraged to help contain spread of the virus [2][3]. Therefore, ICT solutions, VAR in particular, are needed in order to help maintain the teaching and learning experience during the COVID-19 pandemic while teaching and learning continues as before[1]. It has been shown that use of ICT solutions during the COVID-19 helps improve brand performance, student satisfaction among other things [4]. Virtual Reality (VR) is a simulated experience that can be similar to; or completely different from the real world. The created experience is almost real and in three-dimensional (3D) space. Augmented Reality (AR) is a VR style technology where real life is modified and enhanced by computer-generated graphics and audio. The resulting effect makes the computer-generated graphics to appear real and present. In simple terms, VR replaces reality, takes one somewhere else and AR adds digital elements to reality, projecting information on top of what one is already physically seeing.

VR is categorized into two main types, based on the level of interaction and immersive environment, that is, Immersive VR and Non-Immersive VR. Immersive VR environments are presented on various, room-size screens or through a stereoscopic, head-mounted display unit. Specific equipment such as gloves, suits and high-end computer systems might be needed in an immersive VR environment. In Non-Immersive VR, computer simulation is represented on a desktop computer and interaction with the virtual environment is done using keyboard, mouse, joystick, or touch screen [5].

2. Literature Review

VAR has many applications such as travel, gaming, events, home design, and most importantly education as shown in Figure 1. The VAR technology has recently being successfully and largely used in gaming and this paper further explores its use in education. Studies have shown that applications of Virtual
Reality go far beyond gaming, as shown by the Greenlight VR Consumer report in Figure 1. Virtual and Augmented Reality can facilitate the learning process through the development of highly realistic 3D simulations, and has also been shown to shorten the learning curve for learners [6]. VAR is increasingly becoming useful as a learning tool in educational institutions, due to its interactive and animated features. It can therefore be an effective method for teaching and reinforcing complex concepts by allowing learners to interact with the visualization tools [7]. VAR technology can assists in giving both online and face-to-face students ability to improve their spatial visualization skills [8]. These skills are crucial in STEM (Science, Technology, Engineering and Mathematics) fields. Spatial visualization ability is the ability to mentally manipulate a 2-dimensional (2D) and 3D figures. Traditional learning sources such as textbooks, physical models, and modeling techniques have been shown to be insufficient in improving the spatial visualization skills of learners [9].

(STEM) Science, Technology, Engineering, and Mathematics

Simulations play a key role in teaching and learning, not only because they provide realistic models with which learners can interact with to acquire real world experiences, but also because they constitute safe environments in which learners can repeat activities without any risk in order to perceive easier concepts and theories. Learning theories such as Multimedia Learning Theory and Cognitive Learning Theory can be achieved by use of Virtual Learning technologies [10]. Multimedia Learning Theory involves building mental representations from words and pictures [11] whereas Cognitive Learning Theory explains why the brain is the network of information processing and interpretation in the body as we learn [12]. These experiences cannot be easily obtained in any other way in formal education.

2.1 Virtual and Augmented Reality in Open Universities

Due to the disruption caused by COVID-19, Most universities have recently taken a decision to deliver their academic programs online. This untrivial move provides many advantages such as flexibility,
Virtual and Augmented Reality has potential to take Online Learning beyond the traditional online learning experience. The benefits include enhanced engagement, improved retention and experiential learning. This simulation-based technology has huge potential to revolutionize how online programs are delivered in Open Universities.

The continuous changes in today’s education delivery modes provide a continuous improvement in the interaction of information. Distance Education coupled with VAR technologies has capacity to provide rich teaching and learning experience in distance education [13]. One such virtual technology is Desktop Virtual Reality (DVR). DVR is a computer program that generates a real or simulated imagery-based environment, which is displayed on a desktop computer screen. VAR provides immersion which is an enhancement experience for learning from a distance [14].

Research conducted at Plekhanov Russian University of Economics through questionnaires and interviews with lecturers, undergraduate students, and alumni showed the following benefits of distant learning technology in Virtual Learning Environment (VLE) [15]:

- Contribution to improvement of quality of language education and training,
- Reduction of costs of providing supplementary educational material by increasing the number of hours allocated for self-study,
- Increased motivation of lecturers and learners;

The following are some of the reasons why VAR would bring a new perspective to Open Universities if adopted:

- Provides new ways of visualization, an alternative way for presentation of educational material. In most instances, VAR can more precisely illustrate some features, processes, and so forth than by other means, which allows a more close-up examination of an object or model from a greater distance, and examination of areas and events unavailable by other means. 
- VAR motivates students. It requires interaction and therefore encourages active participation rather than passivity. Some types of VAR, for example, collaborative virtual reality using text input with virtual worlds, encourage or require collaboration and provide a social atmosphere.
- Virtual Learning Environment (VLE) allows the learner to go through a complete experience not limited by a regular class schedule, but at their own pace. It also allows the disabled to participate in an experiment or learning environment when they cannot do so otherwise. It therefore transcends language barriers. VR with text access; provides equal opportunity for communication with students in other cultures and allows the student to take on the role of a person in different cultures.
- Virtual and Augmented Reality provides experiential learning which is costly to implement in a distance education setup.
The Virtual Learning Environment can accommodate learners’ different learning styles because the learner has the ability to customize their preferences on the learning style they prefer.

The extension of their subject knowledge made possible by the provision of supplementary information on the VLE can improve the learning process for the learners.

The flexibility of the VLE, of any time, any place aspects of usage and the fact they could communicate with their educators via the VLE makes it more suitable for a distance learner and more applicable in Open Universities where Open and Distance Learning (ODL) is practiced.

The interactivity and communications aspect of the VLE is beneficial to shy learners during tutorials and to international students who might be inhibited about speaking up in class but felt more confident in engaging in online discussions. Open Universities typically have an Internationalization policy which promotes international students therefore this will be very instrumental in completing the experience for international students.

3.0 Applications/Implementations of the Virtual and Augmented Reality Technologies

This section is organized in two sub sections and provides suggestions, solutions and guidelines to the disrupted conduct on classes due to COVID-19 by application of VAR. The paper explores the use of VAR by reviewing related literature, tools and other institutions who have initially adopted these. The first sub-section is presented in this section outlining scenarios which Open Universities can use the technologies for. The second sub-section is under the Appendix Section where a list potential VAR educational apps and services are provided should Open Universities wish to explore them. Open Universities could start by outsourcing the services and subscriptions from established providers or institutions. This will serve as trial run to assess the adoption impact on teaching and learning. The services outsourced should include the following.

**Virtual Laboratories** – Virtualizing the learning environment in any field possible as this will bring the benefits outlined above in Section 2. For instance, in science; STEM, networking, biology, chemistry can all be considered for virtual laboratories as opposed to physical setup costs. Virtual Lab Environment is used to conduct STEM classes. Labster VR provides more than 100 types of virtual labs for schools and universities, for various subject areas and the experience is great. Open University UK also provides the similar learning environment under OpenSTEM. The OpenSTEM Labs offered by The Open University UK challenge the traditional STEM pedagogical model of students and teachers being co-located in a lab during ‘office hours’. It connects students to instrumentation, data and equipment for practical enquiries over the internet, where time and distance is no longer a barrier – any time, any place access.

**Online Virtual assistants** – Adopting an online virtual assistant to assist in dealing with enquiries from the public, prospective students, and current students. The Virtual Assistant should be AI-based so that it can autonomously and independently respond to the enquiries and queries especially to frequently/commonly asked questions and provide a customized response to the enquiries. This is
necessary in ODL since learner support and timely response to public improves reputation and has potential to increase enrolment numbers. This can implemented on the institutions’ website, all other social and digital media platforms. For instance, Chatbots can be considered in this regard.

**Virtual Campuses** – Coupled with the provision of an internationalization policy/guidelines, this enables and promotes enrolment of international students. These types of students are not present in the country where the institution is located. Therefore, it is important to provide them with physical campus experience, that is, Virtual Campus Environment. VirBELA provides similar services. This option is well suited for distancing learning setup.

**Non-Immersive Virtual Reality** – This VR service might not include setting up an expensive infrastructure or require students to acquire new headsets or gadgets. A desktop computer with decent specifications is sufficient for this kind of service. Accessing of VAR content can be done by acquiring VAR apps or VAR service subscriptions. Virtual and Augment Reality is available for both desktop and mobile platforms, the decision regarding which device to use within a curriculum will depend largely on the course objectives and outcomes [16].

**Virtual Classroom (VC)** – Virtual Classroom is an online learning environment that allows for live interaction between the tutor/lecturer and the learners as they participate in learning activities. VR helps a learner attend a tutorial regardless of where they are, provided there is internet connection. Virtual Classrooms are increasingly becoming popular [17]. An example of a virtual classroom is Google Classroom. Google Classroom is a free web service, developed by Google for schools, that aims to simplify creating, distributing, and grading assignments in a paperless manner. The primary purpose of Google Classroom is to streamline the process of sharing files between teachers and students. One example is at Stanford School of Business, which is offers a certificate course fully delivered through VR. Being able to watch a lecture/tutorial online while not being able to physically attend, is breaking a lot of barriers in education. Interactivity is an important feature provided by the VR technology as it gives a user a feeling that he or she is in a real classroom as opposed to the virtual classroom. A learner therefore can interact with their fellow classmates whether they are thousands of kilometers apart.

**Virtual and Augment Reality for disabled people** – VAR is not only enhancing lives of physically fit people but also changing the lives of disabled people. VAR enables the physically disabled to experience things they have not being able to do physically by using various input controls. For instance, if a learner has not been able to physically build electronic components together, VAR accessibility options are able to do so. This paper discusses how virtual reality has changed lifestyles of disabled people and how Virtual Reality (VR) can increase the usability of the systems designed for disabled people [18]. Evaluation of the systems using VR technology against simple systems (without VR) has also been carried out which highlights significant changes in the usability and user experience of devices, designed for disabled people.

**Skills Training** – Immersion of virtual reality and interactivity allows learners to play a role in the
Virtual Learning Environment, devoting themselves to their learning environment, skill training. For instance, medical students' surgical skills, students' teaching skills, vehicle driving skills, electrical maintenance, various vocational skills training, etc. Vocational skills training is cost prohibitive in Open Universities and VAR can possibly be used to offer courses related to vocational training. Vocational training in Open Universities could increase new short course offerings which will in turn increase the third stream of revenue. Due to the virtual reality technology, training is safer with VR, such that learners can practice repeatedly, until they master the skills. Simulations have been found to play a key role in education other than the fact that they provide realistic models with which learners can interact to acquire real world experiences, but also because they constitute safe environments in which students can repeat processes without any risk in order to perceive easier concepts and theories [6].

**Virtual Field Trips** – Learning can be made more interesting with courses which requires virtual field trips. This allows learners to travel the world without having to physical move from their seats. For instance, in a history, geography classes, learners can see everything they are being taught which might be millions of kilometers away.

**Improving Various Skills** – Virtual and Augmented Reality can be used for experiential learning in general. Learners can apply the skills they have been taught in an everyday scenario. For instance, technical skills such as for engineering students, computing students, law students and so on. Law students can do VR representations of real trials as well other fields. Other institutions and other writing services like Flash Essay like to focus on how important VAR is, when it comes to helping a student work on their own skills, whether they have to do with writing or even being presented with real-life situations of what they are studying.

**Game-based Learning Techniques** – Also known as gamification, Virtual and Augmented Reality can provide educators with the opportunity to approach learning from a different perspective. There are many ways in which games can be improved through VAR. Virtual and Augmented Reality games are more interactive than traditional games. The learners can interact a lot better and share their experiences without being judged on their abilities. Furthermore, interactive, and kinesthetic games are known to help learners memorize things they come across in the virtual games. This can truly help learners better memorize things and increase their ability to learn. This can be applied in Early Childhood programmes as they develop memory and ability to learn.

**Better cooperation between students and teachers** – VR Classroom might seem as if it takes away the control for the tutor/teacher to focus on each learner however in reality VR helps one-on-one learning which is actually necessary for some learners. With VR, the educator has the opportunity to communicate specifically to a learner and assist them to improve. Learners will not have to feel ashamed to ask in front of the real classroom hence it improves the relationship between the learner and the tutor.

**Facilitate learning complex concepts** – Makes it easy to understand complex structures especially in ODL where student rely on self study materials where face-to-face tutorials are not done frequently
especially in this Covid-19 era. Zahira Merchant et al. [19] discussed the effectiveness of virtual reality-based instruction on students’ learning outcomes in K-12 and higher education, how desktop virtual reality has been found to make learning easy and helps achieving the learning outcomes.

**Education 4.0** – Adopting VAR Technologies for teaching and learning is a step towards achieving Education 4.0 which is beneficial for today’s learners. Education 4.0 has become the famous buzzword among educationists today. The Fourth Industrial Revolution (4IR) wave is so strong that change is inevitable, including within the educational setting. Education 4.0 is a response to the needs of 4IR where human and technology are aligned to enable new possibilities. Education 4.0 has been found to be a crucial shift particularly for ODL institutions. The next-generation Learning Management System (LMS) sometimes referred to as LMS 4.0 should be integrated with VLE. The traditional LMS is considered dead and therefore the Next Generation Digital Learning Environment (NDGLE), is to replace the traditional LMS [20].

It is important to note that Virtual and Augment Reality is not suitable for every teaching objective. There are some teaching scenarios where VAR can be used and some when it should not be used [21].

The following guidelines will help guide educators when to and when not to use Virtual and Augmented Reality [21]. Use of Virtual and Augmented Reality is recommended when:

- Teaching using the real thing is dangerous, impossible, inconvenient, or difficult.
- A model of an environment will train as well as the real thing.
- Interacting with a model is as motivating as/more motivating than interacting with the real thing.
- Travel, cost, and logistics of gathering a class/tutorial make an alternative attractive.
- Shared experiences of a group in a shared environment are important.
- The experience of creating a simulated environment/model is important to the learning objective.
- Information visualization is needed, manipulating and re-arranging information, using graphic symbols, so it can be more easily understood.
- A training situation needs to be made really real.
- Needed to make perceptible the imperceptible.
- Developing participatory environments and activities that can only exist as computer-generated worlds.
- Teaching tasks involving manual dexterity or physical movement.
- Essential to make learning more interesting and fun.
- Needed to give the disabled the opportunity to do experiments, and activities that they cannot do otherwise.
- Mistakes made by the learner or trainee using the real thing could be devastating and/or demoralizing to the learner, harmful to the environment, capable of causing unintended property damage, capable of causing damage to equipment, or costly.
4.0 Preparatory Work for Implementation of VLE

The following resources and activities are needed to be put in place as preparatory work:

1. Bandwidth – Investigation of how much bandwidth is required to cater for VAR technologies, video conferencing and others. This resource is very key to successful implementation and delivery of VAR.

2. Stable Internet Access – Open Universities should invest in stable internet access to avoid downtime which will cause disruptions in accessing the VAR content. All campuses should have stable internet access and Uninterrupted Power Supply (UPS) for backup power.

3. Support Personnel/Team – Cyber security personnel should be considered since the program delivery and content will be online and thereby adoption of Virtual Learning Environment. A Virtual and Augmented Reality Specialist should be considered as support personnel to manage and advise on the technologies related to VAR. More research is needed to figure out the right support team needed before adoption of VAR technologies.

4. Acquiring of relevant Software and Hardware related to the outsourced services and subscriptions needed to create or use VAR educational content and resources for learners. More research is needed to determine the right software and hardware to support VAR technologies based on the institution infrastructure.

5. Training – training is needed for the relevant people to learn how to use Virtual and Augmented Reality Technologies and creation of VAR content and for change management.

6. Attending of conferences such as Educators in VAR and benchmarking visits to other universities, which are successfully using VAR for teaching and learning to learn from their experiences. Educators in VR is an open, global, cross-platform community of educators, researchers, and trainers exploring and collaborating in virtual and augmented reality. Educators in VAR is the connective tissue between academia and businesses in the VAR education industry.

Twenty-first century classrooms should be technologically advanced places of learning, with the help of VAR technology this can significantly increase students’ engagement and learning.
Disadvantages/risks associated with adoption of using Virtual and Augmented Reality technologies

The possible downsides/associated risks of adopting Virtual and Augmented Reality technologies for teaching and learning could include initial high cost, time necessary to learn using the technologies (hardware and software), possibility of health and safety issues, possible reluctance to change by staff members. However as with any introduction of new technologies, these issues/risks will go with time.

Conclusion

Virtual and Augmented Reality as a distance learning tool will definitely have a positive impact on education particularly in Open Universities. Research has shown that Virtual reality shortens the learning curve and fits well within our ODL philosophy. The recent pandemic of Covid-19 which has disrupted education negatively is a sign and reflection to shift focus to more new distance learning technologies in the future. VAR can put an end to traditional methods of education, which are too constrained and costly. In using this technology, institutions can improve knowledge retention and reduce the cost of training programs. STEM programs are costly to invest in and adopting Virtual Reality Technology solutions will cut costs.
References


APPENDIX - Virtual and Augmented Reality Apps and Services

- ClassVR gives you the opportunity to open up access to virtual and augmented reality technologies across your college or university – not just within the Computer Science building (www.classvr.com)

- Stanford University Graduate School of Business – running its LEAD (Learn, Engage, Accelerate, & Disrupt) - Leadership Certificate programme. which already offers a certificate course (Desktop Virtual Reality) (https://online.stanford.edu/programs/stanford-lead-program)


- Google Classroom (classroom.google.com)

- PhET simulations and the simulations found on the Howard Hughes Medical Institute’s (University of Colorado Boulder) website as free resources for an intro lab class. (https://phet.colorado.edu/

- VirBELA – company for virtual reality - for OPEN CAMPUS activities. The VirBELA Open Campus is a free virtual world where you can host or attend immersive online events, meetings, classes, and more. (www.virbela.com)

- Unimersiv is the largest platform for Virtual Reality Education experiences. It provides services for VR to institutions (unimersiv.com)

- The Open University UK offers OpenSTEM offers labs under various disciplines; OpenScience, OpenEngineering and OpenNetworking amongst others. This a simulation environment through the web interface for various science disciplines. (http://stem.open.ac.uk/study/openstem-labs)

- Labster VR provides more than 100 types of virtual labs for schools and universities. has detailed simulations that walk students through experiments as if they were in a laboratory or doing field work. They work well for lower- or upper-level courses. The company reps report they are able to have labs for a class up and running in 24 to 48 hours. (https://www.labster.com).