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Possible Solutions for Teaching Large Classes in a Dynamic Educational Landscape

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Abstract

The rapid growth of tertiary education enrolments, particularly in science, technology, engineering, and mathematics (STEM) courses, has presented numerous challenges for educational institutions around the globe. The purpose of this article is to review possible solutions that may help mitigate some of these challenges. A phenomenological study is used as an approach to unfold the experience described by the authors experiencing these challenges. Firstly, linked classrooms are considered, allowing for a more flexible and efficient use of limited physical space. Secondly, the integration of extended reality technologies into the teaching process can help students demonstrate key graduate attributes required by Industry today, as well as becoming an enabler of student agency and active learning. Thirdly, the use of video recording software, such as PanoptoTM, can prove effective in managing course materials and assignments and in promoting student engagement. As tertiary institutions continue to face the challenge of accommodating a growing number of students with limited facilities, the application of one or more of these solutions has the potential to revolutionize teaching methods, improve student engagement, and enhance learning outcomes in STEM courses and beyond.

Keywords: Virtual Reality, Augmented Reality, Panopto™, linked classrooms, workload

1. Introduction

The rapid growth of tertiary education enrolments, particularly in science, technology, engineering, and mathematics (STEM) courses, has presented numerous challenges for educational institutions [1]. Some of these challenges include limited infrastructure (e.g., classrooms that can only seat 200 students when a single module as an enrolment of over 500 students), increase workload (academics needing to assess over 500 students who may submit up to 5 practical assignments per semester) and limited student engagement (limited resources may prevent students from personally interacting with specific hardware or technologies).

The development of infrastructure has not kept up with the rising number of student enrolments. Effah [2] provides an example of this in Ghana where a university built for 3,000 students was required to cope with about 24,000 without corresponding expansion in academic and physical facilities. Changes in the higher education landscape and to academic workloads, have increased student-staff ratios, placed more demands on lecturers' time and increased student group sizes. This has made it more problematic for some students to develop a sense of belonging and has reduced the amount of time for individual student support [3]. Engagement has also suffered in terms of students not being able to spend enough time learning to effectively operate specific equipment or hardware. This is especially so in universities that can only afford to purchase a limited number of training equipment due to its excessive costs, thereby limiting the number of duplicate experimental stations that students can use within a singular practical session [4].

To help mitigate some of these challenges, three innovative solutions are reviewed. One approach involves the implementation of linked classrooms, allowing for a more flexible and efficient use of limited physical space [5]. Secondly, the integration of augmented reality (AR) and virtual reality (VR) (forming part of extended reality (XR)) into the teaching process has shown promise in enhancing student engagement and understanding of complex concepts [6]. Thirdly, the use Panopto™, a video-based platform, can allow for further student self-assessments with immediate feedback that can enhance the achievement of specific learning outcomes [7].

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The purpose of this article is to review these 3 innovative solutions in terms of their implementation and benefits. The methodology followed is firstly explained, following by the three innovative solutions and a summary of the benefits of their implementation.

2. Methodology

A phenomenological study is used in this paper. The purpose of a phenomenological study is to determine what an experience means for the individuals experiencing it and those who are able to provide a thorough description of it [8]. In this case, the authors are academics at the Central University of Technology (CUT) in South Africa who have first-hand experienced the challenges of large class sizes. They have witnessed, over a 7-year period, how student numbers have risen from 200 to more than 500 within specific modules. They have also personally implemented one or more of the solutions discussed in this paper in order to cope with this challenge.

3. Linking classrooms

Linking classrooms is not a novel concept but depends largely on how faculties want to implement it [9]. At CUT the classroom or laboratory has been equipped with a microphone that is positioned to receive audio from both the lecturer and any student in the venue. An audio system also provides good quality sound for the speaker or any video or sound clip to be played. Multiple screens within the venue also make it possible for all individuals to effectively view the presenter, other individuals in the joint classes and the material that is projected. A stable internet connection is also included in the system. This is all controlled via a small and simplified control panel that is easy to operate. Figure 1 depict two photos of such a venue.

This further allows a specific lecture room or laboratory to be linked to similar venues on the campus of the university, or to other campuses anywhere in the world who have a similar setup. However, it must be emphasized that a minimum internet connection of 3G is required for this. This creates an almost limitless class size for students and for the university. International students especially benefit from this as they may be exposed to world-renowned specialists within a specific field of specialization.

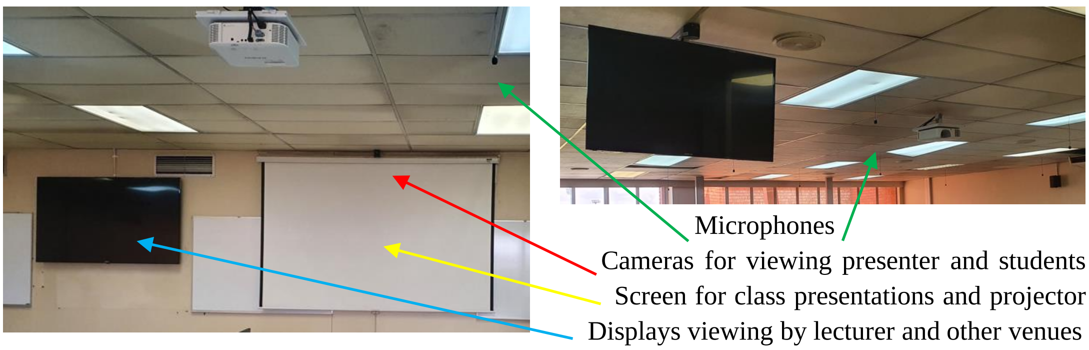

Figure 1. Layout of the minimum audiovisual equipment required in a venue

4. Extended Reality

Augmented reality and virtual reality forms part of XR that is now commonly found in society [10]. The following VR has already been implemented at CUT where a student can be virtually placed within a laboratory space utilizing a 360° photo. This photo was taken by a Ricoh Theta 360° camara and imported into the EON- XR platform. EON Reality is a widely used virtual simulation platform that contains the desktop-network virtual reality to support digital gloves, helmets and VR solutions [11]. A safety lesson plan from the content of a first-year module (including pictures, videos and a PowerPoint presentation) was then incorporated into the photo. Figure 2 shows a screenshot of such an example where the labels are clickable to access the videos and the PPT presentation.

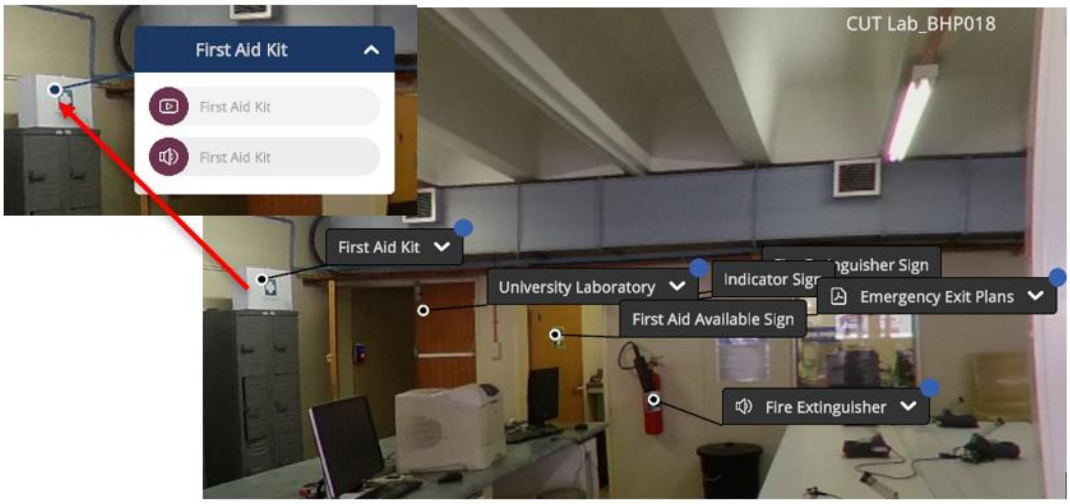

Figure 2. Screen shots of the layout of the VR safety lesson

The VR example focuses on a safety lesson that students must complete before using the equipment in a laboratory. Text, audio and video clips that would have been used by a lecturer in the past is now packed into an interactive session which the students can access and view asynchronously. The student can freely move around the venue, familiarising themselves with the location of the first-aid kit, information signs and exist routes. This enables, yet again, a limitless number of students to cover important preparatory work required before they enter the laboratory to use its equipment. It further enables students to spend more time operating the equipment in the laboratory, as the time originally required to give the safety lesson in the laboratory has now been saved.

A second example of using VR is in an electrical machines laboratory that can only accommodate 40 students. Again a 360° photo is used of the laboratory that is imported into the EON- XR platform. The practical assignments planned for this laboratory, pictures, videos and a PowerPoint presentation is then incorporated where the labels are clickable by a student. The practical instruction can now be covered by a limitless number of students within the same time frame. This enables the students to be well-informed before coming to the laboratory, which in turn enables the lecturer to focus more on the application of the equipment rather than on its fundamental operating procedures or on its location in the laboratory. Figure 3 shows a screenshot of such an example on the same EON-XR platform.

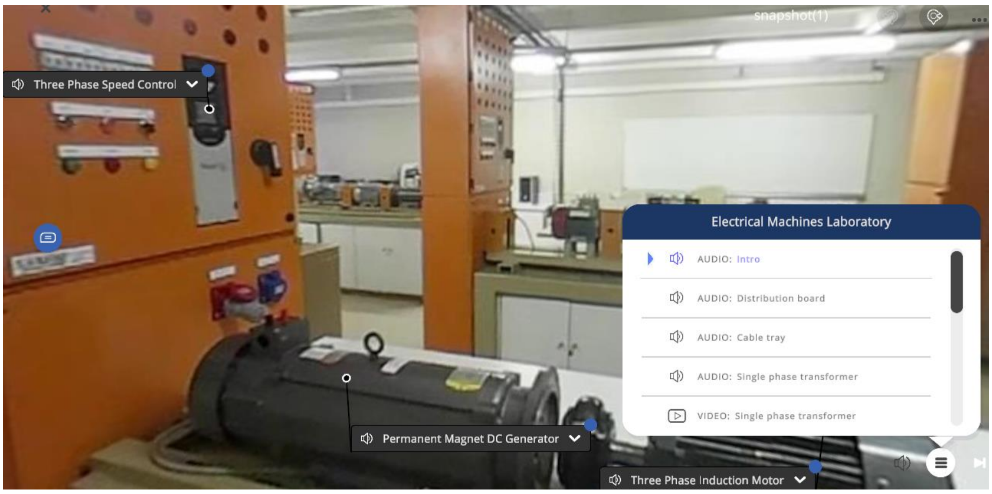

Figure 3. Screen shots of the layout of the machines practical’s VR training exercise

5. PanoptoTM for enhanced video learning

Using videos in teaching and learning is an instructional strategy that has been advocated by researchers and supported by positive research findings for a long time [12]. A lecturer should make use of videos or animations as part of a lesson or even record his or her classes for students to review or reflect on at a later stage. The use of Panopto^{TM} can assist with recording related work, with editing, transcribing, or sharing videos and by adding questionnaires or assessments to it. Panopto^{TM} has been used to generate the content of a lecture explained by an instructor along with the PowerPoint slides used in the discussion [13]. Panopto^{TM} provides opportunities where a video can be paused for such a quiz to be completed, before continuing further with the video. Figure 4 shows a screen shot of some these functionalities of a recorded class, where the author of this paper is shown on the top left, having recorded himself as part of the instructional video.

In this example, the author is explaining the operation of a robot. The transcription (shown below the author) allows the student to also read the information at the same time. The right-hand sketch of the robot shows the quiz link along with other associated links that the student may use to obtain more information on the topic at hand.

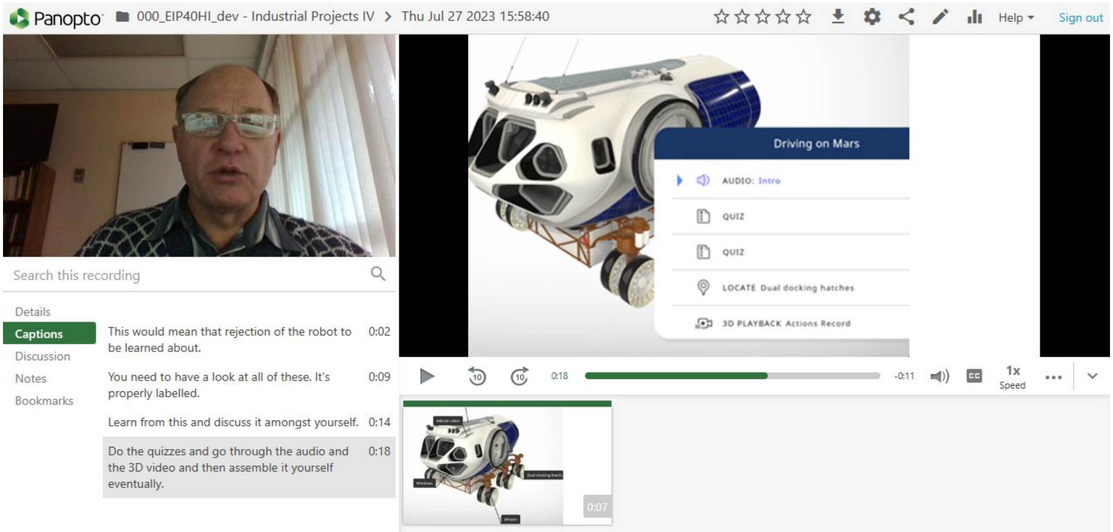

Figure 4. A screen capture indicating the transcription of the video, frames and actual video being played

6. Benefits of implementation

Linked classrooms

Class sizes ranging from 200 and above can now be hosted simultaneously within the same time slot of the timetable and by the same lecturer. The lecturer's workload would be reduced, as he or she would only need to cover a lesson once, as a large class of 500 students would not need to be divided into three different time slots for them to fit into classroom that can only seat 200 students at one time. International student implementation is also a benefit of this approach, where student exposure to field experts residing in a specific location becomes possible. Students need to be exposed to field experts who can share their experience and lessons learned during hours of research or teaching, as this may enhance their motivation or commitment to a specific field of study. Already back in 1971 it was stated that college engineering students should be exposed to professional engineers and realistic design experiences as soon as possible [14].

Extended Reality

Possible cost savings in terms of building extra laboratories or buying duplicate or extra equipment may be avoided by using this approach. It can also enable students to become more technologically literate, a key graduate attribute required by CUT. This requires students to are able to use information and communication technologies effectively [15]. This attribute is linked to the attribute of Modern Tool Usage, as prescribed by the International Engineering Alliance (IEA). The IEA also prescribes Individual and Teamwork, where students need to be able to work independently and in a team.

The use of XR may further enable student agency, as they take responsibility for their own learning and work independently. It could enhance active learning, as students no longer passively sit and just listen to a lecture. It could also lead to satisfaction of learning, as digitally savvy students can now make use of their favourite types of technology in the learning process.

Panopto™ for enhanced video learning

Recordings of actual classes may be done in real time to which notes, videos and website links may be attached. This can enhance student engagement with the course content outside of the classroom environment, where they can review and reflect on the lessons learned in the classroom. This type of recording can include a number of quizzes or self-assessments that feature some form of feedback that that can indeed foster student engagement and academic success [16].

7. Conclusions

The positive outcomes of implementing these solutions becomes evident when considering the potential benefits. Linked classrooms enable institutions to accommodate large student enrolments which are currently being experienced around the globe. Extended reality technologies may enhance student learning experiences and enable them to better demonstrate key graduate attributes such as technological literacy and independent learning outside of the laboratory environment. The use of video recording software, such as Panopto™, can help improve student engagement outside of the classroom environment.

Tertiary institutions will continue to face the challenge of accommodating a growing number of students with limited facilities as more individuals seek to upgrade their professional qualifications. Integrating linked classrooms, XR technologies and video recording software, such as Panopto™, can offer viable solutions to this challenge. These advancements have the potential to revolutionize teaching methods, improve student engagement, and enhance learning outcomes in STEM courses and beyond.

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