Virtual Reality Adventures as an Effort to Improve the Quality of Welding Technology Learning During a Pandemic

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Abstract—Indonesia is one of the countries affected by changes in the education system and learning activities. Learning media aims at attracting students' interest in improving their cognitive and understanding of learning. The selection of media should be based on the following criteria: effective, useful, flexible, affordably accessible, and most importantly in line with learning objectives. Therefore, Virtual Reality-based learning media is the right technology for building online learning conditions to appear more real and real-time. This study aims to develop a VR-based learning media for welding technology courses. This study employed a Research and Development (R&D) method with a 4D development model consisting of define, design, develop, and disseminate. Stages are carried out in stages with analytical and experimental formulations. The results showed that the total average indicators of the VR learning media material validation which was 0.87 (valid) and the design validation assessment was 0.88 (valid). It can be concluded that the validation results of the learning media developed are declared valid and have been well tested and are effective to be applied to welding technology learning.

Keywords—welding technology, virtual reality, learning media

1 Introduction

Education has experienced some downturns due to the Covid-19 pandemic which has changed learning patterns to passive and the internet network is not adequate during online learning. However, the most important factor that caused the downturn is the readiness of human resources and students since the existing facilities will not function if educators are not yet ready [1], [2]. This affects the development of human sustainability as a capital of skills and knowledge needed in the future. According to [3], education aims to develop the ability of students to become people of faith, character, knowledge, independence, creativity, and innovation. Technological developments in the era of the industrial revolution 4.0 affect various human activities rapidly becoming increasingly sophisticated so that it will greatly affect every kind of job [4]. The quality

of Indonesian education in recent years has been very concerning. This is due to various problematic factors such as the education system, education sector management, educational facilities, and infrastructure which are inadequate in some areas [5]. Education is an effort carried out as an effort to develop human resources that have the potential to play an active role in the learning process [6].

The development of science and technology has a significant impact on the education sector [7]. Technological advances in the era of society 5.0 have the opportunity to improve the quality of education in achieving creative, interactive, and innovative learning processes which can compete with countries with the best education systems in the world such as Finland, Japan, the United States, Canada, etc. Moreover, technology in education provides easy access to information in delivering learning materials which can be positive, relevant, and effective solutions to support distance learning [8]. In addition, the learning process should provide easiness in delivering materials to create a more lively and interactive learning atmosphere integrated with technology in building visualized learning media. The steps of learning integration are as follows; (1) analysis of target users, (2) grand design, (3) preparing human resources for implementing the learning process, (4) determining and implementing technology, (5) launching system [9]. So that the integration of learning is expected to be able to explain important factors that affect the learning process based on the latest technology.

Technology in the digital era has grown significantly and has made it easy for humans to utilize existing technologies such as smartphones, computers, laptops, modern machines, Augmented Reality, Virtual Reality, Mixed Reality, Artificial Intelligence, etc [10]. Besides, technology has made a lot of contributions to various sectors including the education sector. According to [11], technology has made work easier and more efficient. One of the benefits of today's technological developments is the use of Virtual Reality (VR) technology, a media that provides a real picture of users in cyberspace. Vocational education is education that provides students with the ability to facilitate human resources to learn competency skills and work independently [12]. Vocational education is an effort to re-engineer existing education so that there will be a vocational education system that resembles the system in developed countries [13]. Online lectures, particularly practice in fabrication workshops, cannot be carried out optimally so the essence of the learning process needs to be addressed.

Virtual Reality is a technology that allows users to enter the virtual world and interacts indirectly (virtually) which can display 3D images visually [14], [15]. Generally, Virtual Reality is often used as a 3D-based game that is carried out in the world in real-time. Therefore, it is important to develop Virtual Reality technology that combines special input and output devices so that the students can interact in the virtual world environment. Moreover, it surely becomes interactive learning media to overcome problems due to learning transitions. Therefore, this study aims to develop a VR-based learning media with a 4D development model research method which is classified as systematic according to the stages of learning media development [16].

During the pandemic Covid-19, learning welding technology was carried out online. The competencies expected to be achieved by students are that they student can perform basic welding techniques using SMAW (Shielded Metal Arc Welding) welding machines. However, these competences were not well achieved, because students

merely mastered the basic theory of welding. This virtual reality-based application should contribute to the achievement of the learning objectives of these courses, which are carried out remotely. A VR application is designed, developed, and tested among experts in digital learning media development and welding technology course.

2 Literature review

2.1 Instructional media

Learning media means an intermediary, while learning is defined as a condition that makes a person perform a learning activity [17]. Learning media is an important tool in the learning process as it transmits information from the source (messenger) and the recipient of the message. In other words, media can be seen as a means to deliver information from the source to the recipient of information [18]. The function of the media is to become a means of information for the general public and as a form of disseminating education to the public. According to [19], learning media is used as a tool to deliver the material in the teaching and learning process so that learning objectives can be well achieved.

In the selection of learning media, there are several stages involved which are (1) analyzing students' needs before determining the form of learning media, (2) setting goals to achieve interactive learning media, (3) targeting materials and feedback in preparing learning media, (4) Further development of technology-based learning media, (5) evaluating each media that has been successfully used to see the level of success of the learning media.

Providing learning media in the teaching and learning process gives merits to the students [20]. First and foremost, learning media increases the students' attention and motivates them to increase learning effectiveness according to their level of development. Another advantage is that learning media has variations and is not monotonous. Lastly, because of the media, learning becomes more practical and increases students' participation.

2.2 Virtual reality

Virtual Reality is a technology that makes users interact with an environment that is simulated by a computer (computer-simulated environment), an actual environment that is imitated, or truly an environment that only exists in imagination [21]. Virtual Reality allows users to interact with the virtual world environment through a digital room where all user movements can be seen. The important thing about Virtual Reality is the level of technology which includes simulation in real time and interaction on various sensory channels through a controller that is in each hand and has buttons to move each character's finger [22]. According to [23], evaluating the ability of an immersive VR system the results of their study show "better spatial perception in non-immersive VR environments, and better overall spatial perception of virtual models when using immersive environments."

Fig. 1. Oculus Rift-Virtual Reality (VR)

The advanced technology of Oculus rift is a tool in the form of a headband that covers the eyes to see the layer and the ears to stay connected. It is usually used by gamers to go to the virtual world gate in the future [24]. The atmosphere provided by VR is equipped with headphones to provide sound effects and a joystick to interact directly in the virtual world. The users can feel the virtual world more real providing a dazzling visual display. The following is one of the simulations using Oculus Rift VR.

In VR, 4 important elements should be highlighted. The first one is the Virtual world which is a type of content that creates virtual worlds in the form of screenplays and scripts. Next is immersion which gives the user of Virtual Reality technology the feeling that they are in a fictitious real environment. In addition, immersion is divided into 3 types, namely: (a) Mental immersion which is to make the user mentally feel like he/ she is in a real environment, (b) physical immersion which is to make the user physically feel the atmosphere around the environment created by the Virtual Reality, (c) mentally immersed which is to give the user a sensation to be immersed in the environment generated by Virtual Reality. The third element is Sensory feedback which serves to convey information from the virtual world to the user's senses. This element includes sight (line of sight), audio (hearing), and touch. The last one is Interactivity which is tasked with responding to user operations so that users can interact directly in cyberspace. Moreover, the user sees a pseudo world which is a dynamic image. Through headphones or speakers, listeners will hear realistic sounds. Besides, all movements will be monitored by a system, which will respond accordingly, through headphones, gloves, and walkers so that the user feels as if he/she is experiencing a real situation both physically and mentally.

3 Methodology

3.1 Research methods

This study was a Research and Development (R&D) which aimed to produce innovative, practical, effective, and valid learning media innovations. According to [25], the R&D method is a research method used in producing certain outputs/products and testing the effectiveness of the products. Moreover, this study particularly employed the 4D development model (Thiagarajan, S., Semmel, D., Semmel, M.I., 1974) because, in terms of the phases, this model is more systematic and detailed. The process began with the define stage and ended with the disseminate stage of the limited field trial process. More detailed elaborations are as follows.

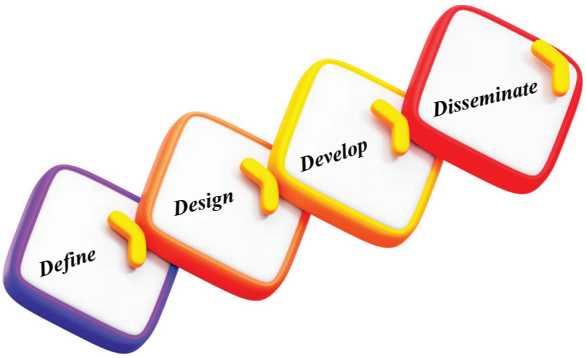

Fig. 2. Chart 4D model (Thiagarajan, S., Semmel, D., Semmel, M.I., 1974)

Define. The define stage is carried out to get an overview of conditions in the field. In this stage, students' needs were analyzed for the process of developing an assessment design. The define stage involved two stages which were observation and studying student characteristics.

Design. At this stage, there were two steps carried out. The first step was designing a prototype and making an initial design (prototype) of a VR-based learning media design with the Exploratory Tutorial method whose content was adjusted to the applicable syllabus. The next step was producing learning media based on Virtual Reality which was conducted after the prototype design was completed.

Develop. At this stage, the following steps were carried out. First was the model validation step which served to see the suitability of the design with the forming elements of the VR-based learning media itself then consulted and discussed with experts. The second step was activity development trials which focused on evaluating whether the prototype (the initial design) could be used as expected and was effective to improve the quality and student learning outcomes. Lastly, the trial phase was conducted in which the media was used in the classroom. Besides, to find out how effective this media was, quasi-experimental research was undertaken.

3.2 Research procedures

Product trials were carried out to obtain data on the validity of virtual reality-based learning media developed including: (1) Preparation of questionnaires by adopting from [26]. (2) media validity testing through validator suggestions (3) individual validity test using 43 respondents table. 1 to see the validity of media based on didactic terms, construction terms, and technical terms. This paper only focuses on testing the validity of the developed learning media. As for testing practicality and effectiveness, it has not been discussed in this paper.

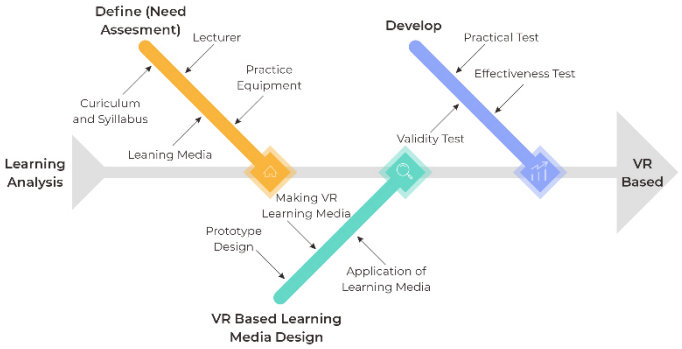

Fig. 3. Fishbone of research diagram

3.3 Research instruments data

The primary instruments to collect the data in this study were three questionnaires. Firstly, the material assessment questionnaire (teaching materials) was a questionnaire containing several responses or aspects assessed regarding the suitability of the material with the Welding Technology syllabus. Secondly, the product validation questionnaire contained expert responses on several aspects such as attractiveness, clarity, color composition, VR-based job sheets, language simplicity, and communicative aspects as well as the suitability of the questions with learning objectives. The last instrument was a wide-scale trial questionnaire using tests.

3.4 Population and samples

The research population is the area of generalization of the object/subject studied by the researcher has characteristics and qualities that are determined by the researcher and then until the conclusion is drawn [27]. The population research taken were students of the Diploma 3 study program, Department of Mechanical Engineering FT-UNP class of 2020.

Table 1. Population research

Courses	Number of Students
Diploma 3 in Mechanical Engineering	76
Sum	76 people

The sample is the part of the population studied that has characteristics that the part of the population [27]. The study used a random sampling technique by taking samples and a population of 76 people, so the researchers determined the sample with slovin's formula [28].

$$n = \frac{N}{1 + Ne^2}$$

Where :
n = Sample Size
N = Population Size
e = Percent of inaccuracy allowance (10%)
It is known that (N) the number population is as much as 90% of students and the percentage of inaccuracy is 10%, then the number of samples can be obtained as follows:

$$n = \frac{N}{1 + Ne^2}$$

$$n = \frac{76}{1 + 76(0.1)^2} = \frac{76}{1 + 0.76} = \frac{76}{1.76} = 43.18$$

The research sample amounted to 43 Diploma 3 study programs, Department of Mechanical Engineering FT-UNP class of 2020.

3.5 Data analysis technique

The data were analyzed by checking the validity of each statement item using the Aiken's V statistical formula formulated as;

$$V = \sum s / [n\,(c - 1)]$$

The results of the Aiken calculation range from 0 to 1 and the number 0.6 can be interpreted as having a fairly high coefficient, the V value of 0.6 and above is stated in the valid category [29].

4 Results and discussion

4.1 Results

This study aimed to develop a Virtual Reality based learning media in welding technology courses for Mechanical Engineering students at, the Faculty of Engineering, Universitas Negeri Padang. This learning media can be installed on VR Headset devices and Windows operating system computer devices. Additionally, the results of each stage in producing VR learning media for metal welding technology courses are elaborated in the following sections.

Define. The observation was undertaken at the Department of Mechanical Engineering, Universitas Negeri Padang. Welding technology is one of the compulsory subjects that must be mastered by mechanical engineering students. This is a practical practice with various competencies in the metal welding field. Based on observations and online learning experiences, many students had trouble understanding the material which made the learning process ineffective. Besides, lecturers were not able to create conditions that allowed the students to have some direct practices. To obtain more detailed information, an interview was conducted with lecturers teaching this course. Based on the results of the interview, it is found that many expected competencies in this course

were not achieved. Besides, they agreed that a VR-based learning media was needed to provide more information with interesting presentations so that students were able to achieve competence in welding technology courses, create a real environment of welding even though it is virtual, and make learning more effective.

Reviewing the curriculum refers to the synopsis and a lesson plan for welding technology courses. In synopsis, there were two main discussions which were identifying the scope of S.M.A.W (Shielded Metal Arc Welding) with 4 learning outcomes; (1) understanding the welding techniques, (2) understanding the components SMAW welding tools and equipment, (3) being skilled at welding fillets, (4) being skilled at welding grooves.

The focus of building VR-based learning media was related to learning objective 1 in the syllabus which is "the students' can understand welding techniques". This VR-based media was designed interactively so that the users could practice welding techniques in a down-hand position. Additionally, several things need to consider. First, the identification of content required for VR-based learning media was useful for controlling student learning outcomes. The learning activities as the basis for building VR learning media for welding technology courses were: Design of S.M.A.W (Shielded Metal Arc Welding) learning components and Welding Components TIG & MIG, virtual design of S.M.A.W (Shielded Metal Arc Welding) welding process and virtual design of TIG & MIG welding engineering processes. Furthermore, the contents needed in making this VR-based learning media were: (a) Welding room design, (b) Main welding equipment (welding machine, electrodes, etc.), (c) Auxiliary equipment (slag hammer, steel brush, etc.), (d) Welding safety equipment (Welding hood, welding apron, gloves). The second aspect was to analyze the VR-based learning media application system. This media was designed using the C# programming language because it was considered strong enough in developing applications that would be installed on VR devices. In addition, VR learning media was built with the help of the Unity 3D Version 2019 application which this application already supported the Oculus integration library to build virtual environments and interactions.

Design. At this stage, VR-based learning media for welding technology courses was developed through several stages. First is the system of functionality. This system was a single user or only accessed by one user. This application required a VR device in the form of Oculus to operate it. The user had the role of controlling the course of the VR learning media application since in this application there was no client-server interaction, also known as stand-alone. Moreover, in operating a VR-based learning media with a VR device in the form of Oculus there are some steps. Firstly, the application is opened through the Oculus Quest VR device which has been installed. Then, the user puts the VR device on the head. Lastly, the user can directly interact with VR learning media virtual environment.

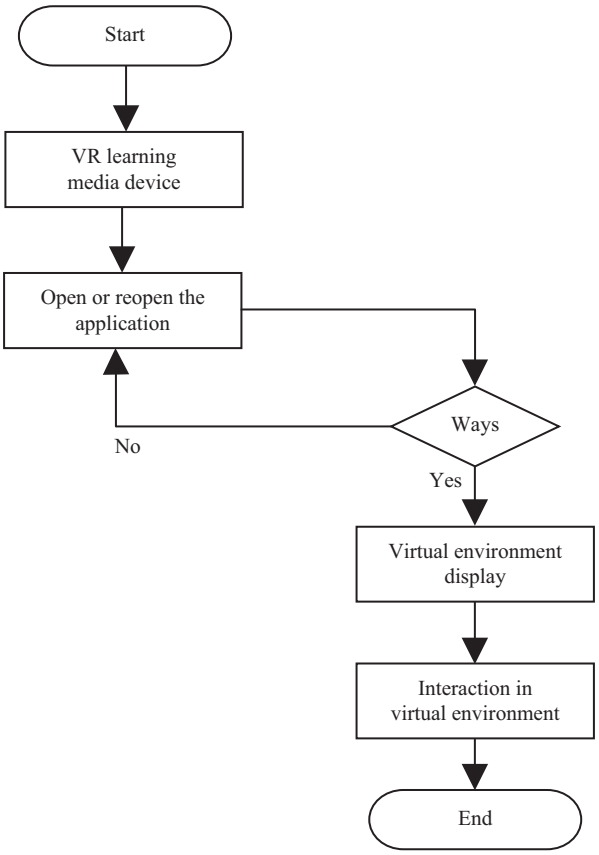

Fig. 4. VR-based learning workflow

In the above Figure, it can be seen that the user has a role as controller of the Virtual Reality-based learning media application. In this application, there is merely one user in which there is no client-server interaction. In VR learning media there is a main character that can be controlled by the user. The character is the intermediary for interaction between the user and the application. The point of view of the character's vision is based on the point of view of the user's eyes, called the first person. The second step in designing the media was system design consisting of several aspects; designing Virtual Objects (3D Assets) and Texturing Assets 3D which were created using the blender application, and operating System design. The system to be built on this application can be operated on Oculus VR devices based on Android with a minimum version of Android 6.0 (Marshmallow). In designing the system, the 3D environment was first arranged in the form of virtual rooms, tables, and virtual objects needed according to the coordinates of the position of other virtual objects.

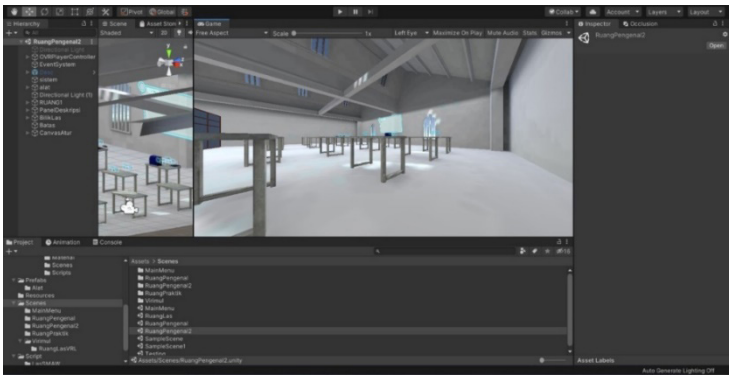

Fig. 5. Virtual environment design

Figure 5 is a design of a virtual environment for the introduction of S.M.A.W (Shielded Metal Arc Welding) welding components. The design was planned in such a way by referring to the Fabrication workshop, Department of Mechanical Engineering, Universitas Negeri Padang to facilitate access and interaction between users and virtual objects. The last aspect considered in this second step was that the interface for this Virtual Reality-based learning media application was designed to user friendly.

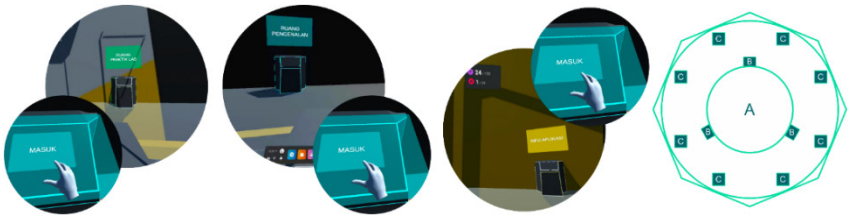

Fig. 6. Features and introduction room, welding practice, and Application info

Figure 6 shows the main features of the system in which there are main menus. First is the tool and material introduction room consisting of protective gloves, slag hammer, steel brush, etc. The second menu is the welding practice room which is the place where the welding process is carried out before the need for preparations such as electrodes, transformer/welding machine, welding handlebars, and electric welding cables, which function as the main component in the welding process to unite two metals into a connection form through a simulated heating process virtually. The last one is application info that provides information about the developer, software version, function of tools, and materials.

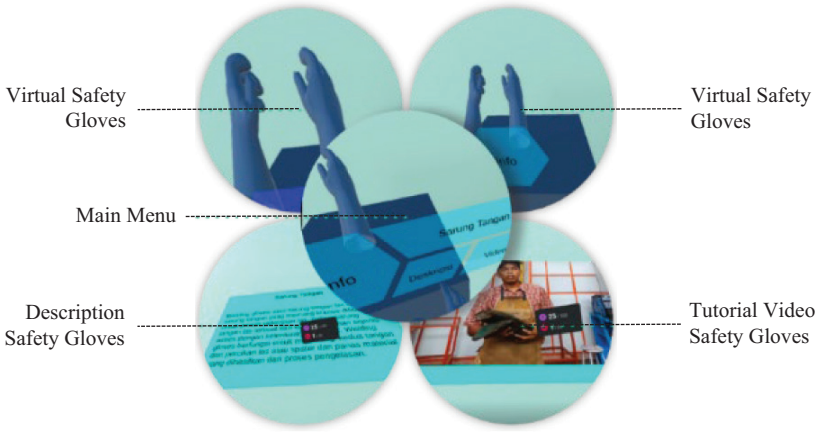

Fig. 7. Virtual safety gloves

Figure 7 shows what a virtual safety glove looks like. These gloves function as a personal protective device in the S.M.A.W (Shielded Metal Arc Welding) welding process to protect the hands from electric current, radiation, impact and blowing hot and cold temperatures, and scratches from sharp/rough objects. This tool was designed in the form of virtual objects as an alternative to simulating welding practices using Virtual Reality-based learning media designed to understand the importance of workplace safety.

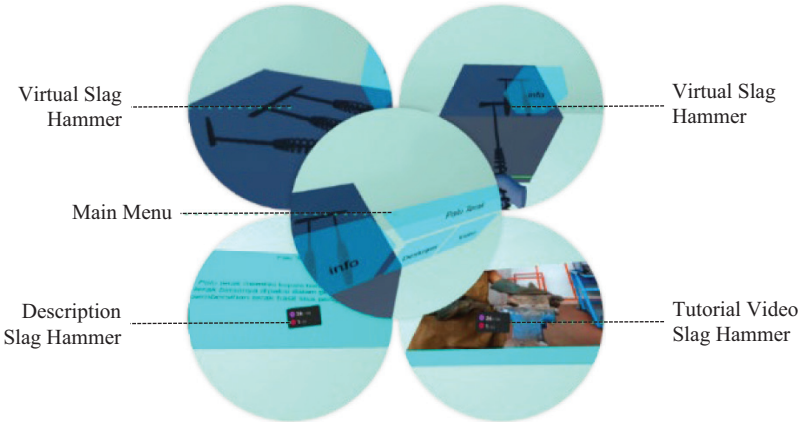

Fig. 8. Virtual slag hammer

The virtual slag hammer shown in Figure 8 is used as a tool to clean the welding for the protective type welding process using spatter and flux (welding sparks). The way to clean it is by hitting or scraping the slag and sprinkling it. The virtual slag hammer, one of the equipment components in the S.M.A.W (Shielded Metal Arc Welding) welding process, was designed in the form of 3D objects based on Virtual Reality in the practice of cleaning welding results.

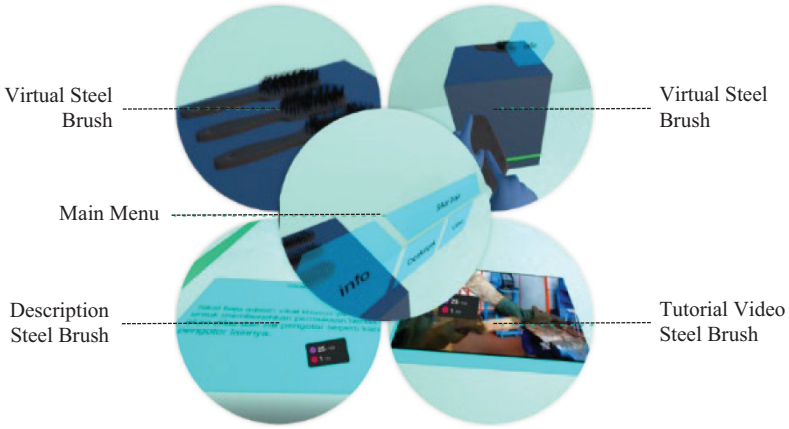

Fig. 9. Virtual steel brush

A virtual steel brush shown in Figure 9 was designed to clean the surface of the object to be welded from dirty substances such as oil, rust, other impurities, and the welding slag and dust. How to operate it is by rubbing the surface of the object to be welded or after welding to get the maximum welding process from the results of S.M.A.W (Shielded Metal Arc Welding). Designing Virtual Reality-based learning media software interfaces is a form of technology utilization in simulations using virtual steel brushes.

Fig. 10. Virtual welding machine and welding process design

Figure 10 shows a virtual welding machine that is the main component in welding to convert electrical energy into heat energy. The design of the welding process is the process of joining 2 objects by compacting the metal into a joint form using the S.M.A.W (Shielded Metal Arc Welding) welding process so that heating occurs by melting the metal part through the electrode as a filler [30]. Designing learning media using technology-based Virtual Reality technology makes it easy to use in its virtual application using the Occulus rift tool.

Develop. At this stage, the development of VR-based learning media for welding technology courses began. 6 stages needed to be undertaken. The first was the Oculus Integration Framework. At this stage, several object frameworks such as characters (players), grabbles that function for scripts so that a virtual object can be held by the character's hands, and various other features that function to develop Virtual Reality learning media applications were provided. Furthermore, accessing Oculus integration can be done by importing packages through the unity asset store. The second step was displaying the Initial Interface which was useful for creating a splash screen display. Unity has provided a splash screen image upload feature and it could be done by following these steps; File → Build Settings → Player Settings → in the inspector select Splash Image. The next step was to display a description of the welding process aids. Display the description, it was done by touching a panel on each welding component. Touch on the panel could be made by utilizing the collision between the virtual finger collider on the character and the collider on the panel. The fourth one was displaying a grabbable effect to make a virtual object be picked up by the character's hand. To create a grabbable effect, the grabbable script from the oculus integration frame was placed into the virtual object that you want to retrieve and inserted the OVR Grabber script from the oculus integration frame into the character's hand. The next step was to pair the electrode virtual object with the welding handlebar virtual object. The installation was done by utilizing the calculation of the distance between the welding handlebar virtual object and the electrode virtual object. At a certain distance, the electrode would be attached to the welding handlebar. The last step was trial. This was done to ensure the application could run smoothly and according to the plan. The testing consists of (a) displaying the application starting with a splash screen, (b) testing the character controlled by the user, – if the character's hand can be controlled with the oculus controller and the character can run according to user control then the test is successful, (c) testing the touch between the character's finger and the description panel, – the more precise the touch between the character's finger and the panel, the better the touch, and (d) testing the take on each virtual object, marked by the virtual object being taken attached to the character's hand.

Validation and revision. In this stage, the validity of Virtual Reality-based learning media was measured using a questionnaire. The questionnaire was distributed to three validators who were experts in digital learning media development and welding technology Course.

Table 2. List of validators

No	Validator	Expertise	Position
1	Validator 1	SMAW Welding Technology Universitas Negeri Padang	Mechanical Engineering Lecturer UNP
2	Validator 2	SMAW Welding Technology Universitas Negeri Padang	Mechanical Engineering Lecturer UNP
3	Validator 3	Digital Learning Media Development	Technology Education Lecturer UNP

The validity process was carried out through a group discussion forum (FGD) with the abovementioned experts. Moreover, the validity results were measured using a

validated questionnaire to see its validity. The results of the validity test are presented in the following table.

Table 3. Material validation instrument

No	Aspect Assessment	Indicator of Assessment	Validity Score	Note
1	Content Quality	a) material coverage is right	0.86	Valid
		b) learning materials are according to the syllabus	0.77	Valid
		c) the use of words in this material is good	0.78	Valid
Average			0.80	Valid
2	Quality of learning	a) clear learning objectives	0.82	Valid
		b) clear learning flow	0.96	Valid
		c) interesting student learning	0.92	Valid
		d) increasing student learning motivation	0.93	Valid
		e) facilitating students to learn independently	0.92	Valid
Average			0.91	Valid
Total Average			0.87	Valid

Based on the results, it can be seen that the average score of the feasibility aspect of the content and learning quality aspect were 0.80 and 0.91 respectively which were in the valid category. Besides, the table also presents the total average from both indicators of assessment for VR learning media validation which was 0.87. Therefore, it can be concluded that the content of the module was in the "valid" category.

In the next stage, individual testing was carried out to see the response of students to the media in terms of didactic, construction, and technical media using questionnaires. The questionnaire was distributed to 43 respondents who were taken randomly and then shown learning media using VR glasses and asked for respondents' responses to the media provided. The results of the student responses are illustrated in the table below.

Table 4. Design validation instrument

No	Aspect Assessment	Indicator of Assessment	Validity Score	Note
1	Didactic Terms	a) This VR media was made referring to the educational curriculum at the D3 Mechanical Engineering Faculty of Engineering, Padang State University.	0.87	Valid
		b) The depth of the material is on the level of understanding of D3 students.	0.84	Valid
		c) The animation shown can stimulate the mind.	0.96	Valid
		d) Activities on VR Media support students' understanding of concepts	0.8	Valid
		e) This VR media can require students to be active in learning	0.83	Valid
Average			0.86	Valid

(Continued)

Table 4. Design validation instrument *(Continued)*

No	Aspect Assessment	Indicator of Assessment	Validity Score	Note
2	Construction Terms	a) It uses simple, clear, and easy-to-understand sentences.	0.94	Valid
		b) This VR media can increase students' interest in learning.	0.93	Valid
		c) This VR media can make learning situations fun.	0.87	Valid
		d) This VR media has a clear learning goal and learning motivation	0.88	Valid
		e) The material in this VR Media is presented systematically.	0.67	Not Valid
		f) This VR media can facilitate students to learn independently.	0.85	Valid
Average			0.89	Valid
3	Technical Terms	a) The VR media uses the right typeface	0.90	Valid
		b) It uses language that is easy for students to understand.	0.93	Valid
		c) It displays animation on VR media that is clear and attractive.	0.97	Valid
		d) This VR appearance is interesting	0.89	Valid
		e) The font size selection in Media VR is right.	0.88	Valid
		f) The text/sentences in VR are made in clear language	0.78	Valid
		g) It uses colors that can stimulate students.	0.83	Valid
		h) This intro (opening part) attracts students' interest in learning	0.84	Valid
		i) The content (text and animation) makes it easier for students to understand the material being taught	0.87	Valid
		j) This part of the Media VR cover is clear	0.6	Not Valid
		k) The choice of the background color is contrasting.	0.93	Valid
		l) The color of the text with the background color in Media VR is clear	0.96	Valid
		m) The use of language in this VR Media is following good and correct Indonesian	0.94	Valid
		n) The sentences used in this VR Media are easy to understand	0.87	Valid
Average			0.82	Valid
Total Average			0.86	Valid

Based on the results of the analysis, it is shown that the average validity for the didactic, media construction and media technical aspects were 0.86, 0.89, and 0.89 respectively. These results were in a valid category. Moreover, the total of the three aspects was then calculated, and the total average was 0.88 indicating that the media was valid.

4.2 Discussion

Previous research on the development of welding technology learning media was conducted by [31] who used Virtual Reality media which provided an overview of the virtual world that appeared in the real world and was interpreted in real time. Meanwhile, the

media developed in this study is a Virtual Reality-based learning media for welding technology which manifests users interacting in a virtual world environment that is simulated directly by Oculus Rift Virtual Reality so that the users are in a virtual world. Moreover, these Virtual Reality adventures are designed in such a way using software consisting of android studio, blender, vuforia engine SDK, and unity. With VR welding technology that provides a visually simulated display in real terms starting from the preparation of the welding process, namely (1) introduction to the demo features of the introduction room, practice room, and application info, (2) introduction of tools and materials using video tutorials and infographics, namely safety gloves, slag hammer, steel brush, electrodes, welding machine, and (3) virtual direct simulation of the welding process using the oculus controller as a hand mover that provides a vibration sensation during the welding process. Learning is carried out online using the zoom platform to directly demonstrate the SMAW welding process by teachers using the oculus rift virtual share screen method with a combination of side quest applications so that students can understand the theory of learning welding technology online. The trial of this product was carried out on 1 student with a duration of 2 minutes and after using the media directly filled out the questionnaire and questionnaire that has been provided to see the practicality of virtual reality media. Based on the following video link: https://bit.ly/WeldingTechnologyVR.

VR-based learning media for SMAW is built using the Exploratory Tutorial method for the Welding Technology course for Mechanical Engineering Study Program, Universitas Negeri Padang. The concept built in this media is the Exploratory Tutorial, which allows students to explore the menu provided and the students are allowed to feel the real welding atmosphere without preparation or reading the material in the teaching material. On the other hand, students can still do independent learning and continue to take tests. This SMAW learning media has been tested for its validity are declared valid indicating the learning media developed has appropriate learning materials to facilitate learning which is carried out remotely.

5 Conclusion

The VR-based learning media designed in this study is declared valid in each aspect being assessed which are the material, module format, and design aspects with the results of validity scores of 0.87, 0.87, and 0.86 respectively. The VR-based learning media in welding technology is hopefully able to provide experience to students in doing welding even though it is done virtually without real welding equipment. However, the development of this application is still in the progress and reaching the expert validity stage. In addition, it still requires various kinds of further testing to improve the quality and effectiveness of this media.

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