Evaluation of Users toward the Virtual Taekwondo Training Environment

Nur Ain Mohd Jelani, Abdul Nasir Zulkifli, MohdFitri Yusoff, Salina Ismail

Abstract: In taekwondo training, basically there are two approaches of learning. Firstly, is to conduct the training in a hall or large open spaces in the presence of a trainer which is widely used nowadays. Secondly, is through self-directed training by using existing supplementary training materials. However, the first approach has some limitations. Thus, self-directed training is required by the trainees in order to improve their skills and performance. Nevertheless, most available supplementary taekwondo training materials lack in terms of three-dimensional visualization. In this paper, the Virtual Taekwondo Training Environment (VT²E) has been introduced as a supplementary for self-directed taekwondo training. The VT²E has been developed using Motion Capture (MoCap) and Virtual Reality (VR) technologies since the technologies have many benefits and been proven in several computer-based training applications. This paper discusses on the development and evaluation of the VT²Eamong a sample of taekwondo trainees. The results of the evaluation indicated that the trainees "strongly agreed" on four measurements (usefulness, engaging, ease of use and satisfaction) and only "agreed" on presence of the VT²E. This innovative application has the potential to improve taekwondo trainees' skills and performance.

Keywords: Martial Arts Training; Motion Capture; Self-Directed Training; Virtual Reality; Virtual Taekwondo Training

I. INTRODUCTION

Martial arts are very well-known and have long existed more than 3000 years ago. They are categorized as exercise and sports that have hundreds of different styles [1]. Millions of people involved in martial arts recognize the importance of martial arts training for health. Martial arts training have its unique benefits compared with other activities [2]. This has been proven by several studies. According to [1], when involved in martial arts, among the benefits is that a person acquires more active thoughts and actions resulting in better actions. Martial arts training involve three important aspects that include discipline, body control, commitment and self-control [2]. In addition, martial arts are associated with health that can provide physical fitness among practitioners [3,4]. Besides that, involvement in martial arts is also due to several factors that include; aesthetics, personal growth, physical fitness, cultural learning and fun [5].

While, according to [6], martial arts can provide benefits such as stress reduction, improved confidence, weight management, self-discipline, increased level of energy, and improved the performance. The World Taekwondo Federation (WTF) defined taekwondo as the right way of using all parts of the body to stop fights and help to build a better and more peaceful world [7].Taekwondo trainees must involve in grading which is a physical examination that martial arts need to take to attain their next belts. As trainees learn and master taekwondo domains, they advance through the ranks that changing belt colour is the way to show the trainees are improving. If the trainees are committed in training, and demonstrated good techniques, the colour would change on their belt. Each of these belts represents a certain level of skill or a certain set of skills indicating that a trainee has achieved a certain rank.

Normally, taekwondo training involves the trainees to learn from their trainer in a classroom or training club whereby the trainer will explain and demonstrate the taekwondo movements and then the trainees will follow the trainer. Training in a traditional class is the fundamental training process whereby it is conducted by a real trainer involving a relatively large number of trainees at one time. The trainer gives explanation and demonstration to the trainees while the trainees follow the movements make by the trainer. Through this, the trainees practice the training with a real trainer face-to-face. The benefit that the trainees will get is that the trainer can immediately correct the mistakes made by the trainees.

Besides that, the trainer is important in taekwondo training since he/she is responsible to guide and train the trainees on how to perform properly in each task in order to improve and achieve successful performance [8,9]. The trainer will explain and demonstrate the task to be performed and the trainees will follow the trainer. If there are mistakes made by trainees, the trainer is responsible to correct and make sure the trainees will perform correctly.

In addition, taekwondo training also conducted through supplementary materials such as YouTube, Website, books and DVD/CD (video). The trainees used supplementary materials in order to achieve quality performance in taekwondo training. The trainees watch the video of the instructor while mimicking and following the steps and movements of the trainer. The trainees can view and playback images from a single angle or 2D image of the environment. Besides that, the trainees will practice alone anytime and anywhere using computer monitor or projection system and allow the user to rewind, fast forward or pause the video.

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In the past, many researchers have identified the vast potential and numerous benefits of Virtual Reality (VR) technology in training [10,11, 66, 67]. VR technology has been proven to have good potential in training; however, it has not been adopted much into martial arts especially for taekwondo training. Even though there are other technologies available for training such as computer-based training, video-based training, and web-based training, VR in training is still considered as a valuable and effective technology for training because it provides 3D environment that makes user feels like being there and looks like real one [12,13].

This paper is structured as follows. In section 2, we discuss the literature review on self-directed training, motion capture, virtual reality, Constructivist theory and Theory of Flow. In section 3, we elaborate on the Virtual Taekwondo Training Environment (VT2E) application. In Section 4, we describe the Evaluation which includes Expert and User evaluations. In Section 5, we present the results which include Sample, Validity and Reliability, and Descriptive statistics. Finally, the conclusion is established in Section 6.

II. LITERATURE REVIEW

Advances in computer technology of today's three-dimensional graphics coupled with the emergence of a variety of powerful devices have provided many benefits to training applications utilizing VR and Motion Capture (MoCap) technologies.

Self-directed training

Self-directed training is defined as an approach in which the individual decodes what kind of training is desired and when and how the training will take place [14]. Normally, self-directed training is conducted by using supplementary training materials such as videos and books. Nowadays, most self-directed training is conducted through the use of technology such as computer, web and mobile. In self-directed training, the trainees usually use existing supplementary training material such as books and videos and they have limitations [15]. Self-directed training has an advantage of being non-binding training schedule and place which makes it comfortable and convenience to the users. The trainees may conduct the training as long or as little as the trainees needed at a time. The trainees will be successful in self-directed training when they are highly involved with the training because there are not conducted by the trainer. The integration of technology into self-directed training will enhance the training quality as well as the knowledge and performance of the trainees. The growth of technologies can make the number of training resources available to increase dramatically. Overall, integrated training environments have been created to provide more effective training.

Seldom, the trainer requires his/her trainees to do self-directed training to improve their performance and skills which could not be sufficiently achieved in a classroom with a large group of trainees. The use of technology such as virtual reality for self-directed training provides a lot of benefits such as the user can view the display in 3D from all angles and playback the 3D display in real time. VR allows the user to practice alone in front of the computer at home or at any other convenient places. The user has a full control of the 3D display, rewind, fast forward, pause, zoom in and out, and these features enable the user to improve the feeling of presence and get the depth information [16].

Motion capture (MoCap)

MoCap technology has been introduced since the 70's and has been widely used in various fields of applications such as in sports, entertainment, television, video games, feature films and medicine. Nowadays, MoCap and VR are a powerful combination that can help in tracking the full body motion which can generate interaction between the virtual environment and human [17]. According to [18], MoCap is the effective method that can provide the realistic human motion in 3D animation.

The main purpose of the MoCap technology is to create varieties of applications as it can capture the human movements [19]. Besides that, MoCap helps to capture difficult and complex movements whereby other techniques or methods might not be feasible.

In the traditional 3D animation process, it is difficult to animate the digital human character with the used of the keyframing technique. Keyframing is a technique to smoothly interpolate key postures over time to generate the full set of frames required for an animation [20]. Using this technique to produce realistic human animation requires a high level of expertise, a lot of effort as well as time. It is used to capture the movements of a real object and map it onto the digital objects. It is usually used to create digital actors by capturing the motions of humans.

There are lots of MoCap systems that can bring benefits to the users. Various studies have been conducted pertaining to the MoCapsystems that make this topic extremely active in the research field. The advanced MoCap technology is required due to the needs of the growing 3D animation technology [21]. Some examples of the use of MoCap include; dancing[22,23],gymnastics [24,25], swimming [26], golf [27],basketball [28], martial arts [29, 30] and many others.

In addition, the availability of more affordable MoCap hardware such as the Microsoft Kinect enables more studies to be conducted in the use of Kinect in capturing human movements for the purpose of martial arts training. These have encouraged many industries and researchers to develop new applications especially in training [31].

Virtual reality (VR)

VR is defined as a computer generated imagery where the users can interact in a real world, navigate and view in real time [32]. VR has also been defined as a technology which combines the use of computers, software and hardware to generate the virtual environment (VE) and allows users to create an experience in the environment [33]. According to [34] and [35], VR is a human-computer interface that allows users to explore, manipulate, real time visualization and interaction then become immersed in a computer-generated simulation environment. The advancements in the three-dimensional (3D) computer graphics technology coupled with the emergence of a variety of powerful and affordable 3D graphics hardware bring a lot of interest in the VR applications [36].

VR technology offers unique experiences to the users which include representative, detailed, and realistic view of the environment. Users can also interact with the VR system in unlimited time and place for self-directed training [37]. According to [38], in education and training, the benefits of using VR technology among others include; it can be fully controlled, cost-effective, safe to use, realistic and interactive in enhancing the learning experience. Besides that, through the use of the Head Mounted Display (HMD) or large projection screen, it will provide the immersive VR system and also give immediate feedback for users [39].The strength of VR is in creating the sense of presence [40]. Steuerstates presence as the “sense of being there”[41]. Meanwhile, [35] defined VR as the “feeling of being in a world that exists outside the self”. These can make users feel like being in the real world which is unavailable with other systems. On the other hand, VR has the capability to create the feeling of immersion to the user. Immersion is the objective level of sensory fidelity a VR system provides [42]. This can ensure that the environment looks realistic and allows users to navigate and interact with the virtual environment [40].

The reason for using VR is the real time interactivity where users will be provided an immediate feedback [43]. Besides that, the interaction can increase the sense of presence in a virtual environment [44]. Consequently, this enables users to interact with all human sensorial channels such as vision, hear, feel or touch [45]. When the human sensorial channels are combined with interactivity, it will make the VR experience more immersive and realistic which cannot be obtained from video and television as well as attract the attention of users to use the VR technology [46]. Furthermore, this can make the users to experience the system which is useful to them in improving their learning performance.

VR is also a system that provides flexibility for user’s convenience. Users can interact with the system in unlimited time and place for self-directed learning [47]. In addition, the use of VR actualizes the three-dimensional representation, authentic representation, visualization tool, multiple perspectives, controlled complexity, active learning, learner-centered and motivation [48]. Through these features can make an application or system more attractive, realistic, engaging, and extremely fun compared to other representation methods such as narrative, text or picture form.

Constructivist theory

In the design and development of the VR application, the constructivist theory was applied during the design process in order to produce a usable and user friendly system. The constructivist theory has numerous definitions, but one of the definitions is the users are controlling their own learning [49]. Users control their learning by applying approaches that he/she definitely knows or with current experiences, help from others and research resources [50]. Meanwhile, the constructivist learning theory sees learning as a process in which users effectively develop new concepts or ideas depending on current and prior knowledge [51]. The users can learn the real world environment from the virtual world where the users could develop new idea and knowledge depending on prior experiences. According to [52], learning experience can be enhanced by the presence of realism in the virtual world. In the design and development of the VR application, the constructivist theory was applied during the design process in order to produce a usable and user friendly system.

Constructivist is a theory that widely used in various applications for learning. In VT^{2}E, the constructivist theory was applied to create an interactive VE application as a supplementary material in doing self-directed training. Furthermore, it can help and identify how the use of a system can solve the problems. Through the existence of constructivist can help the users in learning. Besides that, it can produce an effective design for VT^{2}E as a supplementary material in doing self-directed taekwondo training. The user will be engaged with their activities and this enables the learning process to be more effective.

Theory of flow

Flow is defined as the feeling of users [53, 54] and the enjoyable experience when they are fully involved in certain activities with positive emotions [55].Flow occurs when people involved in activities and achieve their satisfaction that makes them repeat the activity [56].Meanwhile, in the context of computer-mediated environments, [57] define flow as the subjective experience through the human-computer interactions as playful and exploratory. The flow theory shows that individual behaviour towards the use of new information technology related to the holistic experience in using a new technology [57]. In addition, the flow theory can increase the computer use, satisfaction and acceptance of information technology, exploratory behaviour, learning, and training [58,59].

In the VT^{2}E application, the flow is a psychological state when the trainees used the application efficiently and having an enjoyable experience as a tool for self-directed taekwondo training which result in satisfaction. When the trainees achieve a positive goal in using the VT^{2}E, they will use it continuously in the future.

III. VIRTUALTAEKWONDO TRAINING ENVIRONMENT (VT^{2}E) APPLICATION

Based on VR and MoCap technologies, a Virtual Taekwondo Training Environment (VT^{2}E) application has been developed as a supplement to self-directed taekwondo training. The application provides real time 3D display of a virtual trainer performing body movements based on the colour of the belt representing the level. Meanwhile, the VT^{2}E application is meant to be used by the trainees whenever they need to practice on their own in the absence of the trainer at home or outside in the open space. Through the use of the application, the trainees are able to view the body movements of a virtual trainer from all angles, repeat the movements multiple times until they fully understand the movements and consequently able to follow the movements on their own. By doing this, the trainees will be able to improve and perfect their taekwondo movement skills and better prepared to take the test.

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The VT^{2}E application has been designed and developed in such a way to ensure trainee's satisfaction when using it. Additionally, it helps the trainees to achieve good performance in the taekwondo training.

The VT^{2}E was developed as a standalone application running on Windows platform. The application utilizes VR which is capable in producing 3D real time visualization into a computer training application. The 3D visualization enables trainees to control the taekwondo movement patterns in self-directed training and allows them to interact with the application like in the real environment. The contents of the VT^{2}E application focuses on the WTF taekwondo yellow colour belt which is form 1 (TaegeukIl Jang). The VT^{2}E application requires a normal PC, with Random Access Memory (RAM) of at least 2GB and a mouse.

The development of the VT^{2}E application involved two phases that include information gathering and application design and development as shown in Fig. 1. In information gathering, all the information related to taekwondo training, training methods and limitations were identified through literature review and preliminary study. The researchers needed to identify the current needs related to the problems faced by the trainees while doing self-directed taekwondo training and the limitation of the existing supplementary material. Based on the literature review, the researchers were able to identify the problems faced by trainees. In order to have a better understanding of the problems, a preliminary study was conducted among 52 taekwondo trainees in Kota Bharu, Kelantan. The preliminary study was conducted to provide support to the statements obtained from the literature review. In this study, the researchers had identified the problems faced by the trainees while doing self-directed taekwondo training.

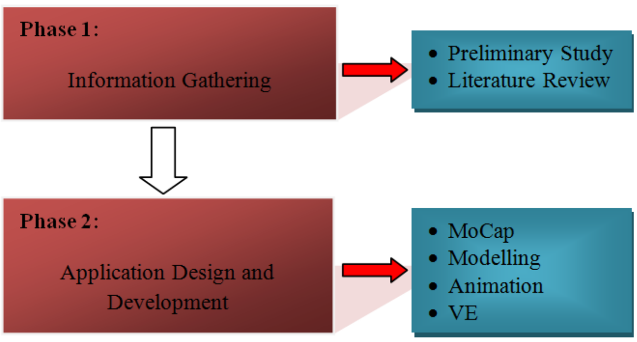

Fig. 1 The development of the VT^{2}E application

The design and development phase discusses in detail the process of design and development of the VT^{2}E application. The design and development phase involved four phases that include; MoCap (System Preparation, Subject Preparation, Calibration, Capture Session, Cleaning and Edit Data), Modeling (3D Character and 3D Environment), Animation (Insert 3D Character, Applying Motion to a 3D Character and Animated 3D Character) and VE (Insert 3D Environment, Placing of 3D Animated Objects in the Environment, Scene Lighting, Camera and Save as exe file).Fig. 2 shows some snapshots of the design and development phase.

The QualisysMoCap system was used to capture the 3D motion of the taekwondo movements. The system utilized five high-speed Oqus cameras, a set of passive markers, QTM for the tracking software and other integration peripheral hardware. Modelling involved producing models that appear realistic which requires additional texturing elements. Object modelling was done using 3DS Max. For the VT^{2}E application, object modelling is all about creating 3D character of taekwondo trainer and the 3D environment. Then, texture was added to the character and also the environment so that they look more realistic.

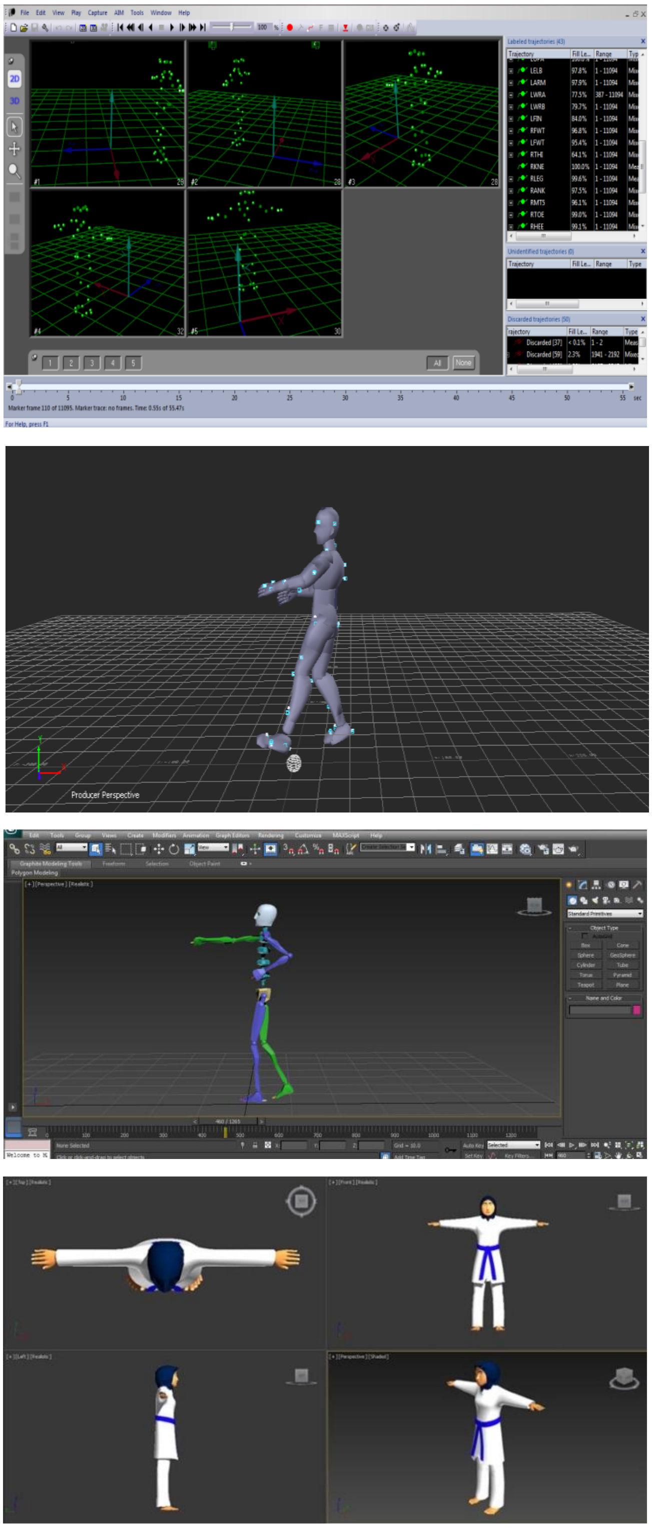

Fig. 2 Snapshots of the VT^{2}E application development process

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Animation is the process to animate the 3D character using the 3DS Max software. The female taekwondo character animation performed the walking stance, punch, kick and block movements. VE combines the 3D models that include 3D character of the trainer and the environment into the virtual environment. The 3D character was assigned collision detection and the environment was integrated with additional effects such as audio and lighting to make it more realistic. All these processes were done in Quest3D.Detail development of the VT^{2}E application is described in [60].

IV. EVALUATION

Evaluation is important in determining the success of a developed product in achieving its goal and provides valuable data in guiding for future development efforts. The purpose of the evaluation was to assess the potential of VT^{2}E, a supplementary taekwondo training application based on the integration of VE and MoCap technologies. The evaluation was conducted among experts and users.

Expert Evaluation

Expert evaluation was conducted to ensure that the contents and user interfaces of the application are easily understood by the users. For expert evaluation, two categories of experts were involved namely; content and user interface. The content experts were responsible in ensuring the consistency of the information in the VT^{2}E application by evaluating it thoroughly and making suggestions for any inconsistencies detected. An experienced and qualified taekwondo trainer having more than five years of experience was involved. Besides that, the content expert ensures that the application is useful to the user.

Meanwhile, for the user interface evaluation, two lecturers were involved. They were selected based on their knowledge and experience in teaching and conducting research related to VR and they have more than five years of experience in their respective fields. The user interface experts were responsible in ensuring the functionality of all the interfaces of the application. Besides that, the experts were required to identify faults in the application and later come up with suggestions on improving the application. Feedbacks and recommendations from the experts were documented and earlier versions of the application were modified accordingly.

User evaluation

After expert evaluation, all the faults and errors that have been identified in the VT^{2}E application were corrected. User evaluation was then conducted to assess the users' perceptions towards the use of the application. User evaluation was conducted to ensure that the application has achieved its objectives, and training outcomes.

V. RESULTS

Sample

The sample for this study consists of 46 World Taekwondo Federation (WTF) trainees. The sample was selected using purposive sampling whereby the selection was based on the characteristics of the population and the objective of the study. The sample involved must be the specific type of people to ensure the objective of the study can be achieved [61]. The evaluation was conducted in a hall. Table 1 shows the demographic data of the 46 respondents. 17 of the respondents were male (37%) and 29 were female (63%). The range of the respondents' ages was 18 to 39 years old. The respondents consist of 30 (65.2%) Malays, 13 (28.3%) Chinese, and 3 (6.5%) Indians. 45 (97.8%) have computer facilities at home while only 1 (2.2%) did not have computer facilities at home. In term of frequency of computer usage, the results indicated that 45 (97.8%) used daily, and 1 (2.2%) used weekly. In terms of VR knowledge, 21 (45.7%) have VR knowledge and 14 (30.4%) did not know about VR. In terms of other supplementary taekwondo training materials that have been used, 44 (95.7%) used YouTube, 4 (8.7%) used CD/DVD/Video, 8 (17.4%) used books, and 3 (6.5%) used others.

Table. 1 Summary of Respondents' Demographic Data

Demographic Data	Frequency	Percentage (%)
Gender		
Male	17	37.0
Female	29	63.0
Age		
18-39	46	100.0
Race		
Malay	30	65.2
Chinese	13	28.3
Indian	3	6.5
Others	0	0
Computer Facilities At Home		
Yes	45	97.8
No	1	2.2
Frequency of Computer Usage		
Daily	45	97.8
Weekly	1	2.2
Monthly	0	0
Knowledge of Virtual Reality		
Yes	21	45.7
No	25	54.3
The Use of Supplementary Material		
Yes	32	69.6
No	14	30.4
Others Supplementary Material		
YouTube	44	95.7
CD/DVD/Video	4	8.7
Books	8	17.4
Others	3	6.5

Validity and reliability

Validity refers to how well a test measures what it is supposed to measure [62]. While, reliability refers to the degree to which an assessment tool produces stable and consistent results [63]. A five-point Likert scale anchored with 1-strongly disagree, 2-disagree, 3-neutral, 4-agree and 5-strongly agree was used.

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Reliability was examined using Cronbach alpha (α) for all the measurements that include; Engaging, Presence, Usefulness, Ease of Use and Satisfaction. The results indicated that Engaging has a Cronbach alpha of 0.874, Presence has a Cronbach alpha of 0.817, Usefulness has a Cronbach alpha of 0.853, Ease of Use has a Cronbach alpha of 0.816, and Satisfaction has a Cronbach alpha of 0.746. [64] state that if the Cronbach alpha value is greater than 0.7, than it is reliable. The Cronbach alpha values for all measurements as shown in Table 2. The Cronbach alphas were calculated using SPSS version 21.0. The internal consistency of > 0.9 indicates excellent, 0.9 > α > 0.8 indicates Good, 0.8 > α > 0.7 indicates Acceptable, 0.7 > α > 0.6 indicates Questionable, 0.6 > α > 0.5 indicates Poor, and 0.5 > α indicates Unacceptable.

Table. 2 Cronbach Alpha Values for All Measurements

Measurement	Number of Item	Cronbach Alpha
Engaging	6	0.874
Presence	6	0.817
Usefulness	6	0.853
Ease of use	6	0.816
Satisfaction	5	0.746

Descriptive statistics

The purpose of descriptive statistics is to determine the mean score and the standard deviation of each item.Table 3 shows the descriptive statistics for all the measurements and items used in the user evaluation of the VT^2E application. The mean scores for all the measurements and items were based on five-point Likert scale. However, in order to determine the participant's level of agreement or disagreement with the statement presented, numerical scales are frequently used. Numerical scale is based on measuring the distance between numbers of positions.

Table. 3 Descriptive Statistics

Measurements and Items	Mean	SD
Engaging	**4.18**	
VT^2E keeps me totally absorbed in the self-directed taekwondo training.	4.02	.577
VT^2E hold my attention.	4.28	.584
VT^2E excites my curiosity.	4.26	.743
VT^2E arouses my imagination.	4.22	.696
VT^2E is fun.	4.26	.612
VT^2E is intrinsically interesting.	4.04	.698
Presence	**3.90**	
I got a sense of presence (i.e. being there).	3.87	.718
The quality of the image increases my feeling of presence.	3.93	.772
I thought that the field of view enhanced my sense of presence.	3.93	.611
I felt being there and part of the virtual environment	3.89	.605
I had a good sense of scale in the virtual environment.	3.98	.683
I often know where I was in the virtual environment.	3.85	.729
Usefulness	**4.22**	
Using VT^2E in my training would enable me to accomplish tasks more quickly.	4.15	.631
Using VT^2E would improve my training performance.	4.20	.582
Using VT^2E in my training would increase my productivity.	4.02	.715
Using VT^2E would enhance my effectiveness on the training.	4.20	.542
Using VT^2E would make it easier to do my training.	4.35	.604
I would find VT^2E useful in my training.	4.41	.617
Ease of Use	**4.08**	
Learning to operate VT^2E would be easy for me.	4.04	.665
I would find it easy to get VT^2E to do what I want it to do.	4.07	.680
My interaction with VT^2E would be clear and understandable.	4.11	.605
I would find VT^2E to be flexible to interact with.	4.02	.577
It would be easy for me to become skillful at using VT^2E.	4.09	.694
I would find VT^2E easy to use.	4.15	.666
Satisfaction	**4.14**	
I was satisfied with this type of computer-based training experience.	4.07	.574
I was satisfied with the overall training effectiveness.	4.11	.605
I was satisfied with the training methods in this type of computer-based training environment.	4.09	.725
I was satisfied with this type of computer-based training environment.	4.11	.567
I found the VT^2E contents meet my needs.	4.33	.668

In numerical scale, the position to be measured has to be classified into two directional categories (strongly disagree, disagree, strongly agree and agree) without neutral position [65]. Thus, Sugiyono equation [65]was adapted to calculate the interval range of Likert scales by performing the mathematical equation as follows:

RS= (m-n) / b
RS = Score range
m = highest score on scale
n = lowest score on scale
b = number of classification
RS= (5−1) / 4=1

Table 4 illustrates the criteria of analysis for each category by the numerical scales.

Table. 4 Criteria of Analysis for Each Category by Numerical Scales

Category	Numerical scale
Strongly Disagree	1 – 1.99
Disagree	2.0 – 2.99
Agree	3.0 – 3.99
Strongly Agree	4.0 – 5.00

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The results indicated that Usefulness has the highest mean score of 4.22 (Strongly Agree) while Presence has the lowest mean score of 3.90 (Agree). Meanwhile the mean scores for Engaging was 4.18 (Strongly Agree), Ease of Use was 4.08 (Strongly Agree) and Satisfaction was 4.14 (Strongly Agree). The results indicated that the users strongly agreed on four measurements (Usefulness, Engaging, Ease of Use and Satisfaction) and only agreed on Presence.

VI. CONCLUSION

This paper describes the development and evaluation of theVT^{2}E application. The application involves the integration of VR and MoCap technologies. The use of these technologies offers a unique experience to the user by offering superior immersive representation as well as realistic motion training system. Besides that, the VT^{2}E application incorporates constructivists and flow theories in producing an effective and useful application. This application is not intended to replace the conventional approach of taekwondo training. Instead it has been developed as a supplementary for self-directed training which is required by the trainees in order to improve their skills and performance. Even though there are various supplementary taekwondo training materials available in the market and online, most of them lack in terms of three-dimensional visualization. The VT^{2}E application provides real time 3D display of a virtual trainer performing taekwondo movements. This allows the trainees to use the application whenever they need to practice on their own anytime and anywhere. The trainees are able to view the virtual trainer's body movements from any angles and repeat the movements multiple times which results in improving and perfecting their taekwondo movements. A set of questionnaires was used to record the perceptions of the trainees towards the use of the VT^{2}E application. The results revealed that the trainees appreciated the VT^{2}E application as a supplementary for self-directed taekwondo training. The descriptive statistics indicated that the trainees "strongly agreed" in terms of Usefulness, Engaging, Ease of Use and Satisfaction and only "agreed" on Presence. This paper focused on the perception of trainees towards the use of the VT^{2}Eapplication. It is hoped that the findings will encourage taekwondo trainees to use the VT^{2}E application as a supplementary for self-directed taekwondo training.Further work to be considered can be a theoretical framework for investigating the important determinants in achieving satisfaction among the taekwondo trainees towards the use of Virtual Reality based taekwondo training application.

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