A Production of Virtual Reality Technology Learning Materials: Driving for Preparator of Practical Driving License Test

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Abstract

This research aims to 1) produce virtual reality technology learning materials of driving test for practical driving license test-takers and 2) to study the samples' satisfaction on virtual reality technology learning materials. The samples are 18-year-old and older eligible for a practical driving license test to get the benefits of the use of virtual reality technology at driving training as well as training in real situations at Rajamangala University of Technology Tawan-Ok : Chakrabongse Bhuvanarth Campus Bangkok. There are 30 people in the trial, 15 are drivers and possess a driving license, and the remaining 15 are potential test-takers for a driving license test. There are four steps in the process: 1) study the principles and criteria of a practical driving test, 2) design and develop virtual reality technology media using developed and proposed 3D driving simulation software, 3) study the results of the trials; and 4) analyze and evaluate the samples' behaviors. The overall samples' satisfaction on virtual reality technology learning materials was deemed 'very satisfied' with a mean of 4.21, and a standard deviation of 0.71. Also, it was found that age differences affected the satisfaction level of virtual reality technology, 20-30 years old were more satisfied than 31- 50 years old adults. Virtual Reality Sickness was common to everyone according to age; yet in older samples, they were quicker to become lightheaded after a prolonged use of the technology. It is hoped that if these samples could drive in real-world situations, they could also drive in a virtual world, except for those who had problems with Virtual Reality Sickness. For aspiring license test-takers, it is but a rule of thumb that they study and practice driving safely before they do in a real situation. Therefore, this developed Virtual Reality technology learning material is hoped to assist aspirants in their endeavors; 15-minute maximum use is also recommended to minimize VR sickness.

Keywords: learning materials, virtual reality, virtual reality sickness, driving license, car driving simulation

Introduction

Thailand is one of the world's most affected countries relating to road accidents, reflecting that the problems of road accidents must be addressed (Office of Transport and Traffic Policy and Planning : Office of Safety Planning, 2019). As a result, the Department of Land Transport has tightened the licensing of motor vehicles to raise safety standards by focusing on written exams that require more accurate responses 45 out of 50 to pass the theoretical test. The strictness in the theory exam is a good solution to make the test taker more understanding of traffic rules. In addition to the theoretical exams, the practical exam stipulated by the Department of Land Transport still applies the same principles and criteria for the driver of the vehicle. The participant who takes the practical driving exam must drive in 3 compulsive positions comprising 1. Driving forward and stopping the car on the pavement. 2. Driving forward and backward in a straight direction. 3. Driving backward to park the car. In the practical exam, the participants need the knowledge of the rules and regulations, driving skills, driving control and safety understanding that require training to achieve expertise (Kanchanasamranwong, 2018). The main obstacle for driving preparators in real situations is that if they lack experience or skill, it may cause an accident or an error during driving. Therefore, promoting learning the right and safe driving skills is very necessary. This requires learning management to ensure that drivers are ready to drive safely, reducing risk factors that will harm themselves and their associates.

The advancement of technology has brought benefits to the design and development of modern learning materials that can improve learners' theoretical knowledge and practical skills. One of the most advanced and modern learning materials that are currently widely used is the virtual reality system (Lau & Lee, 2015). It is a system that users can interact with a computer-simulated environment and require special equipment to view images rendered in a 3D image by using special tools such as 3D glasses or a headset to see and listen to sound. Traditionally, most of the researches used visualization through large-scale controllers that could be connected to three screens, usually for researches related to VR Driving Simulation. However, with the display being limited to the 2D view, the VR experience is still not immersed in the simulated scenario that appears very well. Moreover, the interaction between the players may not be able to freely experience a panoramic view as well as a headset that offers 3D images, 360 views that provide a superior realism experience (Marcel Walch et al ., 2017). In addition to the use of devices to interact with computer systems in response to user orders, users will be able to recognize and interact as if they were in real-world events. When a computer system can detect a user's movements, it is processed and displayed back to the user for the response, and may add other feelings, such as response force or environmental movement, to make the experience feel more realistic (Lau & Lee, 2019). The advantages of virtual reality technology in the use of learning materials are to help learners' access to practice in dangerous situation or situation with security restrictions. (Smith & Salmon, 2017) It has attracted the attention of users and researchers to use in areas such as gaming, military training, architecture design, learning and skill training education, (surgical procedure simulation, assisting the elderly or using virtual reality technology to treat the mind, and it can be used in other areas such as tourism, conferences, industry, news and entertainment. In addition, research by Freeman, Reeve, Robinson, Ehlers, and Spanlang (2017) has focused on the use of VR to assess and treat mental disorders, anxiety, schizophrenia, depression, and eating disorders. Cipresso, Giglioli, Raya, and Riva (2018) stated that a variety of uses into replace stimuli from real-world scenarios that humans sometimes cannot do in the real world (Cipresso et al., 2018). The launch of virtual reality devices such as the Oculus Rift, HTC Vive, Sony PlayStation VR and Mixed Reality Interfaces (MRITF): HoloLens will take virtual reality technology a great stride forward. Consequently, virtual reality research plays a role in enabling companies and organizations to rely on virtual reality to help with training, which is a fast and effective way to train their employees to save costs and it was efficient for learners (Slater & Sanchez-Vives, 2016). In other words, people trained with virtual reality will produce better results in learning than learners who were trained from real-world situations alone.

As a result, the researcher has developed virtual reality learning materials to simulate driving and process through high-performance computers, working with a headset with 3D display, 360 degree high-definition view of the Oculus Rift, and driving control devices, which include a set of steering wheel controls, accelerator kits, and brakes and gearing for virtual reality to simulate the most realistic driving scenarios as shown in figure 1.

According to priorities and issues in terms of driving learning to prepare for the individual driving license test. It is necessary to understand the correct driving procedures to become skilled and safe. Therefore, the researcher was interested in studying "the production of virtual reality technology learning materials for the preparator for practical driving license test". The preparators for a practical personal driving license test using virtual reality technology they will be satisfied and useful to users of virtual reality technology in learning to encourage the skills of driving, as determined by the Department of Land Transport. The learners will be safe and do not have to worry about errors that occur in the virtual reality world when cognitive process can be applied to driving in real-world situations. This research also benefits both public and private operators in using virtual reality technology as an option to develop the skills of the participants to improve their efficiency and suit the needs of the most targeted audiences.

Research Concept Framework

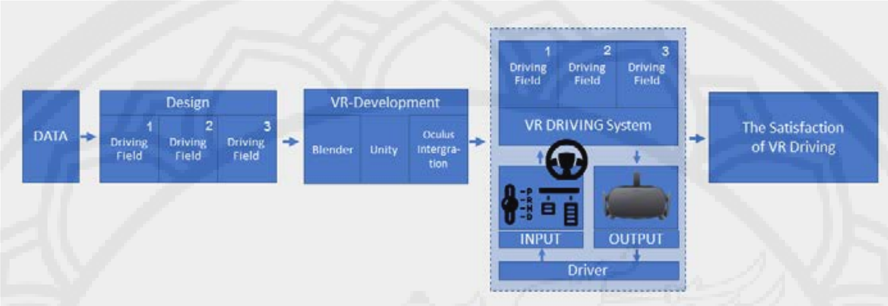

Figure 1 The design and development of VR driving system

Literature Reviews

Most studies related to VR driving simulation require high potential VR players and steep costing. As a result, many researchers have used game hardwares for consumer groups in conjunction with flat screens as alternative to cost-effectiveness, which has not been shown to be soundly proven. Meanwhile, the result of the study of Marcel Walch et al. (2017) suggested that using HMD in place of flat displays could create a more realistic experience. However, participants felt more uncomfortable when using HMD, which was consistent with Chang, Kim, and Yoo (2020). It identified that symptoms of discomfort affected VR users while engaging with movies, game books, or for educational purposes. The symptoms were like motion sickness, also known as VR Sickness. The main symptoms that occur were eye fatigue, confusion, and nausea. There was also a feeling of discomfort. The problem of such symptoms needed to be studied to gain in-depth knowledge of the cause and mitigation of such symptoms for HMD users of VR technology. Therefore, the researchers conducted research on VR driving simulation using HMD devices in conjunction with driving controllers so that the participants had the most realistic experience. They were able to use this material to improve their driving skills effectively by collecting data and analyzing issues that could affect the testers in terms of experience, reality of driving and VR Sickness.

Methods and Materials

The researcher conducted this study based on the concept of research and development. Details and procedures are described as follows:

A : Study the criteria for a practical driving test to obtain a driving license compliance with the Department of Land Transport

The Department of Land Transport has set a practical exam for obtaining a driving license; which requires three standards as the following. 1) Driving forward and stopping the car by the pavement, 2) Driving forward and backward in a straight direction and 3) Driving backward to park the car. In the practical exam, the participants need to have knowledge of the rules and regulations (Kitsiripaisarn, 2016), (Kanchanasamranwong, 2018). The driving skills and understanding of safety rely on frequent practice to acquire mastery and study research and learning materials using virtual reality technology.

B : The design and developing of virtual reality media

The researcher designed and created virtual reality learning materials by selecting the following tools: Blender 3D, Unity Engine, and Oculus Integration. Then, a virtual environment was formed by creating 3D models including a test-ride with roads, obstacles, buildings, traffic signs. The differences in the design and development of the media in this research is not the same as computer games. Car-racing type provided a 2D view and limited driving control through a keyboard or a joystick, which gave players an unrealistic response. Computer games with realistic displays like Car Simulation were designed to force through joy steering wheel and allowed players to use VR players as well as the research team's work, focused on driving along the main route and speed races. Therefore, there was no part related to the driving test, which was set to be three compulsory positions based on the Department of Land Transport.

The driving test field used the 3D design program creating a model for all three scenes as shown in figures 2, 3 and 4., with roads, obstacles, and props referred to the Department of Land Transport to test all three driving positions. The scenes designed in the virtual reality world were different to the real driving test field. In terms of adopting the advantages of virtual reality technology, it was possible to design the environment independently, so it was designed to test the test field in the virtual world, which looked as if in a real-life driving environment. In other words, instead of using a cone or a pole to line the vehicle's collision phase according to the model of the department's examination field, the researcher designed scenes in the virtual reality world instead of objects such as car models, roads, footpaths, buildings, or barriers to give drivers the closest and most realistic experience to everyday driving. If the driver hits a barrier, there would be a loud noise through the loudspeaker as a warning sign that an obstacle is hit, but there would be no harm to the driver and they would not be able to get any injuries in the virtual reality world. The test field is as designed as below.

Figure 2 Simulation 1 driving forward and stopping the car by the pavement

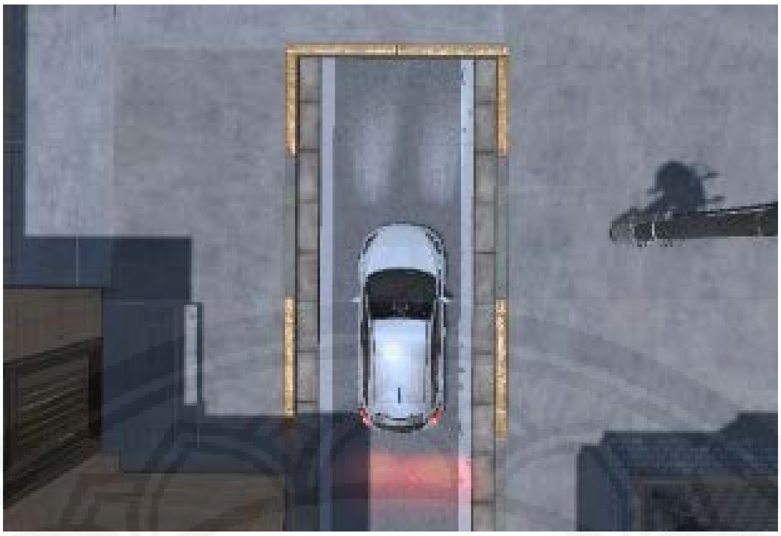

Figure 3 Simulation 2 driving forward and backward in a straight way

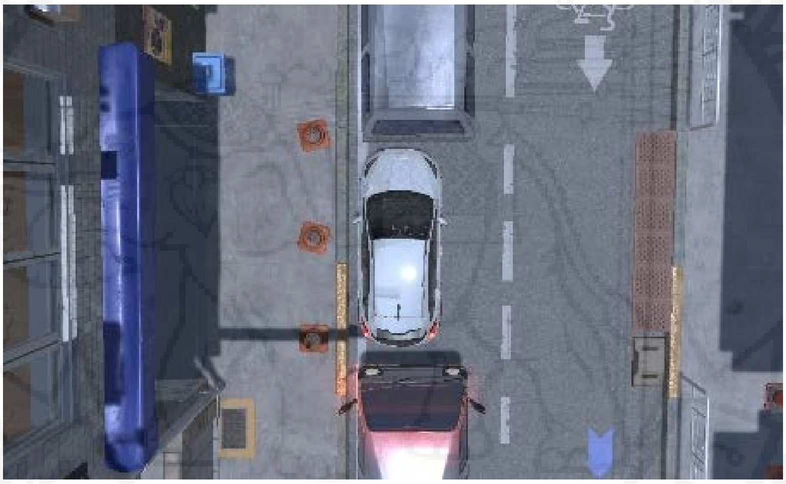

Figure 4 Simulation 3 driving backwards into the parking area

C : Software for the development of virtual reality

Jürgen P. Schulze claimed that a software was required to work in parallel across multiple machines and used multiple calculation principles to manage things such as stereo view calculations, real-time rendering, which must be combined with 3D design software (Schulze, Hughes, Zhang, Edelstein, & Macagno, 2014). Yang Kuang added that because human vision was most sensitive to 3D objects, modeling scenarios for virtual reality systems Kuang and Bai (2018) , therefore was very important. Unity software was a very good tool for creating virtual reality systems, but it is not ideal to be used as a 3D modeling or animation tool (Galvan, Lin, Christie, & Li, 2018). 3D models were creating virtual objects instead of real-world objects such as cars , houses, roads, trees, objects, and color schemes on the surface of 3D models, also using 3D computer graphics techniques (Tang & Ho, 2019), which were used to create 3D models, such as Zbrush, Blender, SketchUp, AutoCAD, SolidWorks, 3Ds Max, Maya, Rhino 3D and CATIA. The researcher used the Blender software to create 3D models as shown in figure 5. Then, models and surfaces were imported into the game engine for the development process. VR had been using Unity Engine as the software to create virtual reality systems. Car models, roads, trees, buildings were introduced into Unity in the FBX or OBJ format.

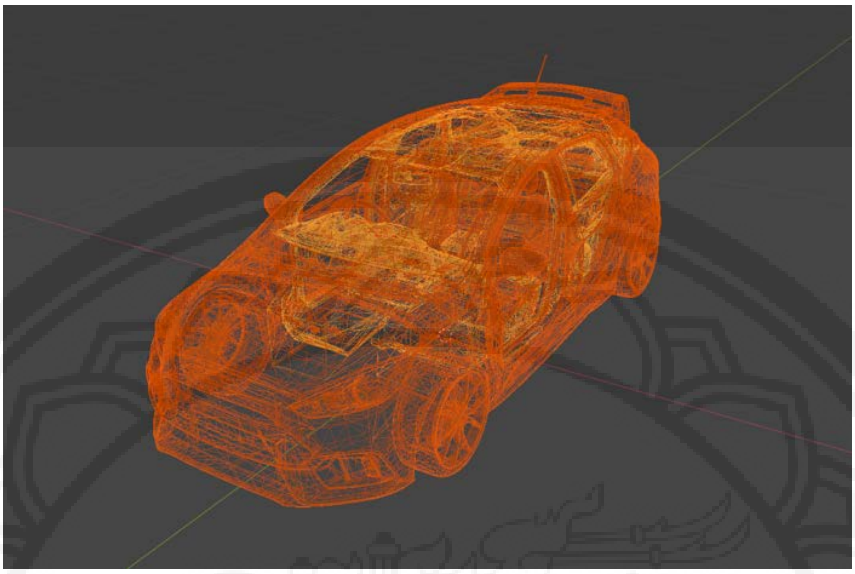

Figure 5 Blender software to create 3D Models

3D models were incorporated into virtual environments to work with Unity. These model components were combined to provide a realistic VR experience (Abrar, 2016). Unity was a very feature-rich game engine for creating interactive 3D content, including an intuitive interface for virtual reality developers. Unity supported and worked with oculus devices by installing the Oculus Integration package which added prefab scripts, previewed tasks, and other resources to be compatible with it. It connected to the head, prefab, first player control, integrated input API for controllers, display features, debugging tools etc (Oculus, 2020).

D: Interaction through input-output devices

With reference to an input device used in response to input - output in a computer system, it is most understood as a keyboard or a simple computer mouse, to a glove that helps grip posture through finger movements. Operations using the keyboard or mouse input and output devices allow users to direct continuous and discrete movements from the real world, and then interpret commands to deliver them to the virtual world (Bailey, Johnson, Chroeder, & Marraffino, 2017). There was also an output device that allows the user to see, hear, smell, or feel everything that happens in a virtual system.

The research studies involved in VR driving simulation relies on seeing the image through a large computer monitor screen, which is the easiest way for drivers to experience virtual reality. However, it has limitations in terms of reality because the monitor may be connected to multiple monitors which usually uses 3 screens to enhance the car's driving even more, but the display is still a 2D display. Three displays are usually used to enhance the driving dynamics, but the display is still a 2D version. It is necessary to design a 3D driving simulator from the original large flat 2D screen to overcome the limitation. There is a weakness in the response when the driver turns his head or changes his observer view, it is unable to analyze the all-around situation as efficiently as it should be. The driver's feeling with the virtual reality experience is critical for safety research and assessments. The more reliable it is, the better it will be to understand the driving situation. Therefore, in this study the researcher focused on the choice of a display, using a special visual display device instead of a flat display. It is a 3D virtual reality glasses or a head mounted display that helps drivers to see 3D images, 360-degree views that interact with the movement of the driver's head turning direction, whether it is top, bottom, left-right, or even head tilt. However, the use of this HMD has its drawbacks, something inevitable with current technology: Virtual Reality Sickness. As several researchers tried to research and analyse the information to solve the problem to keep drivers in the virtual reality as long as possible. Especially in research studies related to VR Driving Simulation that require a considerable amount of time and including the reality seen through the display (Krokos, Plaisant, & Varshney, 2019).

In addition, hearing the sound through the speakers and sensing through the touch of the output device could stimulate the body's senses to perceive the senses and experience more virtual reality; for example, the strength level of the output devices sent to the players had different levels of strength affecting feelings.

Virtual reality media created and developed with Unity Engine must be compatible with 3D headset devices, 360-degree views (Gerschütz, Fechter, Schleich, & Wartzack, 2019). The researcher selected Oculus Rift devices and driving control devices which included steering wheel control, accelerator kits brake and gearbox to achieve the most realistic driving simulation. The devices were used in conjunction with virtual reality media based on human input-and-out perceptive channels, which are divided into four:

1. Visibility refers to visual vision of the head mounted display, showing a 3D image, 360-degree view.

The ordinary The conventional method used to create a 3D image in the virtual world through a display screen showed a single image into two sides, using the principle that the left eye sees the left half of the screen and the right eye sees the right half. On average, the two human eyes are 65 mm apart, which is known as the distance between the pupils, and when looking at the image with both eyes simultaneously, the parallax effect makes it as if the image is 3D.This is an easy way to create a virtual 3D image but there is a problem with the boundary between the image on the left and the right image. This study does not use this method; rather the researcher used a 3D display device called Oculus head mounted display, which has an extended lens to provide a very wide viewing angle. The lenses in the Rift magnify the image to provide a very wide field of view (FOV) to maximize the view. However, this process creates tremendous distortion. Nonetheless, with the oculus developer (SDK) applied post-processing steps to the render view with equal and opposite barrel distortion, so that the visible image returns to normal 3D images as shown in figure 6. (Oculus, 2020).

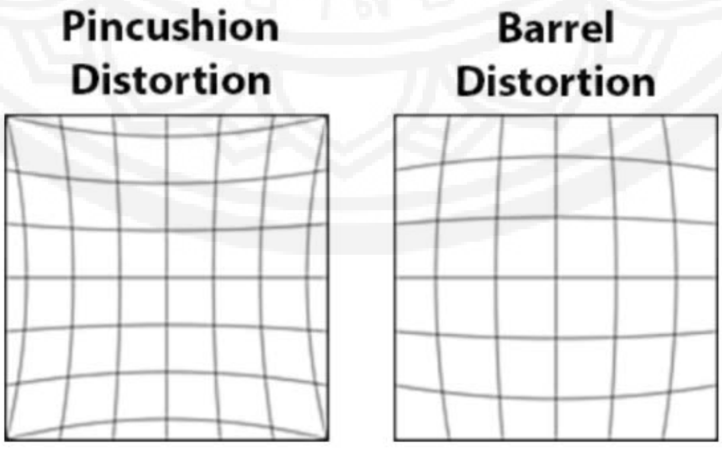

Figure 6 To counteract this distortion (Oculus, 2020)

More than 3D vision, it takes into account the processing of images in the virtual world, which is very challenging to display the reflection through the rear and rear mirrors of the car in real time, which is essential to the production of this virtual reality medium. It allows the driver to see what is behind the car in real-time. In addition to having a realistic reflection, the movement of the mirror's reflection during driving when the driver is looking at the image that appears on the mirror must be seen with smooth movement. It looks natural without tripping or jerking. Therefore, in this study, it is necessary to set the Reflection probe's feature to Realtime as shown in figure 7 (Unity, 2020). To keep the image updated, it is therefore important to adjust the reflection of the light while the image is continuously displayed during the ride. The Refresh Mode helps in terms of how often images should be processed, which, if all frames are processed, can be a problem with processing performance.

As a result, any object or environment placed in a position near or far from the reflection probe can reflect them realistically by configuring the sharpness or resolution of the image rendered through the Reflection probe, considering the speed of the image and the sharpness of the image at the level accepted by the driver.

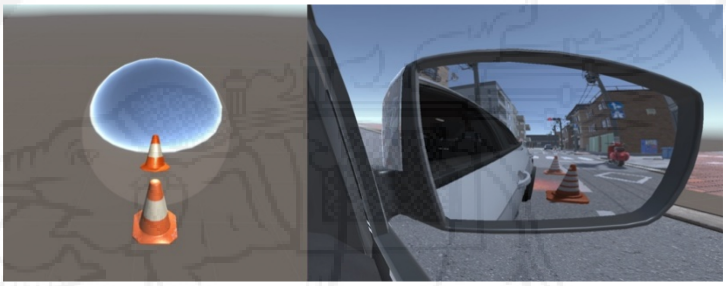

Figure 7 Reflection probe (Unity, 2020)

2. Hearing or listening means hearing sound from the speakers of Head mounted display, showing a 3D image, 360-degree view. This virtual reality medium simulates the sound of events during the ride, the sound of the engine starts, the brake noise, the gear ingress, idle engine noise, the engine noise while driving, and various sound effects, This to indicate as a signal for the driver to know what events are happening. For example, if there is a collision, there would be a loud impact sound according to the weight - lightness of the impact strength, adding to the realism and enjoyment.

3. Haptic refers to the sense of pressure and resistance from the steering wheel control kid, accelerator pedal, brake, and gearbox. Usually, racing games use a keyboard or a joystick to steer cars, but this research requires a control unit that provides the most realistic experience, which consists of steering wheel, accelerator, brake and gear set (Hwang & Ryu, 2010). The features of the device must simulate the resistance between the steering wheel and the road surface; realistically define the driver's exertion to the accelerator and brake pads. The location of the device must be installed in accordance with the driver's position as if one was sitting in a real car. Driving in the virtual world requires a driver's touch to grasp the device instead of looking directly, as the driver sees the image through the head mounted display; therefore, they are unable to look directly at the car control equipment. According to Yuk Ming Tang and Ho's research, VR does not only provide realistic 3D images of virtual environments and sound effects, but participants were able to interact with virtual objects and environments with touch responses. This is especially important in increasing participation and making education and training more engaging. (as shown in figure 8)

Figure 8 Steering wheel control, Accelerator Kits, Brakes & Gearbox

4. Movement refers to the sensory receptors receiving a stimulus or stimulation to the brain to process the two responses and generate the response as a movement through a head mounted display, showing 3D visual effects, 360-degree views. (as shown in figure 9)

Figure 9 Head Mounted Display, allowing to virtually place a trainee in a situation

The motion must rely on Unity's video processing engine that retrieves 3D images to show the environment of the three test courses from the driver's view. The image in the scene can change the view to follow the direction of movement of the head in all directions 360 degrees as shown in Figure 10. Driver view in the driving situation: Scenario 1 driving forward and stopping the car by the pavement in which the driver must turn his head towards the left side view mirror to check the distance between the pavement and the vehicle. Figure 11 shows the driver's view in the second simulation situation, Simulation 2 driving forward and backward in a straight way. In case that the driver wants to reverse the car, it is necessary to look behind the car to check if there are obstacles that would be dangerous. In Figure 12 shows the driver's view in the 3rd scenario, Simulation 3 driving backwards into the parking area. The driver must check the rear-view mirrors, left-right-side mirrors to adjust the distance for the driver to reverse the vehicle parked between the vehicles parked in front and behind.

Figure 10 Driver' view simulation 1. driving forward and stopping the car by the pavement

Figure 11 Driver's view simulation 2 driving forward and backward in a straight way

Figure 12 Driver's view simulation 3 driving backwards into the parking area

Evaluation Methodology

Testing and evaluating the results.

1. Details are being clarified for research projects, objectives, processing time for qualified people in the sample. The sample used in the study were tertiary students, teachers and staff at Rajamangala University of Technology Tawan-Ok: Chakrabongse Bhuvanarth Campus, at least 18 years of age. Purposive sampling is done according to the specified qualifications of 30 people, divided into two groups:

Table 1 The table shows specified qualifications of 30 people, divided into two groups.

Group	People	Specified Qualifications
1	15	1) 18 years of age or older with a driver's license. 2) At least 1 year experience in driving.
2	15	1) 18 years of age or older, who has never had a driver's license. 2) A preparator for obtain a driving license test.

2. Computer and driving controls are installed in a testing room. And, have the testers perform a driving test with a virtual reality medium which is divided into 3 test fields.

Test Field 1: Driving forward and stopping the vehicle by the pavement.

Test Field 2: Driving forward and backward in a straight way.

Test Field 3: Driving backward and parking the car.

3. Collect assessments based on driving tests and in-depth interviews from both groups to assess user satisfaction, virtual reality learning materials, driving for test preparers for practical driving licenses. The questionnaire was used as a tool for data collection. Data were analyzed with descriptive statistics to analyze qualitative data with content analysis.

Experimental Results

Test results of three practical driving positions with virtual reality technology, with the results of both groups of 30 people.

In the demographic, there were 14 female participants, 16 male participants between the ages of 20-30, 21 people, four of 31-40 years old and five 41-50 years of age.

The first group of testers were those with a driving license and had at least one year of driving experience, seven female and eight male, five participants between the ages of 20-30, five ages 31-40 and five of 41-50 years of age.

The second group of testers, who were in the process of preparing for the driver license test were 20-30 years old with seven females and eight males.

Table 2 The table of satisfaction

Virtual Reality Learning Materials Driving for preparator of practical driving license	Satisfaction level	S.D.
1. Content and Presentation		
1.1 Consistency of content with objectives	4.43	0.63
1.2 Suitable for target audiences	4.47	0.57

Table 2 (Cont.)

Virtual Reality Learning Materials Driving for preparator of practical driving license	Satisfaction level	S.D.
1.3 Accuracy, completeness, clarity of content	4.13	0.73
1.4 Content Attractiveness	4.60	0.56
Overview of content satisfaction and presentation	4.41	0.51
2. Design, graphic and presentation techniques		
2.1 Realistic accuracy of car 3D model	4.40	0.86
2.2 Realistic accuracy of field scene driving test 3D models	4.20	0.96
2.3 Realistic beauty of light in driving test field scene	4.20	0.92
2.4 Realistic beauty of colors and patterns on the surface of 3D models	4.10	0.88
2.5 The appropriateness of the soundtrack corresponds to the content.	4.30	0.84
Overview of design, graphic and presentation techniques	4.20	0.80
3. Reality through the car control mechanism		
3.1 Steering wheel response to turning	3.83	0.99
3.2 Accelerator response	4.07	0.69
3.3 Brake response	4.10	0.76
3.4 Gear response for gear switching: forward - neutral - backward	3.90	0.76
Overview of the satisfaction of the reality through the car control mechanism	3.98	0.69
4. Reality through 3D display headset		
4.1 Reality to view of the image (angle of view)	4.10	0.82
4.2 Image movement through 3D display headset	4.00	0.87
4.3 Reality to looking through the left - right side mirror	4.10	0.86
4.4 Reality by looking through the rearview mirror	4.13	0.82
4.5 Sound reality through the speaker, 3D display headset	4.13	0.86
4.6 Quick image response through 3D display headset	4.17	0.65
Overview of reality through 3D display headset	4.11	0.68
5. Skills learned from driving through virtual reality		
5.1 Driving training in the 1st position, driving forward in a straight way	4.27	0.78
5.2 Driving training in the 2nd position, driving forward and stopping at the pavement	4.33	0.71
5.3 Driving training in the 3rd position, driving backward to park.	4.13	0.82
Overview of the skills learned from driving through virtual reality	4.24	0.73
6. Value level of work		
The work is valuable for practical use.	4.33	0.88

The summary of satisfaction assessment in all 6 areas as follows:

Content and presentation showed that all 30 testers were most satisfied with the content's attractiveness. The most satisfied level had a mean of 4.60, with a standard deviation of 0.56. The second is the appropriateness for the target audience. The most satisfied level had a mean of 4.47, with the standard deviation of 0.57. The consistency of the content with the objective had a high level of satisfaction, with a mean of 4.43 and a standard deviation of 0.63 on the accuracy, completeness and clarity of the content and a mean of 4.13, with a standard deviation of 0.73 and the overall content and presentation satisfaction had a mean of 4.41, with a standard deviation of 0.51.

The design, graphics and presentation techniques, the testers were most satisfied with the accuracy of the 3D models of the car with the mean of 4.40 and a standard deviation of 0.86. The second was the appropriateness of the sound composition consistent with the content, the satisfaction level was at a high with a mean of 4.30 and a standard deviation of 0.84. The testers were satisfied with the accuracy of the 3D model of the driving test track and the realistic beauty of the light in the driving test scene. The level of satisfaction is very satisfying, with an average of 4.20, with standard deviations equal to 0.96 and 0.92, respectively. The realistic aesthetics of colors and patterns on the surface of 3D models are very satisfying. The standard deviation was 0.88, and overall, there was a high satisfaction in graphic design and presentation techniques with a mean of 4.20 and the standard deviation of 0.80.

In realistic aspect through the car control mechanism, the testers were most satisfied with the response of the brake pads with the mean of 4.10 and a standard deviation of 0.76. The second was the response side of the accelerator key with the mean of 4.07 and a standard deviation of 0.69. The D-N-R gear switching response was at a high level with a mean of 3.90 and a standard deviation of 0.76. Steering response side for steering had a mean of 3.83, with a standard deviation of 0.99, and overall, realism satisfaction through the vehicle control mechanism had a mean of 3.98 and a standard deviation of 0.69.

Through the 3D display of the head mounted display, the testers were most satisfied with the speed of image response through the head mounted display with a mean of 4.17 and a standard deviation of 0.65. The second is the realism of looking through the rearview mirror and the realism of sound through the head mounted display speakers. The level was very satisfying, with a mean of 4.13, the standard deviation was 0.82 and 0.86, respectively - the realism of the image (field of view) and the realism of looking through the left-right rearview mirror. The average is 4.10, the standard deviation is 0.82 and 0.86, respectively. The 3D rendering headset had a very high level of satisfaction, with an average of 4.00, a standard deviation of 0.87, and overall realism satisfaction through the 3D display headset, with a very satisfied level, a mean of 4.11 and the standard deviation of 0.68.

The skills learned from driving through virtual reality media showed that the most satisfied testers in the first test field were to drive forward and stop by the pavement with a mean of 4.33, the standard deviation equals 0.71. Followed by the training in the second test track, driving forwards-backwards, straight, very satisfied with the mean of 4.27 and a standard deviation of 0.78. Satisfaction in driving training in the third test field for Practicing driving backward and park the car. The participants were satisfied at a high level with a mean of 4.13 with a standard deviation of 0.82. And overall, they were satisfied with the skills gained from driving training through virtual reality. There was a high level of satisfaction with a mean 4.24 and a standard deviation of 0.73.

The Value level of performance was found by testers to be satisfied that the work was worth the actual use with a mean of 4.33 and a standard deviation of 0.88.

In conclusion, users' satisfaction of virtual reality technology learning materials: driving for preparator for a practical driving license test was at a high level with a mean of 4.21 and a standard deviation of 0.71.

Conclusion and Discussion

The discussion of the results of the qualitative data analysis by analyzing the content of virtual reality technology learning materials: driving for the preparator of the practical driving license test from 30 testers found the following:

Age differences affect the satisfaction of virtual reality media users.

According to the results of the study, when comparing the satisfaction of the first test subjects, those who had a driving license and had an average of 9 years driving experience were in the middle age range, most of whom were between 31-50 years of age. Overall satisfaction was less satisfying than the second group of testers. The second group of testers were young adults, aged between 20 and 30, who were preparing for the test. The study found that in terms of content and presentation, the second group was very enthusiastic about virtual reality technology because it was as exciting as playing racing games, and the graphic design and presentation techniques in 3D were familiar with computer gaming. The 3D display did not cause any clutter, heaviness, annoyance. Unlike the first group, who were in middle age, there was a strong opinion that wearing a head mounted display made it felt heavy. The 3D simulations were dizzying and blurry. The steering wheel response feels different from driving it feels more responsive than reality and expects more realistic images and movements than computer games. This led to the fact that even the second group had no prior experience of driving a car, there was satisfaction gained from driving through virtual reality media in all 3 test fields, more than the first group, with the highest level of overall satisfaction. The mean was 4.51 and a standard deviation of 0.69, while the first group, who had experience driving, had a high level of satisfaction with a mean of 3.98 and a standard deviation of 0.68. It was found that the 1st group was satisfied with the value level of the work. The satisfaction with the value level of the performance were based on the results of the assessment of user satisfaction, the learning materials, virtual reality technology, driving a car for a practical driver's license. The satisfaction was at a high level with a mean of 4.00 with a standard deviation of 1.0, while the 2nd test group was satisfied at the highest level with a mean of 4.67 and the standard deviation of 0.62.

Virtual Reality Sickness.

While driving through virtual reality technology provides a similar experience and feel to driving in real-world situations, all of the participants had motion sickness: inconsistencies in movements derived from vision and perception through the vestibular systems sense of movement, sometimes referred to as carsick, seasickness based on symptoms (Aykent, Yang, Merienne, & Kemeny, 2014), which are common, such as dizziness, fatigue, nausea, and symptoms that can occur in driving cars through virtual reality technology. The 40 to 50-year-old testers would experience dizziness as soon as they saw the 3D display, and became dizzier after playing VR for five to 10 minutes, while the 30 to 40-year-old testers felt dizzy as well, but develops symptoms after five minutes of VR and began having a feeling of heaviness of driving after a sudden turn or shift (Lu, 2016). The subjects aged 20-30 had less dizziness than the older group and had symptoms much lesser. However, the dizziness eventually occurs, on average, after 10-15 minutes of playing. According to Eunhee Chang's research, the study had found that the age of VR users could affect the level of sickness (Chang et al., 2020). Nevertheless, most research topics in VR use were limited to most young people in their 20s. Therefore, more research is needed on a wider age group. The safety guidelines for playing VR should last less than 15 minutes to prevent health problems.

Driving skill in the real-world affect driving in the virtual reality world.

Based on observing the driving behavior of the second group of test subjects - those who are currently preparing for the exam to obtain a driver's license and having no real driving experience - tend to be hesitant, thinking, looking at the location of the various devices such as steering wheel, accelerator pedal, brake pedal and gear positions. Some of the testers did not know what a brake was and what the accelerator was; therefore, driving instructions were required. The researcher designed the drive as an automatic transmission with a real-life driving process: reverse gear (R), neutral gear (N), drive forward gear (D) and the accelerator on the far right and brake pedals on the side. It requires a control of the right foot, but some testers do not understand how to drive properly using their left foot to step on the brakes. Another major obstacle is driving in the virtual reality world, requiring hands and feet to touch to locate the device instead of vision, as the driver is looking at the image through the headset. However, the second group, once having understood the process of driving and remembering the device's location, was able to adapt and drive in the virtual world.

For all three test positions consisting of: 1. driving forward and stopping the car by the pavement, 2. driving forward and backward in a straight way, 3. driving backwards and parking the car. Both groups of testers differed in their driving proficiency, with the majority of the first group were able to drive through all three tests, but only one female tester had a severe dizziness and had to leave the test midway due to movement sickness. All members of the second group were able to drive the vehicles in Test 1 and 2, but most of them spent more time training on track 3, reversing and parking.

In conclusion, the result of user's satisfaction was at the high level of the mean of 4.21. Virtual reality media is suitable for drivers in their 20-30s who are eligible for the driving license exam with great enthusiasm for virtual reality technology. As the participants were as excited and interested as playing a racing game, they had to go through the instructions on the steps and how to drive properly, and finally able to practice driving through the virtual reality technology learning materials. The suggestion was that VR media should be used no longer than 15 minutes to avoid the Virtual Reality Sickness problem. There should be more training grounds and a test score rating like a computer game. There should be a clear traffic sign and a comfortable lightweight head mounted display with a clearer visual impression.

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