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A Theoretical Framework of Secure Environment Of Virtual Reality Application in Tertiary TVET Education using Blockchain Technology

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Abstract

The Pandemic of Covid-19 has changed the landscape of many sectors including the education sector. Technical and Vocational Education Training (TVET) which is one of the critical drivers in the Eleventh Malaysian Plan is one of the affected educations sectors. Issues arise when the learning process as well as the assessment and management need to be online. Online security has been a main concern among the universities, lecturers, and the students. This paper aims to propose a secure theoretical framework of virtual reality application in tertiary TVET education by using Blockchain technology. Usage of VR can be seen as psychomotor acquisition devices that can offers efficient online distance learning experience. Measuring learning outcome will be done from the virtual reality simulator by using HMDs. By having online distance learning and everything will be put into the cloud and can be accessed by anyone. Blockchain technology can be seen as potential technology to increase security of the data that will be available in the cloud. Thus, the university's management of TVET education, students and lecturers will have a better learning experience without worrying about the security of online learning through virtual reality.

Keywords: Virtual reality, Blockchain, TVET education.

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Introduction

In March 2020, Prime Minister of Malaysia has announced movement control order (MCO) to reduce the infection of Covid-19 from spreading among citizens. Following the announcement of MCOs across the country, many sectors were ordered to comply with this ordinance, including the education sector. University and school are shut down during MCO, and online distance learning (ODL) is introduced. Effected by MCO, most of the tertiary TVET courses in Malaysia had to change the assessment method to suit the ODL. Laboratories session to deliver psychomotor domain in the subject is cancelled, due to MCO restriction for university to operate as usual.

Since MCO introduced, ODL has been widely used in Malaysia especially during the closure of the education institute. In-line with modern education method, virtual learning has been seen as a promising student-teacher interaction method. The teachers and lecturers used live streaming, video recording, video conference and interactive game method to deliver the cognitive domain of their respective subject. However, in tertiary TVET education, the psychomotor domain cannot be assessed using normal assessment because of numbers of reason concerning the MCO and new standard operating procedure to counter the Covid-19.

The nature of TVET education is required a lot of development in psychomotor domain, therefore there is a critical need to deliver psychomotor domain while respecting the new standard operating procedure in the post MCO. Application of virtual reality in education is something could be considered. Providing a virtual realistic experience, students can be developed necessary psychomotor using gamification [1]. Immersion and appearance are two central principles in virtual reality theory. While the terms are sometimes used interchangeably, immersion refers to the experience of using so-called immersive technology [1].

This technology works by substituting digitally generated sensory input, such as images and sounds, for sensory input from reality [2]. Virtual reality could include first-person perspective and a sense of presence, both of which are related to the unique experience of being in a virtual world, as well as several affordances related to the prospect of giving the learner access to phenomena not otherwise open to daily experience. Figure 1 shows the exploration on Wrench software for automotive maintenance simulation.

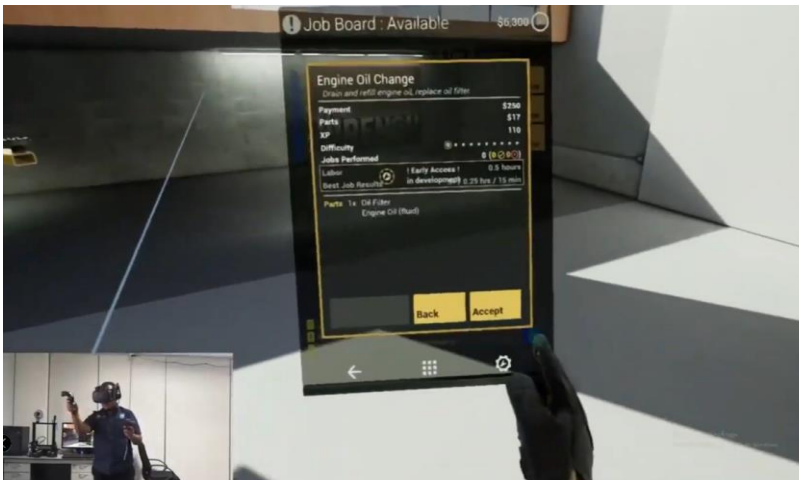

Figure 1: Exploration on Wrench software for automotive maintenance simulation.

However, a few issues need to be highlighted before deciding virtual reality is the best solution to include as part of ODL among tertiary TVET level. SWOT analysis towards the application of virtual reality is needed to show the overview of the risk and potential of this application. Beside the suitability of interaction between users and virtual reality, there is significant risk in ODL need to be considered.

According to [3], there is a lacking in trust when learning via online and potential of data leaking when using an online platform in virtual classes. Data breach will be the main concern among the students, lecturers and the management of the university [4]. Having ODL means everything will be online, including marks, assessment and personal data. Since the main priority in ODL is resources, quality, management and teaching interaction, a secure environment is needed to ensure everyone has a trust while using ODL. Thus, it is essential to provide psychomotor development among students using a realistic virtual experience in a secure environment.

This rest of the paper is organized as follows. Text section will discuss on the literature review of virtual reality in education, especially in TVET. Followed by measurement of learning outcomes and the feasibility of virtual reality in tertiary TVET education. Next, this paper will discuss on the Blockchain and the importance of Blockchain in virtual reality. The conclusion will be presented at the end of this paper.

Literature Review of Virtual Reality in Education

According to [5], virtual reality has become a viable technology due to computer miniaturization and increased computing speed. However, current technology still limited, and the difference of virtual and real environment is impossible to differentiate. However, the potential of virtual reality application in education and training has shown a potential. Ability to repeat the simulation over and over is a feature that unable to be replicated in real world application. This feature is a huge advantage over training in real environment. Current virtual reality using head mount displays (HDMs) to provide a view in spherical virtual environments supporting audio dimension that allows the immersion in the environment. Increasing technology developer introduce new HMDs set, the list of available HMDs set in the Malaysian market and price is listed in Table 1.

Table 1. List of available HMDs set in Malaysia.

Product Model	Information	Price (Malaysian Ringgit)
 HTC VIVE	Precise, 360-degree headset tracking, realistic graphics, directional audio, and HD haptic feedback deliver exciting action in the virtual world.	RM 5,000.00
 HTC VIVE PRO	Precise, 360-degree wireless headset tracking, realistic graphics, directional audio, and HD haptic feedback deliver exciting action in the virtual world.	RM 7000.00 (depends on variant)
 HTC VIVE Cosmos	VIVE Cosmos is the world's first VR system with a suite of versatile modular options.	RM 4000.00
 Oculus Rift S	Oculus Insight translates your movements into VR no matter which way user facing and provides room-scale tracking without external sensors.	RM 3725.00

 Oculus Quest 2	Requires wireless internet access and a Facebook account. Smartphone required to run the Oculus app (free download) to set up device	RM 1649.87 (depends on variant)

To use virtual reality as part of the psychomotor acquisition in tertiary TVET level, a simulator suitable to the course content is needed. Psychomotor skills are often practiced using a training simulator, in which the learner performs the actions being practiced before they are proficient. Some claim, however, that realism can only be used in a limited number of elements in training simulations since realistic representations of extremely complex environments may be confusing to the learner. For example, if a student required to use power tools, HMDs set cannot simulate the realistic perceives on haptic of power tools while in usage. However, several literatures show potential of psychomotor acquisition using HMD-based simulator.

In research conducted by [6], the researchers used an HMD-based simulator to assess learning transfer for a three-ball juggling simulator. Three of nine study participants were able to juggle with real balls after an average of 27 minutes on the very simplistic simulator. While this was a simple pre-post-test with no control group, it clearly demonstrated that psychomotor abilities gained in virtual reality can be transferred to real-life applications.

In another study by [7] the researcher setup participant a goal to classify targets (armed persons) in a simulated environment resembling an urban setting using a device developed for training a visual scanning technique. Subsequently, research in the most difficult scenario revealed that those who had practiced in more practical situations of greater visual difficulty were better at following the prescribed technique. It cannot be ruled out that the training made the research participants better at ‘playing' the simulation because they did not study skills move to a real-world visual scanning mission, but rather assessed success in the most realistic virtual simulation.

A similar study conducted by [8], the researchers discovered that while study participants wearing HMDs improved at a simulated assembly task, this progress did not translate to better results on a real-world assembly task. The researchers discovered that while study participants wearing HMDs improved at a simulated assembly task, this progress did not translate to better results on a real-world assembly task.

It can be concluded that the application of virtual reality using HMDs could deliver the necessary psychomotor required by the students. This hypothesis is proven in study conducted by [6]. However, [8] arguing the perceive level of psychomotor, thus it is not equivalent to the real-world task. This argument is supported also by finding by [7], as in the research conclusion, the participant only performs in the virtual reality simulation, which the researcher described as ‘playing’ rather than study the skills move necessary in real-world application.

According to [6] and [8] it was shown that training transfer is possible, and the accuracy and realism of a peripheral haptic/tactile system have a greater impact on effective psychomotor skills transfer than the HMD but more on the quality and realism of a peripheral haptic/tactile device [1].

However, in a discussion in a study by [1] researcher highlighted the weaknesses of using HMDs in psychomotor skills acquisition. As a result, the utility of HMDs in the development of psychomotor skills is severely restricted when the difficulty of the simulation needs to perform complex tasks. The existing technology provides high simulator fidelity in cases where the psychomotor ability is linked to head movement, such as visual scanning observational abilities. Other psychomotor skills that involve physical contact with apparatus and the environment in general would not be possible to acquire with HMDs until peripheral devices that incorporate the user's body movements into the simulation are greatly improved.

Therefore, there is still a potential of using virtual reality simulation to deliver psychomotor element in the TVET subject, but only as introductory module to the real-world application. This can provide a short-term solution if the facilities are shut down temporarily during pandemic as what happen during Covid-19 outbreak. The limitation of HMDs is generally highlighted as not able to perform complex tasks. Therefore, virtual reality simulation is suitable to reduce the face-to-face lab session on the early stages of the subject where less complex psychomotor domain is applied and minimal usage of complex apparatus suitable to the limitation of HMDs joystick. Application of virtual reality simulation can strengthen the basic skills needed towards the psychomotor needed.

Measuring Learning Outcomes

In [9], they have conducted a study to measure the effectiveness of virtual reality-based instruction with learning outcomes. In this study, the researcher found that if students were tested immediately or after a period of time, the efficacy of games was the same. This suggests that students who learn in games have a higher degree of retention than those who only learn for a brief period of time. Furthermore, consider evaluation techniques when creating a game-based environment where students' ability to apply a concept can be tested in a context other than the one in which they were taught, according to the researcher.

In a study conducted by [10] the author used focus group discussion to collect feedback from participants toward the experience within the virtual reality experience to measure the learning outcome. However, this method is not suitable to measure the performance of the student in the psychomotor domain.

Another similar study by [11] use knowledge quiz to measure the difference in understanding the knowledge compared to textbook teaching. This study shows that the participant using the VR can perform better on the task compared to textbook teaching. This method is suitable to measure the cognitive development of student after learning through psychomotor activities in VR. Therefore, there is an evaluation in form of quiz to measure if the student achieved the psychomotor domain related to the subject in study.

However, due to the nature of ODL, the assessment and marking need to be done online. Lecturers and students need to have access to the HMDs-based simulator via cloud platform such as Steam. There are numerous concerns regarding the safety and trust of data using cloud platform. Therefore, a secure network model is needed to ensure the data of both parties is secure.

Feasibility of Virtual Reality in Tertiary TVET Education

Much of the literature supports that virtual reality promises potential for the education sector including in tertiary TVET. To evaluate the usage of virtual reality in education, SWOT analysis could provide full awareness of all factors involved. Review from numbers of literature summarized below and can be seen in Figure 2:

- **Strength:** The new virtual reality head-mounted displays (HMDs), such as the HTC Vive and Oculus Rift, provide users with a high level of immersion. Immersion is described as a user's participation in a virtual environment during which his or her knowledge of time and the real world is often disconnected, resulting in a sense of "being" in the task environment. This term is described by [2] as ‘‘a perception of being physically present in a non-physical environment by surrounding the user of the VR system with pictures, sound, or other stimuli" so that the participant feels ‘‘there".
- **Weaknesses:** There is currently no systematic study on how researchers have used immersive VR for higher education purposes, which considers the use of both high-end and low-cost head-mounted displays (HMDs) [12]. According to [9], implementing desktop-based virtual reality training in schools and colleges entails not only monetary costs, but also efforts to educate teachers on how to effectively use them. As a result, instructional designers must make careful decisions when designing and developing instructional materials that make use of desktop-based virtual reality technologies.
- **Opportunities:** Virtual reality has been dubbed the 21st century's learning aid [13]. According to research, students who participate in virtual reality exercises retain more knowledge and are better able to apply what they have learned [14]. Given the potential for learning enhancement through VR use, it is easy to see why researchers, organizations, and educators are scrutinizing this technology so closely these days, hoping to add a new dimension to both teaching and learning in the classroom. In [1] provide an alternative viewpoint on the benefits of immersion and presence on learning outcomes.
- **Threats:** When talking about cloud computing and network infrastructure, the most common threat to be concerned is the data breach [4]. Putting everything online, including marks, assessment, student scores and activities will make the university's management to need extra effort to maintain the security. Three important aspects in a data privacy, integrity and trust issues are few essential security concerns of cloud computing.

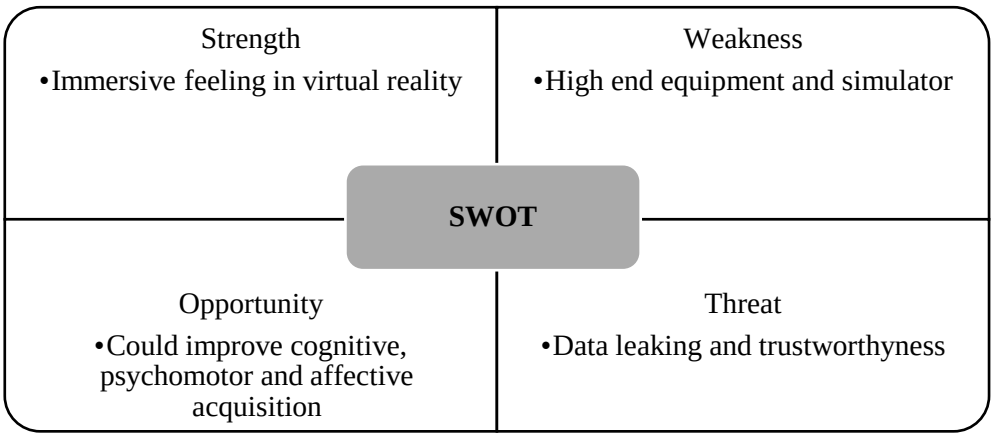

Figure 2. Review of SWOT analysis.

Blockchain

Blockchain is a ledger that consist of blocks that stores records of transactions, data and information that is immutable and cannot be changed or edited. Each block will contain a timestamp, transaction data, and the cryptographic hash of the previous block. By having the cryptographic hash, the integrity of the data can be secured and preserved because the changes only can be made when every node in the network gives their consent [15]. Each block will have a hash reference of the block before it and will establish a link between the blocks and create a chain of blocks which we called, a blockchain. Example of blocks can be seen in Figure 3.

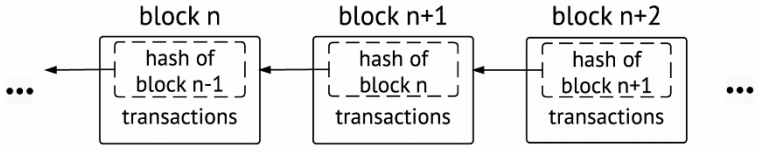

Figure 3. Chain of blocks.

Blockchain will support independent nodes to keep transactions on the distributed ledger to ensure that the data and information stored is transparent and accurate. It will cut intervention of third parties that can change the information without the permission and acknowledgement of other nodes in the network [16]. We say that the blockchain enables trustless networks, because the parties can do transaction even though they do not trust each other. The absence of a trusted intermediary means faster reconciliation between transacting parties.

Blockchain and Virtual Reality

Recently, a novel area of blockchain development focused on VR applications has grown rapidly. The used of VR in ODL will make the students to be fully immersed in a virtual environment and making sure they can participate during the learning session. By doing ODL, everything needs to be put online and in the cloud. Development of trustless education is essential, especially for the monitoring, assessment and management of the learning process. By having Blockchain, it can provide permanent, transparent and sustainable for students, lecturers and administration direct access.

In our digital age, it would make sense to have immediate access to credentials and a system that can provide real-time assessment with a secure environment. Figure 4 shows the relationship between university, students, lecturers and Blockchain.

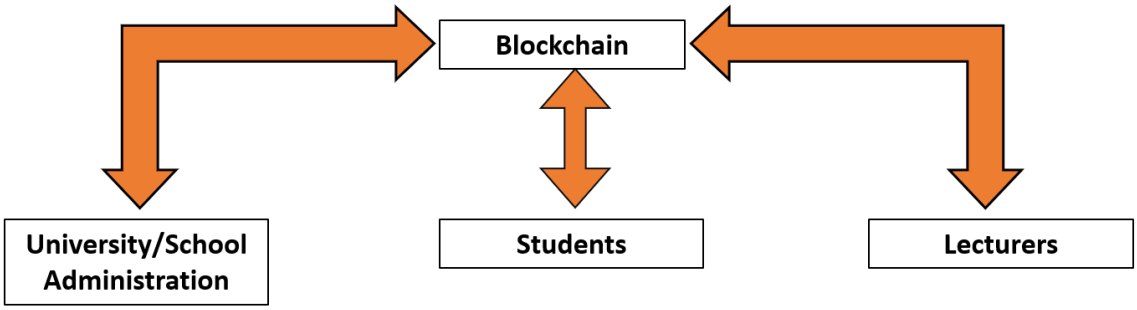

Figure 4. Relationship between Blockchain, University, students and teachers.

Blockchain is a distributed ledger that stores all transactions and data in the network without allowing them to be edited without permission. University administration that offers TVET courses will get to manage and monitor the ODL between student and lecturer without interference the process. Any updates on the marks and assessment are recorded and can be viewed real-time. University admin also manages to cut down costs and manpower in handling the system and the security during the online process.

A student on the other hand will get to access notes and classes through online. Marks and assessment will be given through online and students will not have to worry about the security parts of the system, because through Blockchain, it will create a trusted network for every party.

Conclusion

The tertiary TVET institute could benefit from the advancement of virtual reality technology. In time of crisis, the exploration of alternative methods in teaching and learning should be seek further. Even when the restriction and limitation need to be obliged, teaching and learning could be continuing and create more interactive an interesting for tertiary TVET students to keep their momentum in learning. Users' data in the virtual reality platform via cloud computing should be secure with the application of blockchain. This will increase the integrity of the assessment on learning outcome and prevent intervention from external entities. Moreover, the universities would also benefit in a way of cutting administrative costs and bureaucratic procedures while adding security to the maintenance of student records. Figure 5 shows the theoretical framework of applications of virtual reality for psychomotor acquisition in tertiary TVET.

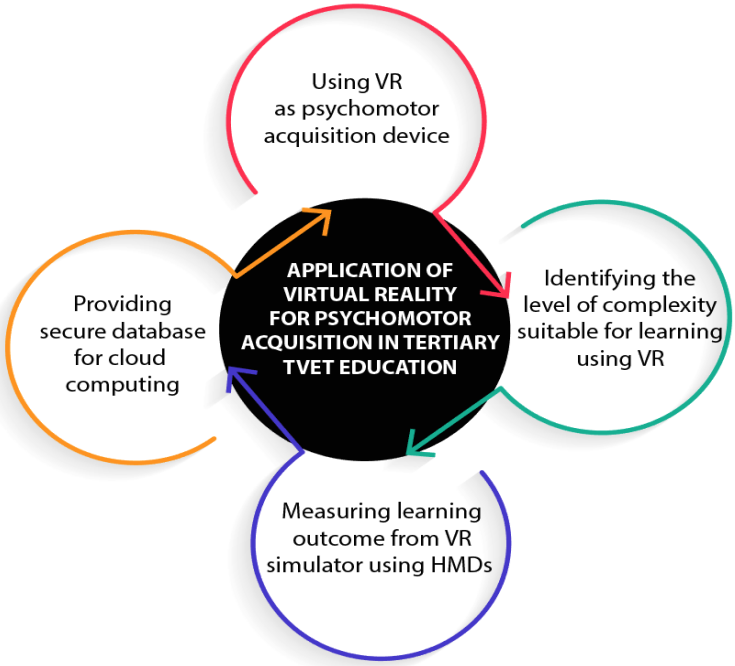

Figure 5. Theoretical framework of application of virtual reality for psychomotor acquisition in tertiary TVET

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