From interactive teaching to immersive learning: Higher Education 4.0 via 360-degree videos and virtual reality in Malaysia

A H M Adnan*1
1Universiti Teknologi MARA Perak Branch, Seri Iskandar Campus, 32610 Bandar Seri Iskandar, Malaysia

* Corresponding author’s e-mail: admin@uforia.edu.my

Abstract. Higher Education 4.0 deals with the spread of technologies and espouses the notion that today’s learners need to be trained and not merely taught by rote and memorisation drills. The present is a period whereby data and information must be made accessible and open 24/7 so that learners can learn about how to find knowledge rather than to wait to be spoon-fed from their instructor’s textbooks. Higher Education 4.0 is contingent upon the concept of ‘immersive learning’ to afford learners with an educational atmosphere that is exceedingly interactive at the physical and virtual levels. Hence, immersive learning experiences could replicate possible scenarios that learners will face in real life and impart specific techniques or skills based on their different academic syllabuses. Employing immersive learning experiences that incorporate 360-degree real life videos and VR technologies to remote teach advanced communication skills to technical and vocational students at several public universities in Malaysia, this research paper highlights the fact that novel learning technologies and immersive learning experiences are not merely fads of Higher Education 4.0. Rather, they are glimpses of tomorrow’s world, based on quantitative and qualitative data collected from end-users (Malaysian university students) of a learning innovation initiative called ‘ELSA 360°-Videos’.

1. Introductory section

Technology has propelled humanity towards remarkable growth and progress, especially spurred by the introduction of the Internet as an information superhighway [1]. With the era of Industrial Revolution 4.0 quickly upon us [2] [3], having breakthrough technologies that allow human beings to fast-forward the speed of communication, as well as to facilitate information exchanges and business dealings within the space of a millisecond, is nothing short of amazing [4] [5]. Together with social advancements in most societies around the globe, it can be said that the evolution of technology [6] [7] has been both directly and indirectly influential in changing and developing instructional pedagogies [8] [9]. The settings in formal classrooms for the period of time before the year 1990 were perhaps more suited for the face-to-face method, due to formal education being more teacher-oriented during that period in human history [10]. After that, as more technological means were becoming available together with the increased accessibility to these technologies, classrooms that mix together direct physical teaching and electronically-mediated learning were becoming more commonplace [11].

Currently, wholly e-learning oriented teaching methods are frequently observed, as well as the popularity of ‘flipped classrooms’ where the pedagogy is mainly focused on being student-centred [12] [13]. Thus, it is not surprising that for practitioners and researchers in the field of tertiary...
education, the drive and enterprise in studying and exploring ways to exploit 21st century Higher Education 4.0 technologies to improve and enhance the teaching and learning dyad is imperative [14] [15].

Nevertheless, with rapid advancements in technology, unemployment is fast becoming a scourge around the globe and an impending worry as more and more jobs are getting replaced due to the disruptive nature of Industrial Revolution 4.0 technologies [16]. The main problem stemming from the progress of high technologies is that the situation is causing not enough work to go around [17]. For instance, with the prevalence of 3D printing processes, AI or artificial intelligence, IoT or the Internet of Things, consumer-grade automatons (robots) and other innovation tools, many employees in different economic sectors are losing jobs faster than society can create them. Take for example, the current situation with robot-human helpers. The idea of robots taking over the labour of human beings is no longer an allegory to technological advancement in science fiction, but rather a sobering truth.

The policymakers at the top of the tertiary education field must quickly get their heads around what is currently happening and adapt quickly to this new human reality. Frey and Osborne [18] maintain that only through a shift in the present direction of comprehensive developments can the occupational stagnation in economic sectors of the digital era be evaded. They assert that, “Whilst the concern over technological unemployment has so far proven to be exaggerated, the reason why human labour has prevailed relates to [our unique] ability to acquire new skills” (p. 89).

2. Review of current related research

Without realising, we have actually crossed the initial phases of the 4th Industrial Revolution [19] [20]. What is currently happening is digital systems are quickly being combined and recombined with biological and physical ones [21]. Human societies are evolving into living systems that might be able to allow all of us to meet the most basic desires of every single person on this planet of ours. The prophecy that up to five million traditional careers might be lost post year 2020 to technology should verily be taken seriously by all stakeholders in all nations of the world [22] [23]. Industries like construction, manufacturing, health, education and human services will continue to exist; that being said, the start of the 4th Industrial Revolution is a game changer that calls for better education and more rigorous training to be provided to the younger generation [24]. The following subsections will expand on these critical arguments.

2.1. From outdated classroom settings to virtual teaching environments

The formal education system needs to step up its game to meet the needs of ‘Generation Z’ and the incoming ‘Generation Alpha’ [25]. Due to this fact, the teaching methodologies in tertiary institutions should no longer rely solely on traditional and rigid methods to impart knowledge within formal settings [26] [27]. Figure 1 below, illustrates the continuum from rigid and formal (traditional) educational mediums to more interactive and immersive ones at this present moment in time.

![Figure 1. The continuum from traditional-formal to interactive-immersive educational mediums](image-url)
Virtual reality (VR) systems and augmented reality (AR) systems for instructing and learning in Higher Education 4.0 must quickly be adopted to truly revolutionise the techniques that instructors use to teach their subject matters and the style that learners use to acquire them [28]. There has been a number of rapid changes in the education realm for the past 20 years since the world celebrated its second millennium or second kiloyear in 2020 [29]. Nevertheless, there are still some old tools being used by instructors at all levels of formal education, such as the use of traditional (and frankly, boring) static PowerPoint slides [30]. By bringing into play VR systems and/or AR systems, hopefully learners will be able and ready to learn not just interactively but immersively in ways that were not really possible 20 to 30 years in the past [31] [32].

Take for instance the use of virtual reality (VR) systems as depicted in Figure 2. This technological marvel gives its users the chance to be transported into, and be totally immersed within, a made-up digital or semi-digital atmosphere. Most interestingly, a user of a VR system can also promptly engage with its contents in real-time [33]. Even though it is not really a cutting-edge technological development, the creation of new technological gadgets such as light-weight Head Mounted Display devices (HMDs) has changed the game, as it were, for virtual reality technologies. HMDs now can implant two or even four to five quick sensing cameras to create a sense of true stereoscopic vision and they can be directly connected to high-end personal computers or even be used as a standalone device, as in the case of the ‘Oculus Quest’ [34] VR system.

These recent developments have helped to turn virtual reality technologies and systems into consumer-grade affordable technologies, effectively opening up innovative ways for immersion to happen in the physical world, mainly for entertainment purposes [35]. That being said, virtual reality technologies and systems are also becoming gamechangers within the world of formal education [36]. In the United States for instance, virtual reality technologies and systems have been adopted by first graders to college (university) learners at a remarkable speed. By putting on virtual reality HMDs, learners can easily be immersed within the virtual world into more engaging and empathic learning of a variety of academic subjects and courses. In addition, a 360-degree ‘look around and walk around’ perspective of a multitude of different educational contents will help make the teaching and learning process feel more true to life, as learners become one with the digital or virtual world they see, hear and feel around them [37].

Figure 2. Immersive learning via virtual reality systems and apps

Be that as it may, no matter how great a certain technology is, unfortunately there are also some flaws detected on the features of VR systems. For example, the size and weight of VR HMD goggles are still considered to be quite bulky, especially for learners who are physically small and with smaller heads and faces. This fact makes it difficult for younger learners and some female learners to use VR systems easily. Moreover, some individuals are prone to experience differing degrees of dizziness and motion sickness whilst being immersed in virtual worlds. All same time, one of the many benefits of drawing on virtual reality technologies and systems for educating learners from all walks of life is the fact that most of them will have a strong sense of involvement within that virtual world, leading to increased concentration and most importantly information or knowledge retention [38] [39]. VR
systems take our learners into a total sensory experience and involvement where all of them can practically see, hear and even touch the educational contents that they experience around them [40].

One such example is the virtual reality application called ‘King Tut VR’, which is available on the Apple Store and Google Play platforms. This particular virtual reality application delivers the full experience of immersion into olden history. The virtual reality application guides viewers into the tomb of the Pharaoh Tutankhamun (or King Tut) with a 360-degree virtual environment full of historical artefacts to be explored. With the adoption of virtual reality technologies and systems, a student of history, for example, does not have to travel to Egypt to learn about and to experience this episode of ancient history [41] [42].

Not much different from virtual reality advances and systems, augmented realities or AR employ the real atmosphere or physical setting all around us to create a sense of being immersed within a different reality. Augmented reality systems can overlay animations or any other types of digital data on any smart device, be it augmented reality goggles or even just a normal smartphone or tablet computer, as illustrated in Figure 3 below. Without a doubt, one of the principal advantages of augmented reality systems is that they do not need specialised and hefty gadgets to access AR-driven worlds. Owing to this fact, augmented reality technologies and systems should become more common in the very near future [43].

![Figure 3. Immersive learning through augmented reality applications](image)

Augmented reality technologies and systems can really assist in developing the imagination of learners; for instance, rather than just reading a boring book chapter, they can visualise the subject matters at hand in real time [44]. It is true that not all subjects have that kind of advantage (in terms of ease of being taught through AR systems) but academic subjects and courses that can be taught with the help of augmented reality technologies should help learners to gain improved comprehension, and even deeper insights into certain academic subjects and more difficult topics. Add to that the fact that all learners can easily engage with augmented reality systems and apps through their day-to-day usage of mobile smartphones or computer tablets, it is easy to see the economical sense of augmented reality technologies and systems over virtual reality ones [45].

Today, a normal AR application just needs a simple smartphone camera. A learner just needs to point her or his (smartphone) camera to a page from a book to magically turn a static image into perhaps a 3-dimensional animation or some other immersive and educational augmented reality element. ‘Dino Park AR’ for instance, available on the Apple App Store, provides an augmented reality experience by whisking younger learners into the prehistoric age where they will be able to see ‘real’ dinosaurs moving around their classrooms or even bedrooms. Undoubtedly, augmented reality technologies and systems possess the potential to engage young learners, to keep them feeling excited, and to help them invest more time and effort in the teaching and learning process [46] [47].

2.2. From virtual teaching environments to interactive learning experiences

In the 4th Industrial Revolution, the digital economy will commercialise and spread technologies that can accompany us and assist us in our day-to-day lives. Relevant technologies have grown rapidly these past few years that gadgets for VR and AR are now available at quite affordable prices [48].
With this development, more people especially learners, will have the chance to learn through new methods and not in the same traditional, rigid and formal ways. Other than using virtually-based technologies for education, most people are widely using them for entertainment [49]. It is not something new but the widespread involvement of people in collaborative gaming adventures, gives advantages to everyone involved. For instance, gamers usually will connect with others from all over the world. Through interactions while gaming, this can give positive impact on one’s communication skills and networking. Indeed, these advanced technologies have been utilised widely in the entertainment industry.

There are many other ways, for example in education, that virtual realities and also augmented realities might be put to good use. Burton and Scott [46] noticed significant drops in museum attendance in the last 20 to 30 years. At the opposite end of the spectrum, the use of the Internet and Internet related technologies, including online learning or e-learning together with using computers for entertaining ourselves, have become more prevalent in most modern societies around the globe. Therefore, it is only apt that we should tap into these technologies and apply them to make museums and living exhibitions more interesting and relevant for the here and now. As Burton and Scott suggest, “to increase attendance [all museums] need to position themselves as attractions with many of the attributes associated with [more contemporary] leisure activities” (p. 66). With this kind of reinvention, the number of visitors visiting museums will surely increase from time to time.

Current advances in virtual realities and augmented realities technological systems have made it conceivable for people to get involved with another version of reality, with the help of apps and gadgets. This opens up opportunities for designers and thinkers to utilise the idea of ‘hybrid spaces’. This kind of space mixes the physical setting with a virtual or digital creation and adds onto the strength of these environments within a singular setting [50]. Researchers are continuing to explore the application of hybrid spaces for virtual reality and augmented reality systems [51]. Indeed, virtual realities and augmented realities can provide the chance for the public to experience being in a historical event or to experience walking about in buildings from a different era whilst engaging and interacting with what they see and feel.

2.3. From interactive learning experiences to futuristic learning via ‘immersive experiences’

The preceding sub-sections mention the advantages of virtual reality-based together with augmented reality-based technologies and systems. Thus, if the formal education system widely implements these technologies in learning, learners will highly likely gain so much than what they are getting now. As traditional tertiary education institutions discover the benefits of online and open learning formats, educational resources are now even more accessible, with a wider range of interesting contents [52]. And, many college and university learners have started using these technologies of learning on a very wide scale [53]. Therefore, their instructors need to be one step ahead in learning how to adapt technology into classroom pedagogy, from traditional methods to more technology-friendly learning experiences. Even the most uncomplicated technology has proven to be quite useful in the process of teaching and learning, for example 360-degrees videos for education as shown in Figure 4.

![Figure 4. Immersive learning using 360-degrees footage/videos](image-url)
Without a doubt, there will be challenges that educators and their learners will experience. For example, some learners might not have sufficiently capable computers or stable and cheap Internet services. For other learners, they might even struggle to adapt to the new learning environment because they tend to be inexperienced with high-end technologies; some might even feel afraid to use these technologies widely [54]. However, through these gaps, the learning and teaching process gets better for both educators and their learners. The role of technology in education is constantly evolving. Newer and more innovative learning ‘experiences’ that will aid in information dissemination and knowledge retention will definitely be more widespread in the near future.

Take for example VR technologies and systems. They will allow learners to explore full 360-degrees and made-up worlds in three dimensions or 3D [55] [56]. The same goes with 360-degrees videos, which enable learners to perceive audio and video inputs in whichever direction they want. They can also easily move through action scenes and cuts recorded with 360-degree video cameras. Most interestingly, these experiences can easily be viewed on a normal smartphone or even a cheap tablet computer [57] [58]. YouTube for instance is now filled with 360-degrees clips. Not merely accessing these videos, learners can upload and share their own clips on a variety of popular platforms such as Facebook and YouTube. There are also AR technologies and systems that can create immersive learning experiences by placing a digitalised overlay on top of the real physical environment, instantaneously. This layer of digitalised virtual scene appearing on the actual real-life scene can make learning more meaningful [59]. Certainly, the emotional and mental features of AR experiences will lead to the creation of an industrious learning experience that will in turn intensify learners’ desire to acquire knowledge and skills, and to attain success in the process of formal learning [60].

Looking at the broader picture, all of these educational technologies that have been extensively reviewed in this current section, could and should bring about positive impacts [61] on the process and practice of Higher Education 4.0 around the globe [62] [63].

3. Research methods and data analysis modus operandi
Based on the research literature above, fieldwork to collect empirical data was carried out in 2019 to early 2020. In the first of two waves, quantitative data were collected from 560 tertiary (public university) students in Malaysia. In the second wave, 102 tertiary students were selected from the first wave and invited to participate in a series of focus group discussions to collect qualitative data. In the next section, both the quantitative and qualitative datasets are presented and discussed. All of the students involved in this empirical study were doing first degree courses at four Malaysian public university campuses; nearly all of them were technical and vocational students with the biggest section comprising of science and technology students. In addition, roughly 40% of the research population were male students with the other 60% females.

For the first wave, all the survey respondents were exposed to, and immersed in, 360-degree educational VR experiences that were meant to help them acquire specific skills in English and also other international languages, prior to the 25-item survey questionnaire being administered. The survey takers were given a series of ‘I-statements’ that they have to respond with ‘Strongly disagree’, ‘Disagree’ or ‘Somewhat disagree’ at one end of the scale, and ‘Somewhat agree’, ‘Agree’ and ‘Strongly agree’ at the opposite end of the scale. The data collected were calculated and grouped into simple percentages to show perception and adoption of 360-degree videos that are packaged as VR experiences over a period of two academic semester (more than one calendar year from the whole of 2019 to early 2020).

For the second and more extensive wave, a series of 20 focus group discussions lasting about 1 hour for each session were carried out, involving 102 research participants. Focus group discussion was used as the second data collection instrument as it allows for the collection of ideas and opinions from a large participant pool whilst also opening up two-way channels to openly discuss specific topics. To facilitate the process of data collection and analysis, a number of research participants were also trained as ad-hoc ‘secretaries’ to record the proceedings using their smartphones and to write up summaries of each focus group discussion session. This helped to increase the involvement of all the
research participants as I only observed the proceedings without interrupting the flow too much. The qualitative data collected were, as norm, subjected to analytical coding and thematising. Where names are used with quotations in the next section, these are actually pseudonyms chosen by the research participants involved in the second wave of this study.

Employing an award-winning VR learning innovation project for Work-based and Professional Interactions [64] called ‘ELSA 360°-Videos’ [65] [66] together with similar materials for Arabic and Chinese to stimulate the discussions, two central research questions below that are linked to the notion of immersive and interactive educational experiences guided this empirical research project.

1st research question: What are the benefits and detriments of learning using VR-based technologies, based on what you have experienced through ELSA 360°-Videos and other related VR-for-teaching projects?

2nd research question: How should educational content developers improve your experience of learning using VR-based technologies before this technology is applied to the teaching and learning of your core academic subjects?

4. Data from the research project

This section presents answers to the questions that drive this research. First, what are the benefits and detriments of learning using VR-based teaching technologies, based on what the survey respondents and research participants have experienced through ELSA 360°-Videos and other similar educational VR-based innovation projects? And second, how should we (as educational content developers and course instructors) help to improve the experience of learning using VR-based technologies, before this technology can be applied to the teaching and learning of the core academic subjects of the survey respondents and research participants?

4.1. Quantitative data from the 560 survey takers / respondents

Due to their familiarity with both technologies, it was not surprising to find that the majority of survey takers from the four public universities prefer using 360-degrees true life videos that are packaged as immersive VR experiences, to aid them to acquire new knowledge, as seen in Table 1. The data quite overwhelmingly show not only the positive orientation of the survey takers towards 360-degrees real life videos that are packaged as immersive VR experiences, but the data also suggest that these technological tools offer good promise for the future of teaching and learning.

| Strongly disagree | Disagree | Somewhat disagree | Somewhat agree | Agree | Strongly agree |
|-------------------|----------|-------------------|---------------|-------|---------------|
| 0.89% (5)         | 2.14% (12) | 5.36% (30)       | 10.54% (59)   | 47.68% (267) | 33.39% (187) |

The biggest advantage and strongest argument for the adoption and wider use of 360-degrees immersive virtual reality videos is related to the ‘exposure time’ that these technologies provide to university students. What this means is that the students can gain more independent self-learning time (or SLT) compared to just normal learning during class or lecture hours. Another weakness of learning during lecture is the time limit imposed on the students. In addition, a student who really wants to learn and to seek answers from the course instructor must also compete for the instructor’s attention. This might not be possible especially when the teaching is done through mass lectures or the course instructor needs to finish the lecture within the limited timeslot given to her or him. Table 2 shows the survey finding related to exposure time.
Moving to the core academic subjects of the survey takers / university students, it is quite surprising to note two additional findings. First, the survey takers believe that other instructors also need to create and use 360-degrees immersive videos as virtual reality experiences in instructing and educating them at their respective campuses. And second, the survey takers feel strongly that other academic subjects can reap positive benefits through the incorporation of 360-degrees immersive videos and virtual reality experiences within their diverse tertiary education curriculum. Both findings are explained in Table 3 and Table 4, below.

Table 2. “I think these technologies (360° videos and VR) give me far more exposure to the subject”

| Strongly disagree | Disagree | Somewhat disagree | Somewhat agree | Agree | Strongly agree |
|-------------------|----------|-------------------|----------------|-------|----------------|
| 0%                | 0.71%    | 1.79%             | 11.96%         | 44.29%| 41.25%         |
| (0)               | (4)      | (10)              | (67)           | (248) | (231)          |

The last notable finding from the quantitative survey instrument within the limits of this empirical research paper relates to the wider adoption of 360-degrees virtual reality videos and VR experiences not just at classroom, department or faculty levels but most crucially at university level. In terms of the wider usage of 360-degree educational videos and virtual reality experiences at campus-wide or whole-university level, again, quite a high percentage of survey takers or university students agree with this proposition. This finding suggests that 360-degree authentic footage videos that are designed as immersive VR experiences should be included in the teaching and learning dyad as part of the future curriculum of universities that align to the Higher Education 4.0 universal movement. Table 5 illustrates this important finding.

Table 3. “I want my other lecturers to also use these new technologies (360° videos and VR)”

| Strongly disagree | Disagree | Somewhat disagree | Somewhat agree | Agree | Strongly agree |
|-------------------|----------|-------------------|----------------|-------|----------------|
| -                 | 3.39%    | 6.61%             | 18.39%         | 48.57%| 23.04%         |
| (0)               | (19)     | (37)              | (103)          | (272) | (129)          |

Table 4. “I believe other subjects should include these new technologies (360° videos and VR)”

| Strongly disagree | Disagree | Somewhat disagree | Somewhat agree | Agree | Strongly agree |
|-------------------|----------|-------------------|----------------|-------|----------------|
| 1.61%             | 2.50%    | 5.89%             | 16.96%         | 48.93%| 24.11%         |
| (9)               | (14)     | (33)              | (95)           | (274) | (135)          |

The last notable finding from the quantitative survey instrument within the limits of this empirical research paper relates to the wider adoption of 360-degrees virtual reality videos and VR experiences not just at classroom, department or faculty levels but most crucially at university level. In terms of the wider usage of 360-degree educational videos and virtual reality experiences at campus-wide or whole-university level, again, quite a high percentage of survey takers or university students agree with this proposition. This finding suggests that 360-degree authentic footage videos that are designed as immersive VR experiences should be included in the teaching and learning dyad as part of the future curriculum of universities that align to the Higher Education 4.0 universal movement. Table 5 illustrates this important finding.

Table 5. “I hope my university can adopt these technologies (360° videos and VR) for T&L”

| Strongly disagree | Disagree | Somewhat disagree | Somewhat agree | Agree | Strongly agree |
|-------------------|----------|-------------------|----------------|-------|----------------|
| 0.90%             | 1.60%    | 3.75%             | 18.39%         | 33.57%| 41.79%         |
| (5)               | (9)      | (21)              | (103)          | (188) | (234)          |

4.2. Qualitative data – Advantages and disadvantages of learning using 360° videos and VR

Based on the comments shared by the majority of the participants / university students in this study, the advantages of 360-degree educational videos that are distributed as immersive VR experiences far outweigh their disadvantages, for the purpose of exposing learners to and instructing them in new knowledge and skills. The ELSA 360°-Videos project, for instance, packages 360° or spherical video clips within ‘learning experiences’ on the freely available VeeR [35] virtual reality video platform.
Using the concept of discussions that go on within corporate meeting rooms, users (i.e., the degree level students) go through a series of short discussions on various topics to teach them about workplace based and professional interactions.

Representing her discussion group, according to Miss ‘Aliya’, “The main advantage for us is we’re able to feel like we’re in the real situation, like in a real meeting with actors and actresses. We can learn sentences and also see the reaction of everyone [in the video].” In truth, all of the discussion groups made this observation and they also appreciate that VR technology helps them “to see” how to use correct body language and how “to use” positive facial expressions when they communicate professionally with other people. For Mister ‘Haziq’ and his group members, “We like that we can understand new skills, for example interpersonal skills and diplomacy skills, and all the professional skills that we need. It's like we ourselves are there in the meeting with you.” Other advantages of VR in the teaching and learning of this academic and professional subject are as follows.

Miss ‘Cassava’, appreciates the fact that she and her group members “can clearly see two-way communication and visually experience the learning on office issues because according to my friends, this is a good example of how learning with new technology can make it better and easier to learn.” The point shared by her finds support in the words of Mister ‘Aizzart’ below:

My friends said that we can improve our language and also see around the room, to see clearly what happened in the room and to understand what the speakers should do. So, when we do our actual test, we also can know how the real negotiation style takes place and how the discussion in the meeting should be done in professional situations, like in the office and for office situations like when we negotiate with other people. … Getting the experience of the real situation like in the video, due to the 360-degrees view is a really positive thing. The main advantage of this is that we are able to see and understand the real situation or discussion without us having to go into a real meeting.

Another group led by Mister ‘El-Hushairy’ shared that they were able to get new and fresh ideas, learn how to solve problems on the fly and “to think outside of the box.” In his own words: “When we can see all the eye contact between all the people in the videos, we quickly learn about manners and how to interrupt during discussions and meetings from looking at the whole situation, 360 degrees in the room.” For him, learning about appropriate body gestures and facial expressions are not easy because he does not yet have the chance and exposure to learn in the real world. Nevertheless, once he gets to join the labour force in Malaysia, it will be too late for him to start learning these essential professional skills. He adds:

So, getting quick understanding and getting these professional skills more quickly than just reading in the boring textbook, together with gaining confidence and becoming talkative after we look and listen to how the professional people/workers actually talk in professional situations when they have important meeting agendas… the experience to me and my group members, is so awesome!

At the same time, some disadvantages of these new technologies that the research participants cite are as follows. First, sometimes they could not catch the real intentions of the video, so they need to watch the video more than one time due to the fact that these are 360-degrees videos. Second, they also argue that they need a lot of Internet or mobile data because they have to watch the video again and again, and sometimes the facial expressions are not that clear if they watched in lower resolutions. Third, poor Internet connection on campus grounds is also costly for them because they have to deal with not having enough mobile Internet data for their other academic endeavours. Finally, even though they like this novel technology, mobile data cost (as most of them use prepaid telephone lines) and constant buffering for some mobile carriers are annoying to them even though they believe that in the future the technology will get better with 5G mobile networks.

4.3. Qualitative data – Application of 360° videos and VR to a wider range of academic subjects
For this issue, it is a mixed bag because although the majority of the university students feel that they want 360-degree VR videos recorded from real life for their more difficult core subjects, a minority group feels that using this technology is not really appropriate especially for subjects where they need to do complex calculations, computer programming or workshop-based assignments and laboratory experiments. However, for students who deal with studio-based drawings and technical drawings, and those who work with 3D models and physical models that represent actual physical things, these tertiary learners feel that their academic subjects can really gain from the application of 360-degrees footage as virtual reality experiences, and even augmented reality technologies and systems.

All in all, for the majority of learners who have participated in this wide scale empirical effort, they are open to the idea of using virtual reality in the instructing and knowledge acquisition processes at degree level. The sole and real barrier to them to accept this technology is the problem with expensive mobile Internet costs and the difficulty in getting stable Internet connections so that they can truly learn anytime and anywhere on campus or from the comfort of their hostel accommodations or rental abodes. With this in mind, hopefully in the future more of their core subject lecturers would get on board and try developing VR or even AR contents to teach core subjects and technical subjects. This move will give more weightage to these novel technologies due to the fact that these are considered ‘must pass’ core subjects for all of these degree level students.

5. Conclusion
Creating immersive and interactive educational experiences is a real challenge for university and college level educators. At the same time, we need to consider how well end users (i.e., our learners) can accept and can readily use cutting-edge and novel learning technologies like virtual reality-based (VR) experiences and augmented reality-based (AR) apps. Undeniably, immersive learning experiences will be the future of teaching and learning at Malaysian universities and tertiary colleges. However, there are still many obstacles to be met that hinder the wider implementation of these educational experiences at Malaysian universities, for instance inadequate network infrastructure and the burden of cost both on the content developers (lecturers and instructors) and the end users (university students/tertiary learners). Still, the demands to create more immersive and interactive experiences will continue to grow strongly not just within the field of education but also in other professional fields. Whatever it is, novel learning technologies and educational experiences that subscribe to the notion of ‘immersive experiences’ are not merely fads, they are glimpses of the world of tomorrow, based on the comments shared by the degree students who have learned through the ELSA 360°-Videos innovation project and related VR-based projects for the teaching and learning of other international languages.

6. Acknowledgments
Dr. Airil Haimi Mohd Adnan wishes to humbly thank Miss Nurul Nadiaha Mustafa Kamal (UiTM), Mr. Ahmad Ariffuddin Yusof (UPSI), Mr. Muhammad Anwar Mohd Kamal (UPSI) and Mr. Muhammad Khairul Ahmad (UM), for improving earlier drafts of the Introduction and Literature Review sections of this empirical paper. Together with Dr. Airil Haimi, they are the founding members of the Future Learning Initiatives content development laboratory or FLI LAB @ UiTM Perak Branch, Malaysia. They were also short term contract lecturers of UiTM Perak Branch for several semesters. This empirical research project received no financial backing from any agencies or institutions.

References
[1] Lester F K 2020 1988–1996: A time of optimism, change, and reflection Journal for Research in Mathematics Education 51(2) 144-149
[2] Schwab K 2016 The Fourth Industrial Revolution (Geneva: World Economic Forum)
[3] Schwab K and Davis N 2018 Shaping the Fourth Industrial Revolution (Geneva: World Economic Forum)
[4] Taplin J 2017 Move Fast and Break Things: How Facebook, Google, and Amazon Have Cornered Culture and What it Means for All of Us (London: Pan Books)

[5] Ahmad M K, Adnan A H M, Yusof A A, Mohd Kamal M A and Mustafa Kamal N N 2019 Using new technologies to teach English in Malaysia – Issues and challenges Proc. of the International Invention, Innovative & Creative (InIIC) Conference (series 1/2019) ed MNNF Network (Senawang: MNNF Network) pp 203-207

[6] Shaw V N 2019 Three Worlds of Collective Human Experience: Individual Life, Social Change, and Human Evolution (Cham: Springer Nature Switzerland)

[7] Coccia M 2019 Why do nations produce science advances and new technology? Technology in Society 59 101124

[8] Adnan A H M, Ahmad M K, Yusof A A, Mohd Kamal M A and Mustafa Kamal N N 2019 English Language Simulations Augmented with 360-degrees spherical videos (ELSA 360°-Videos): ‘Virtual reality’ real life learning! Leading Towards Creativity & Innovation (series 1) ed MNNF Publisher (Senawang: MNNF Publisher) pp 82-88

[9] Hamiti M and Reka B 2012 Teaching with technology Procedia – Social and Behavioral Sciences 46 1171-1176

[10] Moltudal S, Krumsvik R, Jones L, Eikeland O J and Johnson B 2019 The relationship between teachers’ perceived classroom management abilities and their professional digital competence Designs for Learning 11(1) 80-98

[11] Hamedoglu M A 2019 The use of information and communication technologies in classroom management in primary schools Malaysian Online Journal of Educational Technology 7(4) 145-154

[12] Bontly S W, Gomez C, Khalil S M and Mansour T F 2019 Impact of technology on post-secondary classroom culture: A critical literature review Journal of Interactive Learning Research 30(3) 327-346

[13] Adnan A H M and Zamari Z M 2012 “I am a techno-rebel!” Malaysian academics & their personal experiences of progressing into e-learning Procedia – Social and Behavioral Sciences 67 61-72

[14] Adnan A H M and Zamari Z M 2012 Computer-Aided Self-Access Language Learning: Views of Indonesian, Malaysian & New Zealand practitioners Procedia – Social and Behavioral Sciences 67 49-60

[15] Zamari Z M and Adnan A H M 2011 Fusing CALL with SALL: The Good English Language Learner community on Facebook as a case in point English Language Journal (UPSI Press) 4 126-146

[16] Adnan A H M 2018 Industry 4.0 skill sets, higher-order thinking skills and gamification: Lessons from ‘Potentia Project’, Malaysia (Plenary Panel Presentation) Proc. of TING X 2018: The Tenth National Meeting of Teachers (Temu Ilmiah Nasional Guru) 'Innovation in Education for Indonesia 4.0' (Tangerang: Universitas Terbuka Indonesia)

[17] Summers L H 2014 Lawrence H. Summers on the economic challenge of the future: Jobs [Internet] Available from: http://www.wsj.com/articles/lawrence-h-summers-on-the-economic-challenge-of-the-future-jobs-1404762501

[18] Frey C B and Osborne M 2015 Technology at Work: The Future of Innovation and Employment – Citi GPS Report, February [Internet] Available from: https://www.oxfordmartin.ox.ac.uk/downloads/reports/Citi_GPS_Technology_Work.pdf

[19] World Economic Forum 2016 The Future of Jobs: Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution (Geneva: World Economic Forum)

[20] World Economic Forum 2018 The Future of Jobs Report 2018 (Geneva: World Economic Forum)

[21] World Economic Forum 2016 Human Capital Outlook Association of Southeast Asian Nations (ASEAN) (Geneva: World Economic Forum)

[22] Rahmat A M, Adnan A H M and Mohtar N M 2019 Industry 4.0 skillsets and ‘career readiness’: Can Malaysian university students face the future of work? Proc. of the
International Invention, Innovative & Creative (InIIC) Conference (series 2/2019) ed MNNF Network (Senawang: MNNF Network) pp 52-60

[23] Eberhard B, Podio M, Alonso A P, Radovica E, Avotina L, Peisenie L, Caamaño Sendon M, Gonzales Lozano A and Solé-Pla J 2017 Smart work: The transformation of the labour market due to the fourth industrial revolution (I4.0) International Journal of Business and Economic Sciences Applied Research 10(3) 47-66

[24] Kazeem Y 2017 More than half of the world’s population growth will be in Africa by 2050 [Internet] Available from: https://qz.com/1016790/more-than-half-of-the-worlds-population-growth-will-be-in-africa-by-2050/

[25] Adnan A H M, Ya Shak M S, Karim R A, Tahir M H M and Shah D S M 2020 360-degree videos, VR experiences and the application of Education 4.0 technologies in Malaysia for exposure and immersion Adv. Sci. Technol. Eng. Syst. Journal 5(1) 373-381

[26] Adnan A H M, Karim R A, Tahir M H M, Mustafa Kamal N N and Yusof A M 2019 Education 4.0 technologies, Industry 4.0 skills and the teaching of English in Malaysian tertiary education Arab World English Journal 10(4) 330-343

[27] Mohd Kamal M A, Adnan A H M, Mustafa Kamal N N, Ahmad M K and Yusof A A 2019 60 seconds ‘Video-based Learning’ to facilitate flipped classrooms and blended learning at a Malaysian university Proc. of the International Invention, Innovative & Creative (InIIC) Conference (series 1/2019) ed MNNF Network (Senawang: MNNF Network) pp 118-127

[28] Alexander B 2020 Academia Next: The Futures of Higher Education (Baltimore, MD: Johns Hopkins University Press)

[29] Cochrane T and Sissons H 2020 An introduction to immersive reality Pacific Journal of Technology Enhanced Learning 2(1) 6

[30] Bakcek O, Tastan S, Gokay P and Tastan B 2020 Comparison of PechaKucha and traditional PowerPoint presentations in nursing education: A randomized controlled study Nurse Education in Practice 42 102695

[31] Adnan A H M, Ahmad M K, Mohd Kamal M A, Mustafa Kamal N N, Yusof A M and Azamri N M 2019 Virtual reality immersion for ‘Education 4.0’ English education: ELSA 360°-Videos project – Phase 2 Leading Towards Creativity & Innovation (series 2) ed MNNF Publisher (Senawang: MNNF Publisher) pp 329-343

[32] Mustafa Kamal N N, Adnan A H M, Yusof A A, Ahmad M K and Mohd Kamal M A 2019 ‘Immersive Interactive Educational Experiences’ – Adopting Education 5.0, Industry 4.0 learning technologies for Malaysian universities Proc. of the International Invention, Innovative & Creative (InIIC) Conference (series 1/2019) ed MNNF Network (Senawang: MNNF Network) pp 190-196

[33] Al-Gindy A, Felix C, Ahmed A, Matoug A and Alkhidir M 2020 Virtual reality: Development of an integrated learning environment for education International Journal of Information and Education Technology 10(3) 171-175

[34] Kirsch B 2019 Virtual Reality Information Technology and Libraries 38(4) 4-5

[35] VeeR 2019 Introducing VeeR Experience: Create interactive VR experience in minutes [Internet] Available from: https://veer.tv/landing/experience

[36] Adnan A H M 2019 Education 4.0 technologies, Industry 4.0 skills and the critical roles of inventors, innovators and developers (Keynote Presentation) Proc. of the International Invention, Innovative & Creative (InIIC) Conference (series 2/2019) (Senawang: MNNF Network)

[37] Lee V W, Hodgson P, Chan C S, Fong A and Cheung S W 2020 Optimising the learning process with immersive virtual reality and non-immersive virtual reality in an educational environment International Journal of Mobile Learning and Organisatiion 14(1) 21-35

[38] Madden J, Pandita S, Schuldt J P, Kim B, Won, A S and Holmes N G 2020 Ready student one: Exploring the predictors of student learning in virtual reality. PloS one 15(3) p.e0229788

[39] Mohd K N, Adnan A H M, Yusof A A, Ahmad M K and Mohd Kamal M A 2019 Teaching Arabic language to Malaysian university students using education technologies based on
Education 4.0 principles Proc. of the International Invention, Innovative & Creative (InIIC) Conference (series 2/2019) ed MNNF Network (Senawang: MNNF Network) pp 38-51

[40] Choi D H, Dailey-Hebert A and Estes J S eds 2016 Emerging Tools and Applications of Virtual Reality in Education (Hershey, PA: Information Science Reference)

[41] Styliani S, Fotis L, Kostas K and Petros P 2009 Virtual museums, a survey and some issues for consideration Journal of Cultural Heritage 10 520-528

[42] O'Connor E A and Domingo J 2017 A practical guide, with theoretical underpinnings, for creating effective virtual reality learning environments Journal of Educational Technology Systems 45(3) 343-364

[43] Jung T, Tom Dieck M C, Lee H and Chung N 2020 Moderating role of long-term orientation on augmented reality adoption International Journal of Human–Computer Interaction 36(3) 239-250

[44] Chang Y S, Hu K J, Chiang C W and Lugmayr A 2020 Applying Mobile Augmented Reality (AR) to teach Interior Design students in layout plans: Evaluation of learning effectiveness based on the ARCS Model of learning motivation theory Sensors 20(1) 105

[45] Flores-Bascuñana M, Diago P D, Villena-Taranilla R and Yáñez D F 2020 On Augmented Reality for the learning of 3D-geometric contents: A preliminary exploratory study with 6th-grade primary students Education Sciences 10(1) 4

[46] Burton C and Scott C 2003 Museums: Challenges for the 21st century International Journal of Arts Management 5(2) 56-68

[47] López L L 2016 Virtual reality and augmented reality in education [Internet] Available from: https://elearningindustry.com/virtual-reality-augmented-reality-education

[48] Sargent K S, Jouriles E N, Chmielewski M and McDonald R 2020 Using virtual reality to create an observational assessment of adolescent resistance to antisocial peer pressure Journal of Clinical Child & Adolescent Psychology 49(2) 178-189

[49] Davis A, Linvill D L, Hodges L F, Da Costa A F and Lee A 2020 Virtual reality versus face-to-face practice: A study into situational apprehension and performance Communication Education 69(1) 70-84

[50] Silva A S 2006 From cyber to hybrid: Mobile technologies as interfaces of hybrid spaces Space and Culture 9(3) 261-278

[51] Manovich L 2006 The poetics of augmented space Visual Communication 5(2) 219-240

[52] Doucet A, Evers J, Guerra E, López N, Soskil M and Timmers K 2018 Teaching in the Fourth Industrial Revolution: Standing at the Precipice (Oxford: Routledge)

[53] Yusof A A, Adnan A H M, Mustafa Kamal N N, Mohd Kamal M A and Ahmad M K 2019 Education 4.0 immersive learning with spherical videos (360°) and virtual reality (VR) experiences Proc. of the International Invention, Innovative & Creative (InIIC) Conference (series 2/2019) ed MNNF Network (Senawang: MNNF Network) pp 52-60

[54] Áló D, Castillo A, Marín Vial P and Samaniego H 2020 Low-cost emerging technologies as a tool to support informal environmental education in children from vulnerable public schools of southern Chile International Journal of Science Education 42(4) 635-655

[55] 3DLabs 2019 Virtual Reality and Augmented Reality [Internet] Available from: http://www.3d-labs.co.uk/virtual-reality/

[56] Aniwaa 2019 The ultimate VR, AR, MR guide [Internet] Available from: https://www.aniwaa.com/guide/vr-ar/ultimate-vr-ar-mr-guide/

[57] Mohd Kamal M A, Adnan A H M, Azamri N M, Idris K B, Zuraimi N A and Yusof M N 2019 Video-based learning as an Education 4.0 technique for blended learning in flipped classrooms Proc. of the International Invention, Innovative & Creative (InIIC) Conference (series 2/2019) ed MNNF Network (Senawang: MNNF Network) pp 17-27

[58] Ahmad M K, Adnan A H M, Azamri N M, Idris K B, Norafand N N and Ishak N I 2019 Education 4.0 technologies for English language teaching and learning in the Malaysian context Proc. of the International Invention, Innovative & Creative (InIIC) Conference (series 2/2019) ed MNNF Network (Senawang: MNNF Network) pp 6-16
[59] Taskiran A 2018 The effect of augmented reality games on English as foreign language motivation *E-Learning and Digital Media* 16(2) 122-135

[60] Yılmaz Z A and Batdi V 2016 A meta-analytic and thematic comparative analysis of the integration of augmented reality applications into education *Eğitim ve Bilim* 41(188) 273–289

[61] Rüfenacht M 2017 Education 5.0 and why we need to adjust the education system [Internet] Available from: https://medium.com/@MattiaSuisse/education-5-0-why-i-think-we-need-to-adjust-the-education-system-4a669b26396d

[62] Kim J and Maloney E 2020 *Learning Innovation and the Future of Higher Education* (Baltimore, MD: Johns Hopkins University Press)

[63] Richardson J W, Lingat J E M, Hollis E and Pritchard M 2020 Shifting teaching and learning in online learning spaces: An investigation of a faculty online teaching and learning initiative *Online Learning* 24(1) 67-91

[64] Borneo Post 2019 UiTM Negeri Sembilan, UiTM Perak top winners *Borneo Post Online* 25 August [Internet] Available at: https://www.theborneopost.com/2019/08/25/uitm-negeri-sembilan-uitm-perak-top-winners/

[65] Che Lah F 2019 Inovasi siri video maya *Harian Metro ’Bestari’* 9 September [Internet] Available at: https://www.hmetro.com.my/bestari/2019/09/494766/inovasi-siri-video-maya

[66] The Star 2019 Teaching English goes future forward *Sunday Star ’Education’* 15 September [Internet] Available at: https://www.thestar.com.my/news/education/2019/09/15/teaching-english-goes-future-forward