Creation of Interactive Learning Media Introduction to Basic Phrase Practicum Based on *Virtual Reality Technology*

Antonius Adi Soetopo*[1], Yogi Muldani H[2], Dede Buchori Muslim[3], Suseno[4]

Manufacturing Engineering/Manufacturing Polytechnic Bandung, Indonesia [1,2,3,4]

Email: adisutopo@polman.bandung.ac.id

Article Info

Keywords:

Milling Machine, Virtual Reality Technology

ABSTRACT

Interactive Learning Media in the learning process can be in the form of a relationship between humans and computers or software that allows active learning by not only seeing and hearing but also being able to do something. At the beginning of 2020, the world was shocked by the Covid-19 virus which caused people from various fields to work at home or online (online), including in the field of education. The practicum learning process at the Bandung Manufacturing Polytechnic was constrained during the pandemic because it was not fully carried out offline. One of them is the manufacturing process practicum, so an online learning media was created regarding the clamping of workpieces and cutting tools in the basic milling manufacturing process practicum based on virtual reality technology. This virtual reality-based learning media is made with Unity 3D software. The interactive learning media that has been created is installed on the Oculus Quest 2 device. The learning media includes an introduction to milling machines, clamping workpieces and cutting tools. The results of the virtual reality technology-based learning media testing questionnaire to students showed that the average respondent strongly agreed with 58% for the six aspects of assessment and overall effectiveness with a result of 88.34%.

Corresponding Author:

Antonius Adi Soetopo

E-mail: adisutopo@polman,bandung.ac.id

INTRODUCTION

At the beginning of 2020, the world was taken by surprise with the outbreak of the COVID-19 virus, which necessitated a global shift in how people work and interact. This pandemic forced individuals from diverse fields to adapt to remote work or online modalities, significantly impacting the education sector. Educational institutions worldwide had to rethink and restructure their teaching and learning processes to accommodate the new reality of remote education.

In Indonesia, the education system is governed by various laws, including Law No. 12 of 2012. According to Article 59, Paragraph 6 of this law, polytechnics are defined as higher education institutions that offer vocational education in various clusters of science and/or technology. These institutions, if meeting certain eligibility criteria, are also permitted to offer professional education.

Furthermore, Article 16, Paragraph 1 of the same law clarifies that vocational education refers to higher education diploma programs designed to prepare students for employment by equipping them with specific applied skills, extending up to applied undergraduate programs.

The Bandung Manufacturing Polytechnic is one such state university that offers a robust vocational education system. Its curriculum is designed to prepare students for the workforce by emphasizing practical skills through a hands-on learning approach, with a greater focus on practicum sessions than theoretical lectures. This practical orientation is crucial in fields such as manufacturing, where hands-on experience is indispensable for mastering the necessary skills.

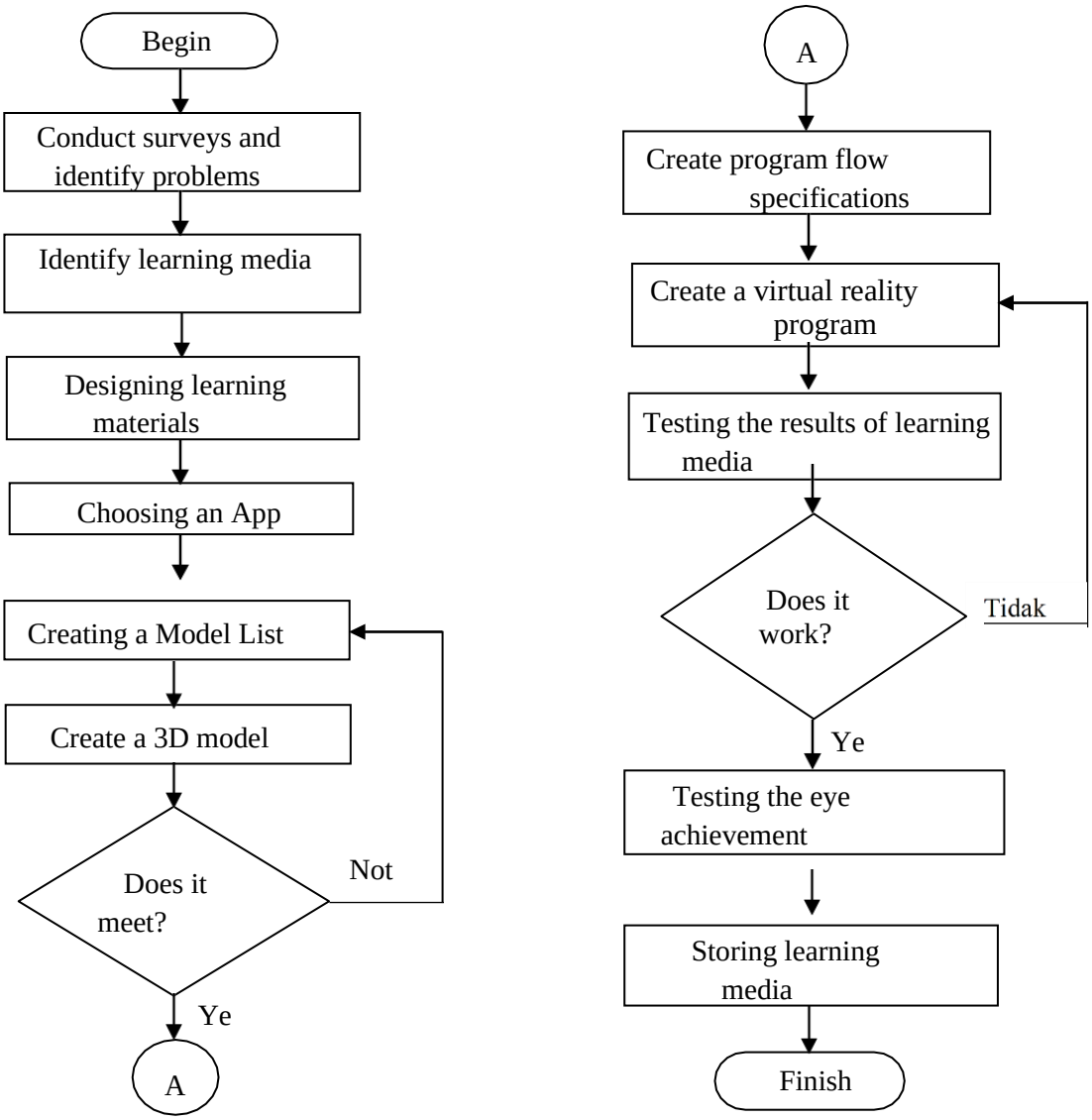
However, the COVID-19 pandemic posed significant challenges to this practicum-based learning model. One of the primary obstacles was conducting practical sessions, such as the basic milling practicum, which is essential for students in the manufacturing engineering department. To adapt to the pandemic's constraints, the basic milling manufacturing process practicum was restructured to be conducted over three days online and two days offline. This hybrid approach, while necessary, revealed several inefficiencies. Online learning was perceived as less effective and did not adequately support the offline sessions, as evidenced by feedback from a questionnaire distributed to first-year students in the department.

In response to these challenges, innovative solutions were explored to enhance the effectiveness of online learning. One such solution was the development of an online learning medium that simulates the clamping of workpieces and cutting tools on milling machines within the context of a manufacturing process practicum. This simulation is based on virtual reality (VR) technology, which offers an immersive learning experience. VR technology presents a promising avenue for educational development, allowing students to engage in practical exercises in a virtual environment. This approach enables students to project themselves into a virtual world where they can perform practicum activities, thereby bridging the gap between theoretical knowledge and practical application during times when physical presence is limited.

Through the integration of VR technology into the educational framework, institutions like the Bandung Manufacturing Polytechnic can continue to deliver high-quality vocational education, ensuring that students acquire the essential skills needed for their future careers, even amidst the challenges posed by a global pandemic.

METHOD

Flow Diagram



Concept Stage

1. Problem Identification

Distance learning or online learning has been implemented during this pandemic which aims to reduce all forms of activities that cause associations. Adjustments to learning methods need to be made in this online learning so that student achievements can be achieved as they should. The methods used in online or online learning also vary, such as learning media in the form of presentations presented through zoom meetings or google meet, in the form of quizzes, and there are also in the form of independent assignments.

Therefore, this virtual reality technology-based learning media was created as an update of the previously used learning media and also welcomed the application of industry 4.0 in the field of education. It is hoped that this learning media can motivate and provide students with interest in learning this course.

2. Identification of Learning Media

Interactive learning media based on virtual reality technology regarding the clamping of workpieces and cutting tools functions as an intermediary to convey material to students so that students already know and understand before experiencing the actual clamping of workpieces and cutting tools.

Design Stage

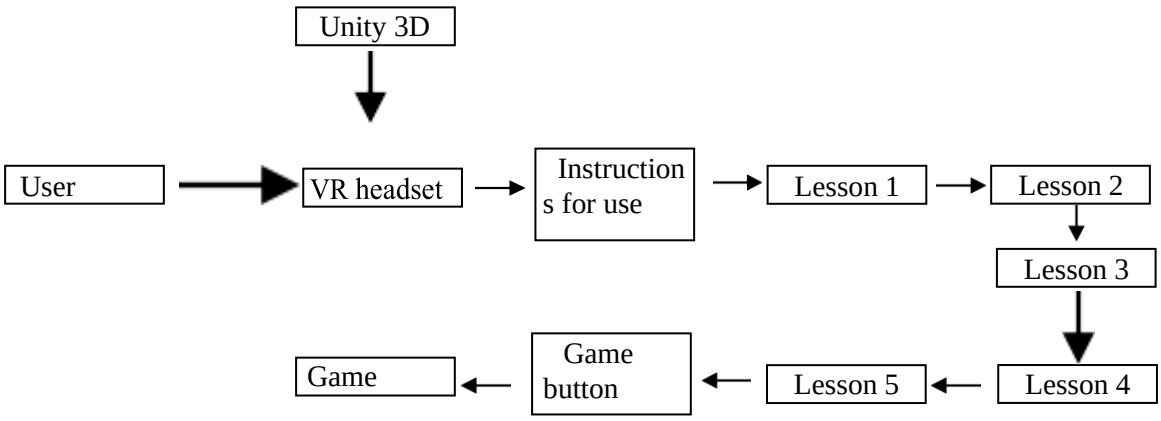
At the design stage, it is carried out by designing learning materials, learning media flow specifications, and selecting applications to be used. The application used for creating 3D models is Solidwork and for creating virtual reality programs is Unity 3D.

Material Collecting Stage

Based on the previous material design, a list of materials was obtained, namely in the form of 3D models and other supporting images. Then an existing 3D model is created and registered with the selected application, namely Solidwork.

Manufacturing or Assembly Stage

After making the material, a virtual reality program is created using the Unity 3D application. The creation of this program is placed based on the design of the material and layout that has been made. Each 3D model is given a program function so that it can be according to the design made. The flow specifications of the program are:



Testing Stage

Testing is carried out by testing learning media and testing student course achievements. The testing of learning media was carried out in general and questionnaires were given to respondents, while testing course achievements was carried out to new students by comparing the learning media of practical modules with virtual reality-based learning media. In addition, tests are carried out by observing the practicum directly.

Distribution Stage

The distribution stage is the stage for the storage of learning media that has been made. This learning media is stored in a VR headset and can be used as a support for learning media for the basic framing practicum gs.

RESULTS AND DISCUSSION

Results and Discussion of 3D Models

The creation of a 3D model to support the creation of interactive learning media programs based on virtual reality technology is assisted by a virtual reality team consisting of 3 (three) people, namely from 3 (three) level students majoring in Manufacturing Engineering who are students who will develop virtual reality for the next year. Meanwhile, some of the supporting 3D models are obtained from the internet, namely from the https://grabcad.com web. The format of the 3D model obtained is in the form of .stl which is then converted to .fbx format so that it can be used in Unity 3D software.

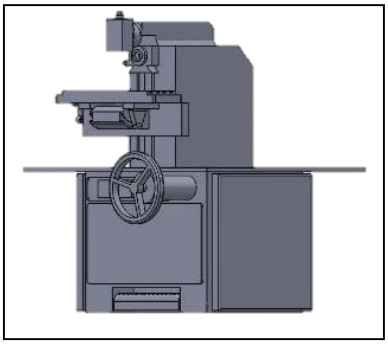
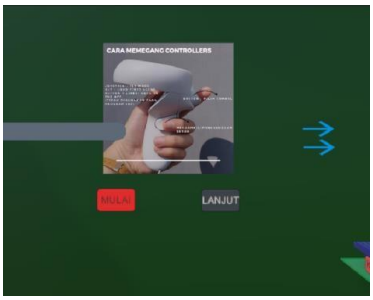


Figure 1 Contol 3D model created

Results and Discussion of Learning Media

Table 1 Results in the scene or material space

No	Description	Picture
1	Welcome, tutorial on using controllers	
2	Material 1: Introduction to milling machines and types of milling machines	
3	Lesson 2: Introduction to the ACIERA F3 milling engine and its main parts	
4	Material,3:Introduction of clamping of workpiece by stepped beam clamping and clamping method	

5	Material,4:Introduction to the stages of clamping the cutting tool	
6	Material,5:Introduction to occupational health and safety on the grip of workpieces and cutting tools	

When the user finishes material five, the user is welcome to press the game button to enter the second scene or the next scene. In the game scene, there are three games about simulating the clamping of workpieces and cutting tools without a tutorial, saving the shape of the workpiece according to the type of crumple, and saving the cutting tool according to the question on the wall by guessing the cutting tool to be used. The description of the results in this game scene is as follows:

Table 2 Scene or game room results

No	Description	Picture
1	Game 1: installation of the workpiece on the vise and installation of the cutting tool	

2	Game 2: select the workpiece and store it according to the shape of the workpiece for a specific type of vise.	
3	Game 3: guess the right cutting tool for the question and move it according to the question sequence number	

In addition, when the game is over, students are given evaluation questions to see the extent of their introduction to milling machines, clamping workpieces and cutting tools so that it can make it easier for teachers to see the introduction of students to explain other materials.

Test Results

1. Testing Against the Purpose of Learning Media

The testing of this interactive learning media was carried out from Wednesday to Friday, July 20 to 22, 2022, starting from 10.00 WIB to 15.00 WIB in the theory room B212, Bandung Manufacturing Polytechnic.

Figure 2 Image when the respondent tries to use the VR headset Discussion:

Calculate the overall effectiveness of the data:

P = (Total number of respondents' answers / Sum of all ideal scores) x 100% P = (773/875) x 100%

P = 88.34%

Then the percentage of results is compared with the table, so that 88.34% is included in the interval of 76-100% with the category of very effective.

2. Testing of Course Achievement

The testing of interactive learning media on course achievements with virtual reality was carried out on Monday, August 22, 2022 starting from 10.00 WIB to 12.30 WIB in the hallway on the 2nd floor of the Bandung Manufacturing Polytechnic. Meanwhile, testing with practical modules was carried out on Wednesday, August 24, 2022 in the B203 theory room of the Bandung Manufacturing Polytechnic. This test is performed with the following test description:

Table 3 Description of the test

Testing	Virtual Reality	Practice Module
Description	Usage Time: 25 Minutes Done by: 5 Students Questions: 7 questions	Usage time: 25 Minutes Conducted by: 5 Students Questions: 7 questions

Figure 3 New students trying VR headsets

Discussion:

Testing was carried out to new students of the Department of Manufacturing Engineering as many as five people tried virtual reality and five people learned using books/practical modules. The discussion of the test results is as follows:

With virtual reality

Table 4 Average virtual reality results

No	Question	Respondent Score					Average
1	Definition of milling machine	0	10	0	0	0	2

2	Types of milling machines	40	40	40	40	40	40
3	Main parts of milling machine	8	6	2	10	10	7,2
4	Workpiece clamping equipment	7,5	5	5	2,5	2,5	4,5
5	Cutting tool installation equipment	4	6	6	2	10	5,6
6	Errors that occur	10	5	10	10	10	9
7	Potential and efforts of K3	5	5	5	5	5	5
Average Amount							3,3

With practice module

Table 5 Average grade of the results of the practice module

No	Question	Respondent Score					Average
		1	2	3	4	5	
1	Definition of milling machine	0	10	0	10	10	6
2	Types of milling machines	40	40	40	40	40	40
3	Main parts of milling machine	2	4	4	0	2	2,4
4	Workpiece clamping equipment	0	5	2,5	0	2,5	2
5	Cutting tool installation equipment	0	2	0	2	2	1,2
6	Errors that occur	0	10	5	0	10	5
7	Potential and efforts of K3	0	5	0	0	5	2
Average Amount							8,6

With these two learning media, students can get to know about milling machines, milling machine parts and their equipment in accordance with the semester learning plan. However, the scores of students who use virtual reality are slightly higher than students who read practical modules because in virtual reality, the shape of the equipment is available in three dimensions so that it is more depicted than a book that provides images of equipment in two dimensions.

Testing of Direct Learning Methods

Testing is carried out by observing and comparing direct/conventional learning methods with learning that has been briefed with virtual reality learning media, then determining the disadvantages and advantages with the two methods. The debriefing of virtual reality learning media was carried out on Wednesday, August 24, 2022 in the B203 theory room of the Bandung Manufacturing Polytechnic, while the basic milling practicum was carried out on Monday, August 29, 2022 at the Basic Machining Laboratory of the Bandung Manufacturing Polytechnic.

Figure 4 Debriefing with virtual reality learning media

Figure 5 In-person practicum

Discussion of the results of testing the direct learning method:

Table 6 Results of direct practicum observations

Practicum Stages	Direct/Conventional		With Virtual Reality Briefing	
	Excess	Deficiency	Excess	Deficiency
Understanding / introduction to the use and operation of the machine	It is explained in detail about the movement of each axis and students can try.	-	-	The movement of each axis of the machine is not present in virtual reality

Material division and working drawings	Distributed directly and know exactly what materials Used	-	-	Not shown image yet Work and materials Which to use
Equipment required	It is mentioned about the equipment needed in the practicum.	Students do not have an idea of the shape of the equipment so it takes time to ask questions previo usly.	Students already have an idea of the shape of the equipment.	There is no exact list of equipment needed in the practicum.
Workpiece Clamping	Explained in detail about the cleanliness of the workbench, balanced tightening, and requirements arrest.	Students do not know the clamping device that will be used.	Students know the clamping device to be used and warnings for cleanliness.	Not yet There are conditions of clamping with a vise and a reminder for tightening Balanced.
Installation Cutting Tools	Shown How to install the Cutting tool And cleanliness.	Not exist Place for Fasteners Arbor Easy.	Exist commemorati on to Hygiene and place Fasteners Arbor.	Not yet Shown step installation cutting tools.

After observing the shortcomings and advantages of the learning media made to the practicum directly, the shortcomings that need to be corrected in the virtual reality learning media are obtained as follows:

1. The procedure for using a milling machine which includes the movement of the machine on each axis.
2. Show drawings of work and materials to be worked on

3. Adding a list of equipment needed in a basic milling practicum
4. Describes the clamping conditions of the workpiece with a video description in each condition and provides a warning for balanced tightening of the vise.
5. Shows the steps to install the cutting tool in the form of a video.

In addition, in the observation, it is seen that the time needed by the direct/conventional method is ± 3 hours to explain starting from the use of the machine to the installation of the cutting tool. Meanwhile, in virtual reality, students can find out the equipment to the installation of cutting tools takes ± 25 minutes, so that with this virtual reality-based learning media can minimize the use of time for equipment introduction to the installation of cutting tools

The results and discussions contain the findings of the service and its scientific discussion. Write down the results of service obtained from the place of service that has been carried out but must be supported by adequate data and photos of existing activities. .

CONCLUSION

After making virtual reality-based interactive learning media and conducting tests on 25 respondents, it can be concluded that the interactive learning media based on virtual reality technology that has been made can be said to be an update in the field of learning media where students can get to know the milling machine and its equipment before doing the practicum directly. With this learning media, it can be used as an optimization effort for online practicum learning of the basic milling manufacturing process with virtual reality technology so that student competency achievements are still achieved. Interactive learning media is 88.34% effective for the initial introduction of practicum or online student learning (in the network).

Based on the results of testing student achievements or course achievements, it can be concluded that the goal of making interactive learning media based on virtual reality technology has been achieved. The purpose of evaluating interactive learning media based on virtual reality technology on student achievement has been carried out with an average score of 73.3 for students using VR, which means that students know about the introduction of basic frais practicum.

In addition, based on the results of testing the direct learning method, there are still shortcomings that can be added. Thus, this learning media can be used as an initial briefing of basic milling practicum to students before conducting practicum directly as an effort to minimize the time for introducing practicum and improving student competence.

REFERENCE

Arikunto, Suharsimi. 2002. Research Procedure. Jakarta: Rineka Cipta.

Fozi, Hammad, et al. 2020. Game Development Project with Unreal Engine. UK: Packt Fublishing Ltd.

Gerard, Richard, et al. 2015. Cry Engine Game Development Blueprints. UK: Packt Fublishing Ltd.

Gerling, Heinrich. 1972. All About Machine Tools. New Delhi: Wiley Eastern Private Limited

KBBI. 2021. The Great Dictionary of Indonesian Online. (https://kbbi.kemdikbud.go.id/) accessed: January 2022.

Computers, rides. 2021. Easy to Make 3D Unity 3D Games. Yogyakarta: Andi Publisher

Indonesia. Law No. 20 of 2003 concerning the National Education System.

Statute Book of the Republic of Indonesia, No. 4301. State Secretariat. Jakarta.

Polman. 2001. Advanced Manufacturing Process Module 2 (Basics of Fracking). Bandung: UPT. Multimedia Manufacturing Polytechnic Bandung.

Susilana, Rudi and Cepi. (2009). Learning Media (Essence, Development, Utilization and Assessment). Bandung: CV Wacana Prima.

Sutopo, Ariesto Hadi. 2022. Development of Metaverse-Based Teaching Materials. South Tangerang: TOPAZART

EMS Team. 2016. AutoCAD for Jakarta Students: PT. Elex Media Komputindo

Vince, John. 2004. Introduction Virtual Reality. United States of America: National Centre for Computing Animation Bournemouth University