THE EFFECTIVENESS OF A VIRTUAL REALITY TECHNOLOGY IN TRAINING STUDENTS BY ASSESSING THE MOTIVATION, MOTOR PERFORMANCE SCORES, AND ACCEPTANCE

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by

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LIST OF ABBREVIATIONS

3 D	Three-Dimensional
ADDIE	Analysis, Design, Development, Implementation, Evaluation
AI	Artificial Intelligence
ANOVA	Analysis of Variance
AR	Augmented Reality
ASD	Autism Student Disorder
AU	Actual Use
BI	Behavioural Intention
CAI	Computer-Assisted Instruction
CDT	Curriculum Design Teaching
CG	Control Group
CITM	Centre for Instructional Technology & Multimedia
CP	Cerebral Palsy
DCD	Developmental Coordination Disorder
DS	Down Syndrome
EM	Extrinsic Motivation
HIIT	High-intensity interval training
HIFT	High-intensity functional training

HMD	Head-Mounted Device
HOTS	Higher Order Thinking Skills
ID	Instructional Design
IM	Intrinsic Motivation
IVFIT	Intelligent Virtual Fitness Trainer
KEGA	Key Economic Growth Activities
KMC	Kedah Matriculation College
MLT	Motor Learning Theory
MPS	Motor Performance Score
RMPS	Rubric Motor Performance Score
PE	Physical Exercises
PEOU	Perceived Ease of Use
PT	Physical Training
PU	Perceived Usefulness
PVR	Police Volunteer Reserve
RH	Research Hypothesis
RO	Research Objective
RQ	Research Question
RTM	Regression of mean
SDG	Sustainable Development Goals

SDT	Self-Determination Theory
SM	Sports Motivation
SMS	Sports Motivation Scale
SMS - II	Sports Motivation Scale - II
SPSS	Statistical Package for the Social Sciences
TA	Technology Acceptance
TAM	Technology Acceptance Model
T-test	Two groups are compared using a statistical test
TPACK	Technological Pedagogical Content Knowledge
TPB	Theory of Planned Behaviour
TPD	Teacher Professional Development
USM	University Sains Malaysia
UTAUT	Unified Theory of Acceptance and Use of Technology
VR	Virtual Reality
VRE	Virtual Reality Exercises
VFT	Virtual Fitness Trainer
VRT	Virtual Reality Trainer
WBBG	Wii Balance Bord Group
WHO	World Health Organization
WoS	Web of Science

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KEBERKESANAN TEKNOLOGI REALITI MAYA DALAM MELATIH PELAJAR DENGAN MENILAI MOTIVASI, SKOR PRESTASI MOTOR DAN PENERIMAAN

ABSTRAK

Terdapat ramai penyelidik telah membuat kajian tentang penggunaan teknologi VR dalam sukan. Kajian ini bertujuan untuk mengenal pasti keberkesanan teknologi VR dalam melatih pelajar, khususnya dalam senaman fizikal yang dikategorikan sebagai sukan rekreasi individu, dengan mengukur markah prestasi motor dan motivasi serta mengenal pasti penerimaan teknologi. Kajian ini menggunakan pendekatan kuantitatif dan kualitatif kaedah campuran untuk mencapai objektif kajian ini. Kumpulan pra dan pasca tunggal kuasi eksperimen digunakan untuk kaedah kuantitatif, manakala kaedah kualitatif menggunakan protokol temu bual. "*Rubric motor performance score*" (RMPS) digunakan untuk mengukur skor prestasi motor. Manakala *"sports motivational scale"* (SMS) digunakan untuk mengukur motivasi sukan pelajar, dan protokol temuduga *"technology acceptance model"* (TAM) digunakan untuk mengenal pasti penerimaan teknologi. Kajian ini terdiri daripada dua mod iaitu Mod A (latihan fizikal menggunakan kaedah tradisional) dan Mod B (latihan fizikal menggunakan latihan realiti maya (VRE)). Gabungan reka bentuk model ADDIE dan *"12 Mayer's Principles of Multimedia"* digunakan untuk membina aplikasi ini. Dapatan kajian ini menunjukkan perbezaan yang signifikan dalam menggunakan VRE bagi kedua-dua pembolehubah, skor prestasi motor dan motivasi, berbanding kaedah tradisional. Hasil temu bual menunjukkan bahawa VRE berguna untuk latihan fizikal, mudah dilaksanakan dalam latihan fizikal, persepsi positif yang diperoleh daripada pelajar seperti minat, keseronokan, dan keselesaan, dan kesan

negatif penggunaan VRE. Hasil keseluruhan yang diperolehi daripada kajian ini mendapati bahawa menggunakan teknologi VR meningkatkan prestasi motor pelajar. Ia juga telah meningkatkan motivasi untuk bersenam dan telah diterima oleh pelajar untuk teknologi VR digunakan dalam aktiviti fizikal, rekreasi, atau dalam kurikulum pendidikan.

THE EFFECTIVENESS OF A VIRTUAL REALITY TECHNOLOGY IN TRAINING STUDENTS BY ASSESSING THE MOTIVATION, MOTOR PERFORMANCE SCORES, AND ACCEPTANCE

ABSTRACT

Many scholars have been sparked to investigate the use of VR technology in sports. This study aims to identify the effectiveness of VR technology in training students, specifically in physical exercise categorized as individual recreational sports, by measuring the motor performance scores and motivation and determining the acceptance of technology. This study uses mixed-method quantitative and qualitative approaches to achieve these research objectives. A quasi-experimental pre and post-single group are used for the quantitative method, while the qualitative method uses an interview protocol. The rubric motor performance scores (RMPS) are used to measure the motor performance scores. Meanwhile, the sports motivational scale (SMS) measures students' sports motivation, and the technology acceptance model (TAM) interview protocol is used to identify technology acceptance. This study consists of one independent variable which is learning mode that has two modes which are Mode A (physical exercise using the conventional method) and Mode B (physical exercise using virtual reality exercises (VRE)). The combination of the ADDIE model design and four of 12 Mayer's Principles of Multimedia is used to construct this application. This study's findings showed a significant difference in using the VRE for both variables, motor performance scores, and motivation, compared to the conventional method. The interviews showed that the VRE is helpful for physical activity, easy to use, and has both positive and negative effects on students' interest, fun, and comfort. The overall outcome derived from this study discovered that using

VR technology increased students' motor performance. It has also increased the motivation to exercise and has been accepted by the students for VR technology to be implemented for physical activity, recreation, or in the educational curriculum

CHAPTER 1

INTRODUCTION

1.1   Overview

The University of Putra Malaysia and the University of Baghdad collaborated on a study that found that more boys were underweight and overweight than girls, with 14.8% versus 12.4% and 28.8% versus 19.4%, respectively, for underweight and overweight (Aboshkair, 2012). It is estimated that Malaysia has the highest rate of obesity and overweight in Asia, according to the World Health Organization (WHO, 2019). Specifically, 64% of men and 65% of women are represented on the committee. Those with these conditions in their body are at an increased risk of heart attack, musculoskeletal disorder, and some cancers (WHO, 2021). According to the statement above, the author discusses a health issue affecting Malaysian youths. As a result of these occurrences, many people are interested in exercise and weight loss. This phenomenon has been the subject of many studies, all of which have sought to assist people in maintaining a healthy weight and level of physical activity throughout their lives. It incorporates health education lessons into the curriculum through the use of technology. Thus, Virtual Reality technology can be one of the new interventions in attracting people to exercise. Since this technology is the most widely used fitness technology in the world right now (Mokmin & Jamiat, 2021). Over the last few years, virtual reality (VR) technologies supplementing people's conventional physical activity have emerged as a new trend.

1.2 Background of the Study

Based on the statistical report by WHO (2019) stated that the obesity and overweight rank in Asia, specifically Malaysia showed the highest rank among the countries. There were many factors of obesity and overweight in the community. The studies by

Ishida (2020) and Worku (2021) claimed that one of the factors of obesity was a lack of exercise. The increases in obesity in the community need to be prevented before getting worst. The studies by Blüher (2019) and Kivimäki (2018) started to prevent obesity by targeting the individual level. Even though recent studies by Kotsis (2018) and Weihrauch-Blüher (2019) already discussed the early prevention started from childhood, Barkley (2020) and Browning (2021) claimed that there was still a lack of awareness and fitness among adults, specifically for tertiary students.

Besides that, injuries were one of the issues in physical exercises. A recent study by Memon (2018) claimed that sports injuries were reported by 127 out of 403 students. The most commonly injuries reported by these students were overuse injuries due to overtraining which might lead to cramps and sprains. Hence, the impact of injuries in sports reduced motor performance (Burcal, Needle, Custer, & Rosen, 2019). Furthermore, another popular issue in conventional physical exercise was the variability of motor learning. Many studies, such as Pesce (2019) and Srinivasan & Mathiassen (2012), discover motor variability. This motor variability refers to an intrinsic and advantageous characteristic of adaptive motor behaviour, and is ascribed a functional purpose that can be leveraged through a discovery-based approach to motor learning (Pesce, 2019). It is also can be influenced by several factors, including fatigue, stress, and changes in the environment. However, this study wanted to investigate how the environmental can give an effective motor performance during the exercises for the motor variability in physical exercise since the study by Kuok Ho (2021) claimed that the environment affects athletic performance.

In addition, the issues that happened among the tertiary students in physical exercises included motivation, interest, and concentration levels. This statement was supported by several research findings such as Dong (2021), H. Li (2021) and Y. S.

Wang (2017). These researchers stated that students had d a lower concentration, motivation, and interest level when involved in the conventional exercise method. Furthermore, the previous study by Feito (2018) and Sahar (2018) claimed that three factors affect motivation: autonomy, competence, and relatedness. Autonomy is the degree to which an athlete feels that they have a say in their sport, such as choosing their training schedule, setting their own goals, and having input into their team's strategy. The lack of autonomy triggered negative emotions among people (Leisterer & Jekauc, 2019). Meanwhile, competence refers to the belief that one can effectively perform a task or achieve a goal. The lower perceived competence would be less likely to enjoy the exercises (Shen, 2018). Relatedness refers to the degree to which athletes feel that they are part of a team and have positive social interactions with others in their sport. The lack of relatedness affects the activeness of the students Gil-Arias (2017).

Revolving around the issues above, the use of technology was again necessary for helping people to maintain their health. Technologies nowadays play an important role as a centre for every field, such as education, health, engineering, and social sciences (Aleksandrova, 2019; Budd, 2020; Maraza-Quispe, 2019). However, even though the technologies were used in sports, it is still many things to discover (Düking, 2018). Virtual reality (VR) technology is one of the new field and utilization technology in sports that can enhance learning and training methodologies (Checa & Bustillo, 2020).

Virtual reality (VR) is an interaction between humans and machines using a three-dimensional (3D) environment (Maples-Keller, Bunnell, Kim, & Rothbaum, 2017). According to Brookes (2018), VR is a powerful tool for human behavior since it combines auditory and visual stimuli in a 3D environment. VR also enables users to

experience a fully immersive 3D environment (Yoon, Kim, Park, & Heo, 2020). Research by Rutkowski (2019) claims that VR is based on the use of computer programs to record movement patterns using a three-dimensional (3D) camera or sensors worn on the body during exercise. In addition, Farley (2020) stated that with virtual reality, the fundamental conditions of sports have significantly improved, allowing for the effective exchange of sports information and the complete satisfaction of the users' actual needs when pursuing sports knowledge. However, according to Han (2021), the implementation of VR technology in physical exercises is still in its infancy.

The use of VR technology can overcome the issues stated in the previous paragraphs. According to the study by Reif (2021), the increased physical education (PE) lessons were expected to increase the movement time in daily school life. Students can improve their motor performance using virtual reality exercises (VRE). Following D. Li (2021) conclusions, virtual reality can improve students' movement and motor skills. The use of virtual reality (VR) also helps to enhance sensorimotor skills and eliminates contact by using controlled visuals and mimicking them instead. Removing these factors during practice reduces the potential for injury before the sports competition (Farley, 2020). According to the findings above, motor skill performance had been discussed in relation to physical education in schools rather than physical exercises. As per Annie Simoneaux (2020) assertion, physical exercises are deliberate, structured, and repetitive movements that necessitate energy expenditure. According to Pangrazi (2019), the provision of physical education is crucial in equipping students with the requisite competencies, information, and dispositions that are vital for maintaining an active, healthy, and productive lifestyle.

The findings by Sáez (2021) claimed that motivation is a critical variable in physical activity. Besides that, Harris (2020) stated that there is an improvement in motor skills when the user experiences VR. Accepting the use of VR is also related to the student's motivation to do the exercises. According to the study by Nur (2019), only 63.64 % of students are motivated, indicating the need for innovative approaches to teaching and learning. Many studies have discovered that infusing technology to increase motivation is effective. Several of the previous studies, like the work of Zamzami (2020) and Lee (2019), claim that there is an improvement in the users' motivation when using VR in sports games like basketball and badminton, but not in terms of physical exercises. However, an excellent instructional framework design must be developed to prove that there is an improvement in motivation for physical exercise by infusing technology regarding VR.

1.3 Problem Statement

Physical activity or fitness is one of the most important aspects of human life. Furthermore, fitness training has been developed and taught to every individual since elementary school. This is due to the importance of physical activity in the development of young people to help them maintain a healthy lifestyle (Sáez, 2021). A sedentary lifestyle will lead to a host of health issues. As a result, fitness exercises have been implemented to keep students healthy.

However, in terms of motor performance, the issues that always happen during physical exercises are injuries and lack of motor variability, and both of these issues lead to the retardation of motor performance (Burcal, 2019; Pesce, 2019). Moreover, if the athletes get injuries caused by force applied to the body, it interfered with the continuity and mobility to exercise (Franklin Square, 2021). Besides that, environmental changes and fatigue during physical exercise also affected performance

(Kuok Ho, 2021). Nevertheless, the infusion of VR technology reduced injuries in conventional exercise (Farley, 2020). Farley (2020) also claimed that virtual reality (VR) improves sensorimotor skills and eliminates contact by using controlled visuals and mimicking them instead. Hence, the VRE application was designed to optimize the motor performance due to the issues that occurred by creating the actual appearance of the indoor and outdoor environment inside the VRE and optimizing the mobility to minimize injuries for better motor performance.

Furthermore, challenges have arisen with individuals opting for traditional exercise modalities, including diminished motivation and sustained interest in physical activity, as noted by Meyns (2018) and Bruun-Pedersen, Serafin, & Kofoed (2016). The lack of motivation that consists of autonomy, competence, and relatedness down the efficacy of exercise (F. Wang, 2022). Nevertheless, the previous study by H. Y. Lee (2019), Nur (2019), and Zamzami (2020) claimed that the use of VR technology increased the motivation level among students in their field of study. Hence, by applying the SDT in this Virtual Reality Exercise (VRE) designed specifically for individual recreational sports, this study wanted to measure the effectiveness of VRE by assessing the students' motivation.

Many studies show the importance of integrating technology into physical exercises to overcome the issues, as stated in the paragraphs above. Fitness mobile applications were the common technology used for helping people maintain their health. Despite the availability of many health and fitness applications on the market, the diversity of these programs, particularly those that use virtual trainer technology, remains restricted (Mokmin, 2020). The research by Han (2021) claimed that less than half of the current computer-based virtual training systems are determined to be

effective. However, the use of virtual reality technology in this area is still beginning and still has many things to rectify.

Thus, this study aims to determine whether virtual reality exercises (VRE) can be used to train students by focusing on their motivation, motor performance, and acceptance. In the meantime, to overcome the motivation issues, Self-Determination Theory was applied because it consists of three universal basic needs of humans, which were autonomy, competence, and relatedness (Maulana, Helms-Lorenz, Irnidayanti, & van de Grift, 2016). In addition, since Motor Learning Theory (MLT) was significantly related to motivation in terms of self-esteem, sports efficacy, and motion movement, as stated by Abbas & North (2018) it was applied in this study for motor performance. Consequently, this study will determine the substantial difference in motor performance for physical exercise when using VR compared to the conventional method. Moreover, the Technology Acceptance Model (TAM) by Davis (1989) was used for the acceptance of VR technology for physical exercise, specifically among students.

1.4. Purpose of the Study

1.4.1 Research Objectives

General:

To investigate the effectiveness of VRE when training students by focusing on motivation, motor performance scores, and acceptance, specifically for physical exercises.

Specific:

(i) To measure the effectiveness of the VRE by assessing the students' motor performance scores in physical exercises.

(ii)   To measure the effectiveness of the VRE by assessing the students' motivation in physical exercises.

(iii)   To identify the level of students' acceptance of this application when they experience it.

1.4.2   Research Question

RQ1: Is there any significant difference in terms of the students' motor performance scores when engaged in physical exercise between the conventional method and using the VRE?

RQ2: Is there any significant difference in terms of the student's level of motivation in relation to physical exercises between the conventional method and using the VRE?

RQ3: What is the student's acceptability of doing exercises using the VRE?

1.5   Theoretical Framework

Many researchers from instructional design education, technology, and sports education have explored the essential variables when developing immersive technologies in the education field. However, in this study, several theories were used to determine the effectiveness of the VRE. Four of Mayer's 12 Principles were included.

Before engaging in physical activity, the Pre-Training Principle ensures that students know the names and characteristics of the major concepts. Following the Segmenting Principle, the VRE is segmented into indoor and outdoor environments and sections for each exercise. The Multimedia Principle is selected due to the presence of multimedia elements that enhance student learning text and images (Mayer, 2011). In addition Ou, Joyner, & Goel (2019) stated that, the strategic utilization of multimedia principle involves the incorporation of visuals, such as

graphics, charts, or animation. According to the Image Principle, the efficacy of learning through a talking head video is not necessarily superior for humans (Mayer, 2011). The utilization of talking head videos is a prevalent practise in the realm of eLearning courses and Massive Open Online Courses (MOOCs) (DeBell, 2019). DeBell (2019) asserts that the fundamental concept is that when substantial information is to be obtained, relevant visuals presented on the screen are more effective than showcasing an instructor's speaking face. The study also cites prior research indicating that segmented learning outperforms pretraining for students with a high level of prior knowledge, as stated by Huang (2018), and that the use of virtual reality in group contexts can increase student motivation compared to traditional methods (Parong & Mayer, 2018).

The activities in VRE used the Motor Learning Theory (MLT) by Croce & DePaepe (1989), who claimed MLT emphasizes that abilities are gained through specific procedures and perfected by extensive practice and skill transfer to new activities. For example, the exercise in VRE included fitness, strength, speed, and balance. So, the students transferred different skills when they moved to another section until the exercise finished. As there were 3D characters that act as a guide for the students to do the exercises, it had a useful impact on the movement of the body since it is already manipulated by the environment (Raiola & Di Tore, 2017). Thus, it increases autonomy as motor learning increases since both are related (Wim Westera, 2019).

In other situations, the original Self-Determination Theory (SDT) by Deci & Ryan (1985) was used to measure the student's motivation level, including the three elements of intrinsic, extrinsic, and motivation, when they used the VRE for physical exercises. Besides that, Technology Acceptance (TAM) by Davis (1989) was used to identify the

students' acceptance level towards the VRE when infusing all the theories mentioned above. TAM consists of perceived ease of use (PEOU) and perceived usefulness (PU). The use of TAM in this study to identify how it was relevant to be used in training students.

Hence, these theories were used in this study to guide the design of VRE by assessing motor performance, motivation, and acceptance specifically for immersive physical exercise.

Figure 1. 1
Theoretical Framework for Virtual Reality Exercise in Physical Exercises
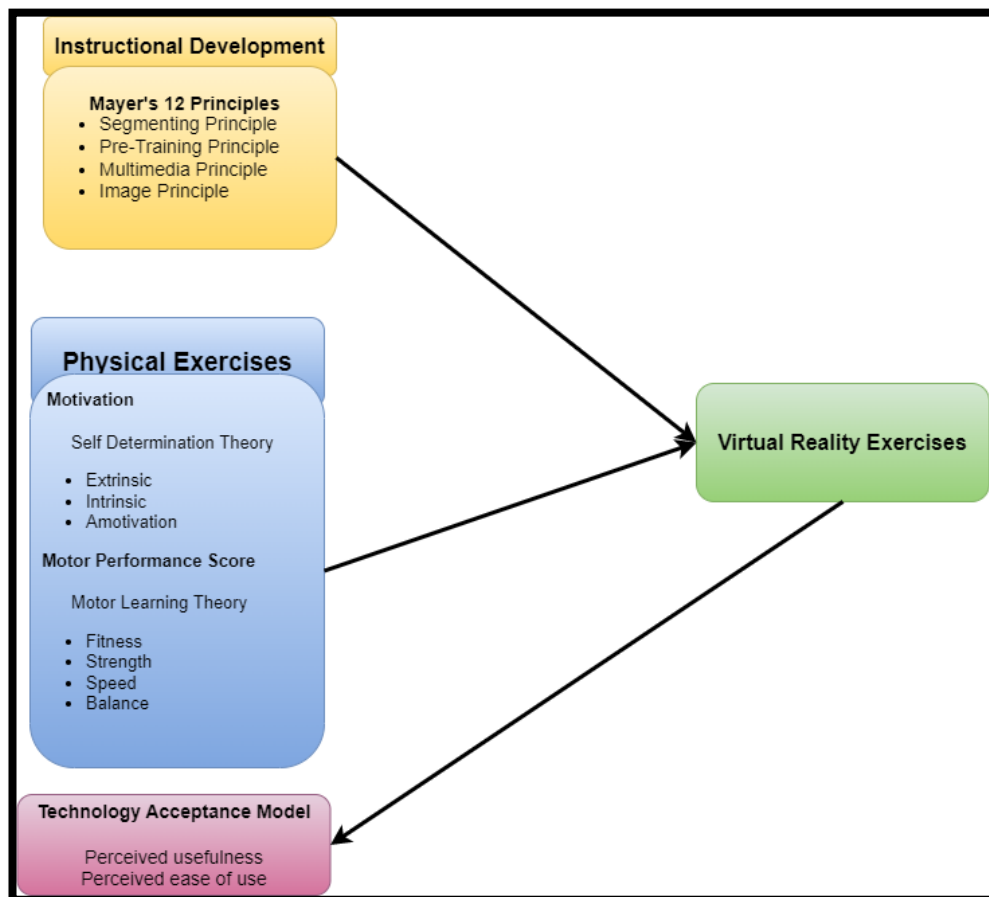
1.6   Conceptual Framework

This study consists of one independent variable and three dependent variables. The novelty of this study was the VRE in physical exercise, specifically for individual

recreational sports. Since VR technology is the interaction of human-machine in the 3D immersive environment, as stated by Sandoval-Henríquez & Badilla-Quintana (2021) and Xioran & Yu (2019), this study used learning mode as the independent variable where it consisted of two groups which were Mode A (physical exercise without using VRE) and Mode B (physical exercise by using VRE). The term "learning mode" was suitable to use for the VR study as the independent variable (Smith, 2021).

The learning mode has manipulated the measurement of motivation and motor performance. In addition, from the learning mode, this study came out with two hypotheses that were related to two dependent variables, (i) motivation and (ii) motor performance. In order to test the hypothesis, the levels of intrinsic, extrinsic, and amotivation were assessed as indicators of the students' motivation. Concurrently, the motor performance scores, which were indicative of speed, fitness, strength, and balance, were assessed to validate the hypothesis.

After the students experienced the VRE, they were then randomly selected to answer the interview to identify their level of acceptance towards VRE. Acceptance was also the third dependent variable in this study. TAM by Davis (1989) was used to identify the perceived usefulness and perceived ease of use among the students towards VRE. The third dependent variable, which used the qualitative method, supported the other two dependent variables, which were used quantitatively to strengthen the findings evidence for this research as supported by Guetterman & Fetters(2018).

Figure 1. 2
The conceptual framework for measuring the instruments.
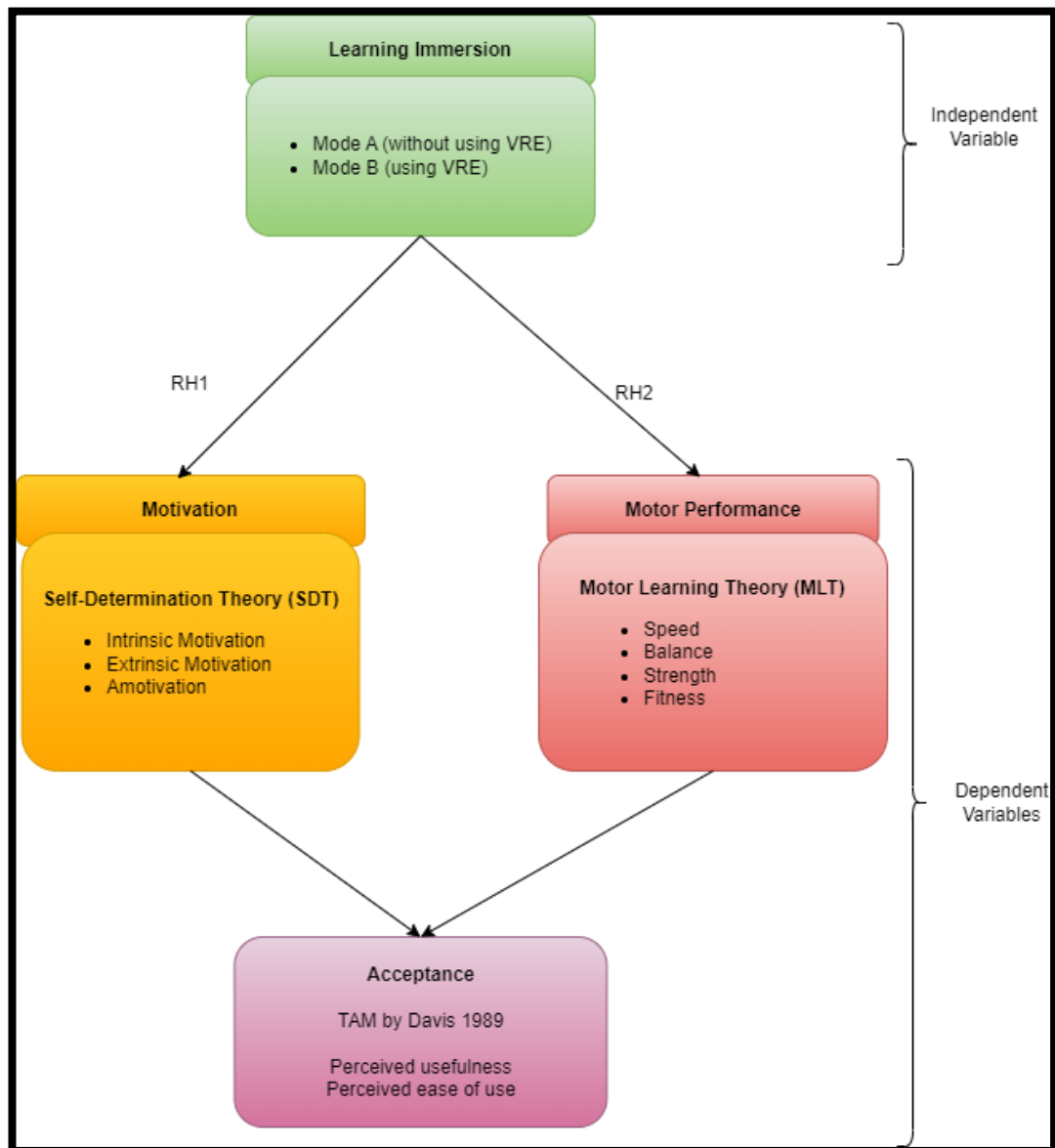
1.7   Research Hypothesis

H_1: There is a significant difference in the motor performance scores for physical exercises between the group presented with Mode A and Mode B.

H_2: There is a significant difference in the motivation scores for physical exercises between the group presented with Mode A and Mode B.

1.8   Significance of the Study

This research helped KEGA 2 (Digital Economy) and KEGA 3 (Industrial Revolution 4.0) with their respective focus on the Key Economic Growth Activities (KEGA). According to the Ministry of Economic Affairs (2019), by focusing on KEGA 2, Malaysia will formulate a direction to become a country with ownership, manufacturing, innovation, funding support, intellectual property, and more in-depth research in the field of technology. Besides that, the activities of big data, artificial intelligence, augmented reality (AR), virtual reality (VR), and machine learning have been included in the Fourth Industrial Revolution (4IR). Malaysia must seize the opportunity presented by IR 4.0. The government will facilitate the development of producers, inventors, suppliers, and service providers in the ASEAN market for this industry.

Sustainable Development Goals (SDG), specifically Indicator Goal 3, can be achieved with the help of this outcome. According to the Malaysia Sustainable Development Goals (2022), the SDG 3 target of ensuring that everyone has access to good health and well-being has seen some positive progress, but the mortality rates for heart disease, cancer, and diabetes have remained unchanged in recent years. From the report above, this study promoted early prevention by integrating technology into physical exercises.

Aside from that, the outcomes of this study were utilized to demonstrate the efficacy of using virtual reality technology in physical exercises. It can also serve as a guideline for developers to better develop an algorithm to make virtual reality technology more flexible and relevant to physical exercises while maintaining its relevance in the long term.

Last but not least, the findings of this research can be used as a reference for other researchers who may like to continue in the same field in the future.

1.9 Limitations of the Study

This study is the same as any research in that it contains limitations. These are listed below:

1. The experiment was conducted with participants that already physically fit and have no health problems.

2. The study is limited to tertiary students already on campus to facilitate data collection.

3. After consulting with an expert, the researchers decided to focus on the undergraduate and postgraduate students, which must be done in CITM, USM. This is because the experimental devices were limited and could not be taken arbitrarily.

4. The findings were based solely on student impressions, and the instructors' perspectives were not considered. Learning about this from both perspectives was essential because they were supposed to operate together during teaching and learning.

1.10 Operational Definition

1.10.1 Virtual Reality

Virtual reality is a technology interface that lets consumers experience computer-generated surroundings in a controlled context (Maples-Keller, 2017). Additionally, VR technology is useful in human behaviour studies (Brookes, 2018). Audio, visual, 3D, and animation are used in virtual reality (Xioran & Yu, 2019). This study aims to improve the VRE to help people maintain their health by incorporating

physical exercise activities. Han (2021) found that VR's use in physical exercise is still in its infancy. During development, the VRE was combined with 12 Mayer's Principles of Multimedia and the ADDIE instructional design to build an interactive and successful programme for tertiary students to maintain their health through immersive physical workouts.

1.10.2 Virtual Reality Exercises

Virtual reality exercises (VRE) are a novel approach that integrates VR technology into individual recreational sports, aimed at helping tertiary students maintain their health. The use of VR technology in education and sports has shown potential to enhance motivation and increase motor performance. However, the research on using physical exercises in this context is still in its early stages. This study measured the effectiveness of VRE by tracking users' motivation, motor performance scores and acceptance. The VRE included four exercises (zig-zag running, jumping jacks, jumping rope, and obstacle jumping) in indoor and outdoor modes, guided by a 3D character. The study used Oculus HMD to display the VRE and focused on individual participants, particularly tertiary students, using a single pre-post design approach. By incorporating multimedia principles and instructional design, the study aims to develop an interactive and effective application for tertiary students to engage in immersive physical exercises for maintaining their health.

1.10.3 Motor Performance

The study focused on the importance of a person's ability to move freely for their overall health and fitness. Motor-performance fitness, which involves specific motor tasks, was used as a measure of an individual's fitness level. Motor Learning Theory (MLT) was employed to improve motor performance, emphasizing skill acquisition, practice, and skill transfer to new tasks. The study specifically focused on

motion movement related to fitness, speed, strength, and balance. Motor performance scores were used as the variable in the study, and an intervention study mode was utilized to assess the subjects' motor abilities. The students were required to perform exercises such as zig-zag running, jumping rope, and doing star jumps over obstacles. The research team measured the students' motor performance scores using the Rubric Motor Performance Score (RMPS) and evaluated the interaction between the movement and Virtual Reality Exercises (VRE) using a rubric score sheet. The results obtained for this variable provided insights in addressing the research question (RQ1).

1.10.4 Motivation

Motivation plays a crucial role in physical exercise, as it greatly influences its success (Sáez, 2021). The Self-Determination Theory (SDT) developed by Deci & Ryan (1985) has been used as a guideline in overcoming motivation issues in physical activity. SDT consists of three main components: intrinsic motivation, extrinsic motivation, and amotivation. To assess the effectiveness of Virtual Reality Exercises (VRE) in motivating students, this study examined the level and nature of motivation. The dependent variable was motivation, which was measured using the Sports Motivation Scale (SMS) adopted from Pelletier (1995). The SMS questionnaire included 28 items that reflected the intrinsic, extrinsic, and motivational factors of SDT. The results obtained for these variables provided insights in addressing the research question (RQ2).

1.10.5 Technology Acceptance

Technology acceptance is a critical aspect when introducing new technology to users. The Technology Acceptance Model (TAM) proposed by Davis (1989) is a widely used framework for assessing technology acceptance. However, the Unified Theory of Acceptance and Use of Technology (UTAUT) model developed by

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Venkatesh (2003) has also gained recognition. Various variables can influence the effectiveness of teaching and learning, as noted by Ching & Roberts (2020). In this study, TAM was employed to examine the interaction of these variables. Specifically, perceived ease of use (EOU) and perceived usefulness (PU) were measured to assess the students' acceptance of Virtual Reality (VR) technology. Thematic analysis, as outlined by Braun & Clarke (2006), was utilized to analyze the data. The results obtained in this study provided insights in addressing the research question (RQ3).

CHAPTER 2

LITERATURE REVIEW

2.1   Introduction

This study's literature review will focus on the application of virtual reality in physical exercises. It is a survey of academic materials on a subject, known as a literature review. This includes VR technology, the issues found in physical exercises, motivation in physical exercises, motor learning theory, motor performance, technology acceptance model, and the instructional design that is a part of VR development. In addition, the empirical studies include the authors' names, the title, the study focus, the variables utilized, the sample population, and the findings listed systematically to identify the gaps in the prior studies that were reviewed in the final portion of this chapter.

2.2   Virtual Reality Technology

Technologies have evolved into being close companions of humans, helping them complete tasks in their daily lives. Virtual reality is a simulation of real environment-generated computer software (Calabrò, 2017). Virtual reality is human-computer interaction in a 3D environment (M. T. Y. Lin, 2017). Virtual reality is one of the immersive technologies that Ip (2018) used to immerse users in a computer-generated controlled environment (Maples-Keller, 2017). As the VR application offers a powerful tool for human behavior, as Brookes (2018) stated, it has become the most well-known technology in the last few years (Mokmin & Jamiat, 2021).

VR technology must have an output device so the users can see and feel the 3D environment in the VR content. To allow people to immerse themselves in the environment of this immersive technology fully, a head-mounted display (HMD) is one of the best among the common visual output devices such as screens, projectors,

and holographs that, according to H. Zhang (2017), enable a stereoscopic view (Ip, 2018). H. Zhang (2017) also claims that there have been several HMDs announced in the last few years, such as the Oculus Quest, the Oculus Rift, and HTC Vive. According to Checa & Bustillo (2020), HTC Vive HMDs were more suitable for training due to their better explorative interaction capabilities than the Oculus. This is supported by O'Connor (2021). They used HTC Vive Pro as the HMD for training students to X-ray the patients in VR. However, since this study was aimed to be used for physical exercises rather than physical education, Oculus Quest was used as the output device because it is suitable for physical activities that use a lot of motor skill performance (Campo-Prieto, 2022). Thus, Oculus Quest HMDs were more highly recommended to be used in this study to identify and measure the VRE's effectiveness in relation to physical exercise.

Several areas have begun to explore the use of VR, including health, sports, history, and education, as supported by (Bremner, Gibbs, & Mitchell, 2020; Farley, 2020). Modern VR technology is becoming increasingly popular, particularly in the sporting industry (Farley, 2020). Sports training can no longer be constrained by physical space (D. Li, 2021). Due to VR's 3I features (immersive, interactive, and imaginative effects), sports performance training for students can be improved by increasing the intensity of physical activity (Qingtao, 2020). Even though the uses of VR are increasingly popular in sports, according to Han (2021), it is still in its infancy when it comes to physical exercise. In addition, to support the findings of Han (2021), a systematic study has been applied in Table 2.1:

Table 2. 1
The uses of Virtual Reality

No.	Authors	Title	Focus
1	Wang (2017)	Effects of applying virtual reality to athletic adventure education on students' self-efficacy and team cohesiveness	Applying virtual reality to adventure education to improve the athletic students' sense of self-efficacy and teamwork.
2	Kiefer (2017)	Virtual Reality As A Training Tool To Treat Physical Inactivity In Children	Identifying the potential of VR to prevent and treat student inactivity.
3	Mousavi (2018)	The Effect of Virtual Reality Training on Learning and Kinematics Characteristics of Dart Throwing	Dart-throwing performance and kinematics will be studied due to using virtual reality.
4	H. Y. Lee (2019)	Research on Virtual Reality-Based Badminton Teaching in Physical Education Courses	Focusing on how virtual reality can be used in physical education to help teach badminton better.
5	Zamzami (2020)	The Effectiveness of Using Virtual Reality Technology on Learning	Concentrating on the usefulness of virtual reality

		the Jump-Shot Skill in Basketball	in developing the jump-shot technique in basketball
6	C. Li (2020)	Feasibility Analysis of VR Technology in Physical Education and Sports Training	Concentrate on the comparative examination of training intensity, interest, the application effect of virtual reality equipment, and the degree of preference
7	Szary (2020)	What Virtual Reality Can Do For Sport? A Narrative Review Of The Literature	Determine how virtual reality can be used in the training of professional athletes.
8	D. Li (2021)	Research on College Physical Education and Sports Training Based on Virtual Reality Technology.	Focusing on the use of VR technology in sports training and physical education among college students.
9	H. Li (2021)	Research on Basketball Sports Training Based on Virtual Reality Technology	Demonstrating the concept of virtual reality and the importance of simulation technologies.

10	H. S. Lee (2021)	The Effect of Elementary School Soccer Instruction Using Virtual Reality Technologies on Students' Attitudes toward Physical Education and Flow in Class	Testing the impact of virtual reality on the students' attitudes in elementary school soccer classrooms.
11	Marwan (2021)	The Use of Virtual Reality Media at the Level of High-Order Thinking Skills in Sport Education	This study examines how high-order thinking skills (HOTS) can be used in sports education materials during the pandemic of Covid-19 Athletes and artistic gymnasts will be tested on football, volleyball, basketball, and athletics games
12	Mokmin & Jamiat (2021)	The effectiveness of a virtual fitness trainer app in motivating and engaging students in fitness activity by	This study examines the effectiveness of a virtual fitness app in motivating and enticing students to engage in physical activity.

applying motor learning

theory

VR technology has increased from 2017 to 2021. Many fields use VR to facilitate training. The pace of industry and education can benefit from this type of innovation. Sports, public health, and health education are just a few areas that use virtual reality technology. Studies by Wu (2021) have shown that VR can help stroke patients improve their balance and upper-limb function, while H. S. Lee (2021) has examined the effects of virtual reality on elementary school soccer. However, as the number of VR technology publications has rapidly grown, there is still a lack of future studies on VR concerning physical exercises, which needs to be addressed.

In addition, according to Table 2.1 above, most of the previous studies have discussed the use of VR in physical education and sports games rather than physical exercises. Physical exercises and physical education are two different things. According to Annie Simoneaux (2020), physical exercises are movements that require energy and are planned, structured, repeated, and done on purpose. Physical education is essential to providing students with the skills, knowledge, and attitudes necessary to remain active, healthy, and productive (P. Pangrazi & Beighle, 2019). Consequently, this study aims to determine the efficacy of VR concerning physical exercises to fill in the gaps left by the previous studies on VR usage.

2.3   Issues in Physical Exercises

Physical activities involve the movement of each muscle and joint in the body as a whole (Annie Simoneaux, 2020). Besides, fitness is characterized as short bursts of

intense exercise that target multiple joints and build muscle mass. It also helps to improve the human cardiovascular system. In leisure time, fitness training is a planned, structured, repetitive, and purposeful physical activity to improve or maintain physical fitness (Hassett, 2017). Fitness also can be categorized as High-intensity interval training (HIIT) (Feito, 2018). In contrast, high-intensity functional training (HIFT) employs functional exercises of varying intensities and durations. According to Zhai, (2020), students' overall performance improves when they are physically fit. According to the research by Griban (2020), insufficient physical exercise orientation, a lack of student interest, and low motor activity contribute to a fitness decline.

The rising of physical exercise technology leads to improved performance (Rutkowski, 2019). This is supported by Zhou (2020), who claims that the use of technology has improved the level of in-school training. However, people usually utilize mobile applications as training aids, but there is still a lack of VR technology used for physical exercises. The findings by (Han, 2021) claim that only a small percentage of current computer-based virtual training systems have been found to be effective. Table 2.2 shows the gaps and issues associated with physical exercises.

Table 2. 2
Gaps in the physical exercises

No	Authors	Titles	Focus	Gaps
1	Hassett (2017)	Fitness training for cardiorespiratory conditioning after traumatic brain injury	Fitness training improves cardiorespiratory fitness in people who have sustained a	Performance.