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COUNTENANCE EVALUATION OF VIRTUAL REALITY (VR) IMPLEMENTATION IN MACHINING TECHNOLOGY COURSES

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ABSTRACT
This study aims to evaluate whether virtual reality (VR) learning media can be used in Machining Technology courses which are practical learning but implemented virtually. The research using the Stake Countenance evaluation method was carried out at the Department of Mechanical Engineering FT-UNP in the July-December 2021 semester with 60 students as research subjects. This study was mix method by using sequential explanatory design. which is the collection of quantitative and qualitative data that is carried out sequentially. Data related to the antecedents, transaction, and outcomes phases were collected using questionnaires, interviews, and observations. The research begins with developing VR media that is implemented to learning materials in the field of Machining Technology and then applied to learning. Then first stage is carried out using quantitative then the next stage or the second stage is carried out using qualitative. The result of research showed that this VR application can help students understand the theory of introducing machine tool operations but have not been able to run machine. This study imply that students' learning process should be enjoyable and also influence existing practices of Student-Centered Learning. The novelty of this study showed the evaluation result of technology, especially virtual reality can be implemented in the practice learning course, it can be reference for educator to consider implementing technology in practice learning. This study will contribute to existing knowledge and various instructional method that can be implemented by educator.
Keywords: *Virtual Reality, Machining Technology, Countenance Evaluation*

1. Introduction

The Machining Technology course is a required course that has been mastered by students in the Bachelor Education of Mechanical Engineering, Faculty of Engineering. The learning outcome of this course is that students are able to operate machine tools such as lathes, Fracturing machines, Drilling Machines properly (Duran et al., 2013). So, they have to learn the machining theory material and machining practicum. The theory is learned by students concerning to introductory theory of practicum, introduction to machine tools such as names, functions, and how to operate these components for various machine tool jobs (Hartanto et al., 2020; Jalinus et al., 2023; Riehl et al., 2014). After introduction theory learning is studied by students and conducted the assessment, it assumes that students have understood the machining theory, then students can get the opportunity to doing machinery practicum (Manoli et al., 2021). If without understanding of machining operation introduction theory, the error and mistake will be taking place in operating machine which can be fatal dangers for machine and its operator (Jalinus et al., 2022; Suryo Hartanto et al., 2022). So, the learning process is supposed by face to face.

However, because of Covid-19 pandemic, for health reasons, the learning cannot be conducted by face to face, but fully online (Reno Renaldi et al., 2022; Sepulveda-Escobar & Morrison, 2020; Kurniawan, 2022). This situation creates some problems, which students are difficult to achieve the learning outcome that has been settled on syllabus curriculum (Folkourng & Sakti, 2022; Luo & Du, 2022). Educator is difficult to deliver the material about machine introduction without directly see these machines (Bozkurt et al., 2020). So, there is lack of learning method that used in this course, because students need real experience to understand and master the competencies in this course. Also Bloom (Anderson, 2001) said that psychomotor aspect of learning outcome can be reached by students when they do and practice by hands on the machines.

In order to solve the problems, VR is one of the solutions that can be used by educators as instructional media that made students can interact with the online environment by assisting of computer simulation. So, students can feel that they are in that online world (Fortuna et al., 2023; Gregory & Bannister-Tyrrel, 2017). VR offers the interesting solution because it gives the realistic and interactive real experience for students, which they can experiment and practice without having to worry about the risk of accidents or engine damage. Other than that, VR can give flexible learning environment and can be used everywhere (Chang, 2021). The combination of VR and pedagogic concept will be positioning the VR not only just instructional media as well as learning simultaneous. VR is an instructional media that can make students focus, active and successful in providing feedback to students (Rho et al., 2020). Students is being more motivating and having highness curiosity in learning is the main goal of VR (Kwon & Morrill, 2022). VR assists students to feel the digital life experiences toward the difficult learning material that conducted in the real life as well (Bahari, 2022). The reason for choosing VR technology was also triggered by research which in recent years has highlighted the effectiveness of VR from learning target competencies (Tai et al., 2022).

However, based on the observation that conducted by interview method, it showed that VR implementation in practice learning has not been optimally implemented. Most of educators have not designed learning material using VR yet. The interview result of some students showed that all of students understand how to use VR in learning and they have supporting facilities such as laptop and smartphone. The observation results concerning to facilities in the university showed that the supporting media has been not optimally used to implement VR in practice learning.

Other than that, previous research result showed the inconsistency of VR implementation in learning, both in learning theory and practice. There are several research tend to showed that VR has positive impact in enhancing students' learning outcomes (Williams et al., 2022), due to the VR gives students the opportunity to be more exploring their self (Sprenger & Schwaninger, 2021). Some of research argue that, it showed the negative impact of VR in learning, it is proven that VR has not took effect to enhance students' learning outcomes and motivations (Kaplan-Rakowski et al., 2021), due to the using of VR in learning was just implemented on certain topics (Kugurakova et al., 2021).

Therefore, the evaluation research is assumed to be needed to know how the implementation of VR in learning, certainly in practice learning. Then, to know what the factors that affected in VR implementation of learning practice. Evaluation model that used in this research was countenance model, which the systematic model and focus on decision consideration (Fegely et al., 2020), it is not just used to be compared to determine the gap between the results and expectation, but it is also compared with the absolute standard to know the benefit the evaluated program clearly (Choi & Noh, 2021).

Several previous researches also depicted that countenance evaluation was frequently used evaluation model and effective to evaluate the program in learning (Rappa et al., 2022), the evaluation countenance is assumed as the best choice to be used in this research. So, this research aims at evaluating the learning system on Machining Technology course by using VR and describing the VR effectiveness on the course that has learning outcomes of psychomotor characteristic. The novelty of this research is the information concerning to implementation of VR in learning practice, while VR is still implemented in learning theory recently and countenance evaluation of implementing VR in learning practice has not been conducted yet. So, it can give the beneficial impact for educators and students to prepare their self and the VR-based learning process on learning practice can performance well and according to educator expectation, and it will give the convenience both for educators and students.

So, this study aims at evaluation the effectivity of VR implementation in Machining Technology course, by focusing on VR implementation to practice students' skill through interactive simulation and practice. This study also aims at evaluating students' response of VR implementation and identify the factors that influencing the successful implementation of VR. This study will contribute to the existing knowledge, particularly in implementation of VR in learning and the effectiveness of VR in learning. The finding of this study will imply educators in preparing their learning process using VR. The assessment and instrument of this study can be references for the future researcher who will do the similar research.

2. Literature Review

Machining technology courses are essential in preparing students for careers in the manufacturing industry. Traditional education approaches such as lectures and hands-on instruction, on the other hand, have limitations in providing a full grasp of machining operations. Virtual Reality (VR) technology provides a novel method to improving learning outcomes in machining technology courses. In a machining technology course, a VR-based learning platform was developed and implemented. The VR platform boosted students' grasp of machining operations and raised their enthusiasm to learn (Thompson et al., 2021). Furthermore, the VR platform allows students to learn and experiment with machining techniques in a safe and controlled environment, reducing the danger of classroom accidents.

Bos et al. (2022)investigated the efficacy of a VR-based training program for CNC (Computer Numerical Control) machining. The study discovered that when compared to traditional training techniques, the VR-based training program increased students' cognitive and psychomotor skills. The study also found that the VR-based training package lowered training time and expense. Hu-Au & Okita (2021) examined the possibilities of VR technology in machining education. The authors emphasized the benefits of virtual reality technology, such as its capacity to deliver a realistic and immersive learning environment, its adaptability to diverse learning styles, and its potential for remote learning. Overall, the literature demonstrates that virtual reality technology has the potential to improve learning in machining technology courses. VR technology can provide a safe and regulated environment for students to practice and experiment with machining operations, thereby improving cognitive and psychomotor abilities and increasing motivation to study. More research is needed to investigate the efficacy of VR technology in various contexts and to determine the aspects that contribute to its success.

VR technology has the potential to revolutionize the way engineering and machining courses are taught. VR technology can provide a safe and immersive learning environment that enhances students' learning outcomes and engagement (Yang et al., 2022). Because VR technology can provide a realistic and interactive learning environment that enhances students' motivation and engagement, facilitates the acquisition of practical skills, and reduces the risk of accidents and injuries in the classroom (Yildirim et al., 2020).

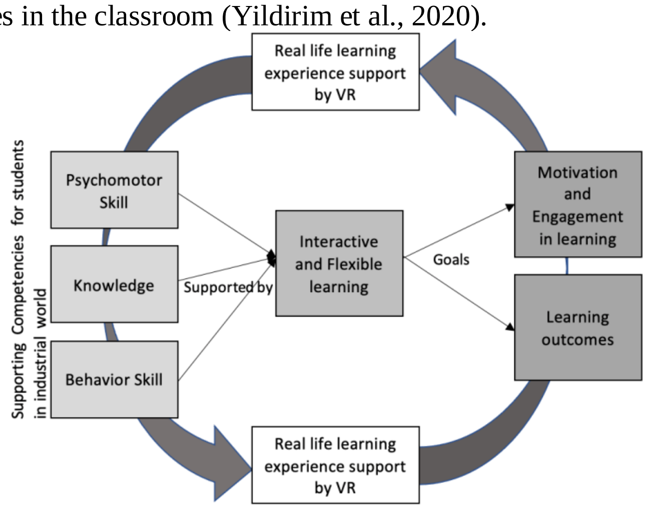


Fig. 1. Research Conceptual Framework
Source: (Yildirim et al., 2020)

3. Research Methods

Research Type and Procedures

Research type was mixed method by using sequential explanatory design approach (Christensen, 2001). Research method consists of four stages, are follows: preliminary research stage, prototype designing stage and implementation of VR in learning stage, and the last stage was evaluation. First stage, the research investigates the problems that took place during Covid-

19 pandemic concerning to Machining Technology learning. In this stage, it is found the problem of Machining Technology learning practice problems because of Covid-19 pandemic, the students cannot learn in laboratory to operate the machines. Stage 2, it is developed the VR application with Machining Technology material. After finishing the VR application, it is assessed to the peer to know the VR application has been according to be used in Machining Technology learning, VR technology that developed has been according to the Machining Technology learning need. Stage 3, implementing the Machining Technology learning uses VR application that has been developed to 60 students. Stage 3, conducting the evaluation of implementing VR application of practicality, convenience, and effectiveness on students using VR application that has been developed.

Evaluation method used was Countenance model. There are three phases of Countenance evaluation model, as follows: 1) antecedents, 2) transaction and 3) outcomes. Antecedents is the condition before learning, while transaction is a learning experience process. Each phase will be implemented on observation, analysis and recommendation phases. Research data was collected by questionnaire, interview and observation. The data was analyzed using two ways, are follows: correlation and descriptive to find the contingency among antecedents, transaction and outcomes, these will be according to the expect research goal and condition that observed.

Antecedents phase will evaluate syllabus of Machining Technology course, facility and infrastructure to implement VR, and students' readiness. On the transaction process, the assessment criteria in the aspects of learning time, the ability to use VR, and learning implementation. Outcome phase will assess students' satisfied level in implementing the Machining Technology learning. Antecedents, transaction and outcome category between expected (intents) and observed condition concerning to the horizontal assessment (congruence).

Research Subject

This research was conducted in Mechanical Engineering Department, Faculty of Engineering, Universitas Negeri Padang (UNP). The simple random sampling technique was conducted to choose the research sample, while the population was the Mechanical Engineering students who register Machining Technology course. It means that all population have the same opportunity being sample. Therefore, 60 students and 30 educators of Mechanical Engineering, Faculty of Engineering UNP were randomly selected as research sample, which students of bachelor and diploma degree. The object of this research was VR application in Machining Technology learning.

Research Instruments

The observation activity used questionnaire that consists of 35 statement items of Likert scale. The instrument was used for quantitative data, which the indicator of the questionnaire can be seen in detail at Table 1.

Table 1 - Questionnaire's Indicators

No	Stages	Indicators
1	Antecedents	Planning, in syllabus of Machining Technology course (A1)
		Need, in facility and infrastructure to implement VR (A2)
		Students' readiness (A3)
2	Transaction	Learning Time (T1)
		The ability to operate VR (T2)
		Learning implementation (T3)
3	Outcome	Students' satisfied (O)

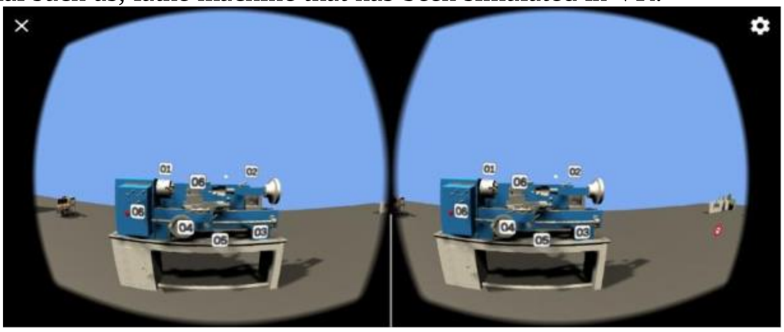
In order to fulfill the qualitative data, interview was conducted to obtain the data. The interview's questions that prepared was focused on the research objective concerning to the three phases of Countenance model, as follows; antecedents, transaction and outcome. So, the qualitative collecting data activities was conducted by structure and systematic interview.

Data Analysis Technique

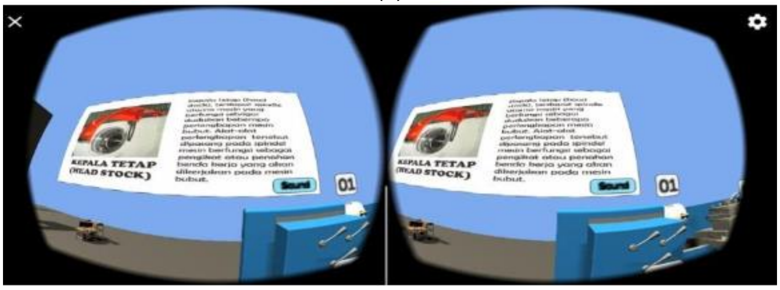
Data analysis technique used in this mix method research consists of two stages of analysis data, are follows; descriptive and correlation descriptive for quantitative data, and conclusion verification and data display for analyzing qualitative data

4. Results and Discussions

VR can be used in inquiry-based learning that focus on critical and analytical thinking process to seek and find solution of the problems by their own ability. Inquiry-based learning involves students actively to seek the answers of the questions or problems (Prasetya et al., 2023). By using VR, information that accepted by students will be better than using another technology tool, such as video, slide and other (Vicente dos Anjos et al., 2021). In learning, students do not directly touch with educator and the tool, but they seem to interact with the tool and educator. By using the tool and VR application that developed, students can learn individually, Figure 2 depicts the view of VR when students using it on Machining Technology course. Figure 2 showed the learning material such as, lathe machine that has been simulated in VR.



(a)



(b)

Fig 2. (a) Lathe Machine on VR and (b) One of material in Machining Technology course on VR

The Countenance Stake was the evaluation model that used in this research. It has three phases of evaluation stage, there are antecedents (input), transaction (process) and outcome (output). These three phases were used to describe the effective the VR implementation in learning practice. The data used was obtained from interview and questionnaire. Antecedents phase or input phase of VR implementation in Machining Technology learning practice can be reviewed from three assessment indicators, are follows: the planning, such as syllabus of Machining Technology course, the requirement such as facilities and infrastructures to implement VR, and students' readiness. Transaction phase was also reviewed from three assessment indicators, are follows; learning time, the ability to operate VR, and learning implementation. While output was reviewed from one assessment indicator, that is students' readiness. The obtained antecedent data can be seen in detail at Table 2.

Table 2 - Frequency Distribution of VR Learning Plan Indicators

Categories	Educators		Students	
	Frequency	Presentation (%)	Frequency	Presentation (%)
Very Suitable	8	26,67	28	46,67
Suitable	20	66,67	29	48,33
Unsuitable	1	3,33	2	3,33
Very Unsuitable	1	3,33	1	1,67

Table 2 depicts the frequency distribution of VR learning between educators and students toward planning indicators. The planning phase of VR learning that obtained from the questionnaire that filled up by educators, it showed that 26,67% of educators assume very suitable and 66,67% of them categorize it to suitable, it means that the planning of VR learning had been suitable to VR implementation in learning practice. Looking forward to the students' number, it showed that 46,67% of students assume very suitable and 48,33% being suitable. It can be concluded that the planning of VR learning had been suitable to the existing learning curriculum.

The aspect of this educators' readiness is categorized suitable, it means that educators have been ready in planning and designing the VR-based learning material. It will be better if educators can more increase the learning material understanding, certainly if it is combined ICT there. The using of instructional media in assisting learning process has not utilized maximally. The educators' ability using technology in learning and designing the instructional media tend to low for some educators. It will be obstacle to maximize the educators' ability in planning and designing the VR-based learning material. transaction data in this research will be seen in detail at Table 3.

Table 3 - Frequency Distribution of VR Learning Implementation Indicators

Categories	Educators		Students	
	Frequency	Presentation (%)	Frequency	Presentation (%)
Very Suitable	25	83,33	35	58,33
Suitable	4	13,33	23	38,33
Unsuitable	1	3,33	2	3,33
Very Unsuitable	-	-	-	-

Table 3 describes the frequency distribution of VR learning implementation indicators between educators and students. The implementation phase of VR learning that obtained from the questionnaire that filled up by educators, it showed that 83,33% of educators assume very suitable and 13,33% of them categorize it to suitable in implementing VR on learning practice by existing material and curriculum. As the same as students, it showed that 58,33% of students assume very suitable and 38,33% being suitable. It means that implementation of VR in learning practice has been suitable to the learning curriculum and support the existing practice learning material. The outcome data of this research can be seen in detail at Table 4.

Table 4 - Frequency Distribution of VR Learning Satisfaction Indicators

Categories	Educators		Students	
	Frequency	Presentation (%)	Frequency	Presentation (%)
Very Suitable	23	76,67	37	61,67
Suitable	6	20	20	33,33
Unsuitable	-	-	3	5
Very Unsuitable	1	3,33	-	-

Table 4 explains the frequency distribution of VR learning satisfaction indicators between educators and students. The satisfaction phase of VR learning that obtained from the questionnaire that filled up by educators, it showed that 76,67% of educators assume very suitable and 20% of them categorize it to suitable. It means that educators are satisfied to implement the learning by using VR. It regards to the students' number, it showed that 61,67% of students assume very suitable and 33,33% being suitable. It means that implementation of VR learning has encouraged the students' satisfaction and motivation in learning practice. In order to make it clear, here is the chart of three assessments indicator phases from Countenance Stake on practice learning by using VR.

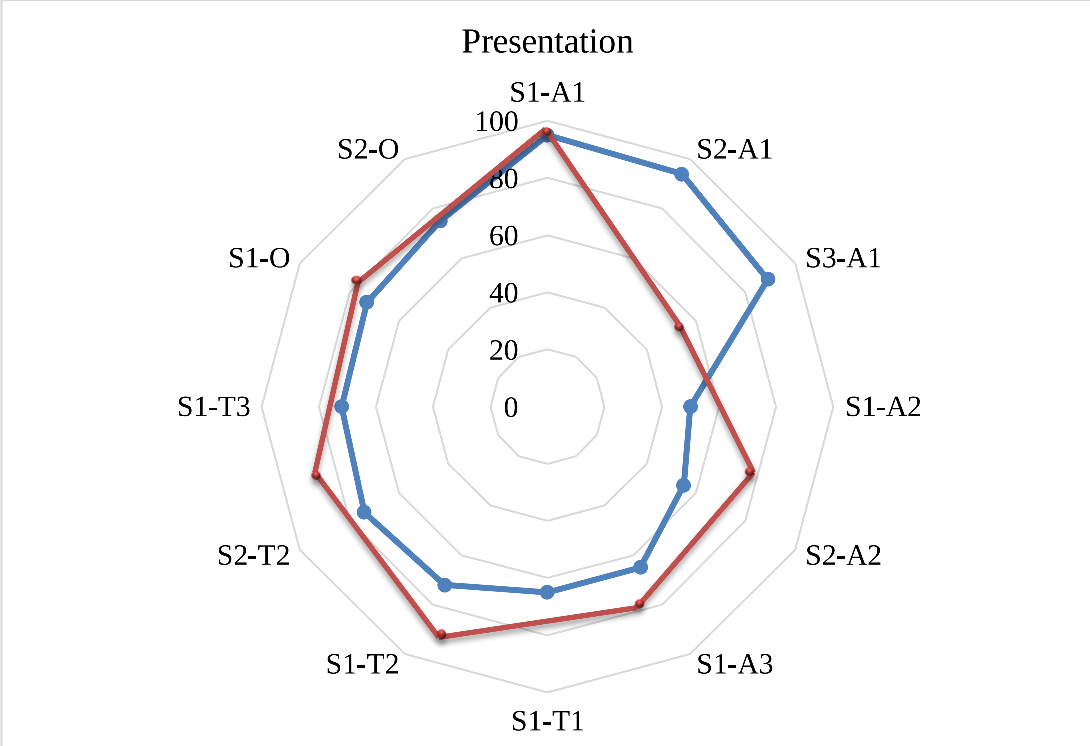


Fig. 3. Chart of Sub-Indicator Presentation on Countenance

The explanation of figure 3 was the presentation spreading on each sub-indicator of antecedents, transaction and outcome assessment. The detail explanation can be seen in detail on Table 5, the following table showed the analysis matrix of Countenance's three phases.

Table 5 - Analysis Matrix of Antecedents, Transaction, and Output Phases

Description Matrix		Judgement Matrix	
Intense	Observation	Standard	Judgement
<u>Antecedents</u> Educators plan the implementation of VR in learning practice	The observation result showed that 95% of course's syllabus has been designed, but there are 52% of facilities and structures to conduct learning practice by implementing VR, while the students' readiness by 65%.	There are learning plan in implementing VR in learning, such as VR program design, lesson plan and learning material, facilities such as oculus and students are ready in implementing VR.	Most of educators on Machining Technology course has been ready to implement the VR in learning practice, but the facilities are not enough to support VR implementation, such as oculus. So, it will affect to students' readiness.
<u>Transaction</u> Students conduct the learning practice process using VR that according to the design that has been planned.	The observation result showed that VR implementation on learning practice has been saved the educators' time of 65%, in delivering the learning material. The ability of students in operating VR by 74% and the implementation of VR in learning practice has been performance of 72%.	Students be able to operate VR in learning practice, and VR implementation in learning has been effective to save educators' time in delivering the material before practicing.	Implementation VR in learning has been effective to save educators' time. So, it will give positive impact on students' ability in operating VR, and VR in learning has been fully implemented.
<u>Outcomes</u> Students satisfy in VR learning	The observation result showed that students' satisfaction in implementing VR on learning practice of 74%.	Students are satisfied and motivated of VR implementation in learning.	Students are satisfied of VR implementation in learning practice.

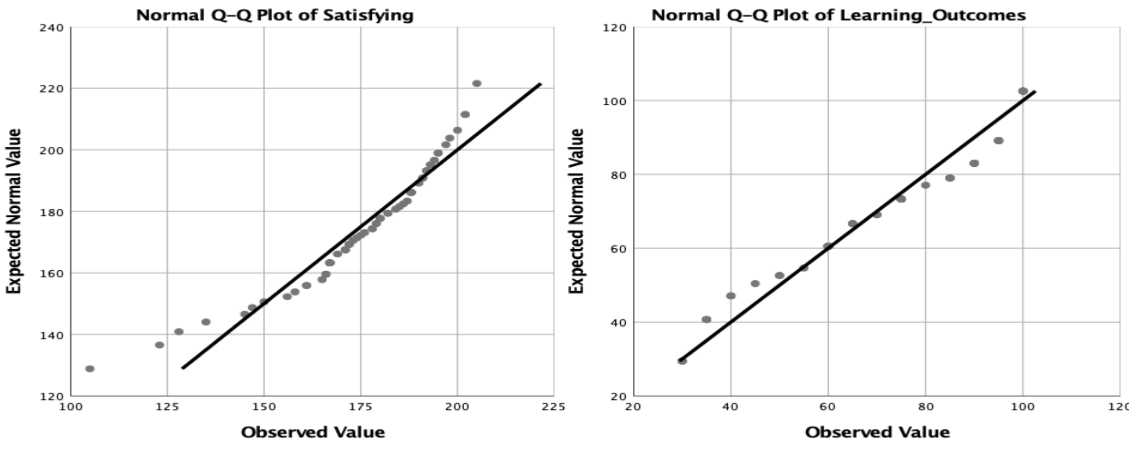
Students' satisfaction of ICT cultured learning environment indicators falls into the appropriate category. It includes support from educators to provide ICT facilities according to student requests, and currently they are easy to get ICT facilities. The involvement of human resources in VR-based learning is an absolute requirement, but high-capacity human resources are not a main requirement because supporting infrastructure is also needed to achieve the goals of VR-based learning. The availability of complete infrastructure will support the implementation of VR-based learning.

The transaction stage measures the ability to implement VR in the learning process. The ability of educators in implementing VR-based learning is the main basis. If the educators' ability is low, then the educators will rarely deliver the assignments or learning material to students by utilizing VR. The ability that has been improved by the educators is to practice using VR features and VR can be utilized optimally. At the stage of VR implementation result, it is related to the two previous aspects, namely the antecedents and transactions aspects. In order to increase the output aspect, it can be done by increasing the ability to understand and operate VR, then students will be happier with the material taught with VR implementation. the stage of VR implementation result showed that students are motivated in learning, and they showed high satisfaction of VR implementation. The following table showed the results of the correlation analysis between VR implementation and students' satisfaction.

Table 6 - Correlation Analysis Between VR Implementation and Students' Satisfaction

Variables		X	Y
VR Implementation (X)	Pearson Correlation	1	.767**
	Sig. (2-tailed)		.000
	N	60	60
Students' Satisfaction (Y)	Pearson Correlation	.767**	1
	Sig. (2-tailed)	.000	
	N	60	60

Table 6 showed the figure of correlation analysis between VR implementation and students' satisfaction. Based on the Table 6 showed that correlation between VR implementation (r(60)=0,767, $p < 0,05$) and students' satisfaction (r(60)=0,767, $p < 0,05$) were statistically significant. It means that learning by using VR implementation has positive effect to students' satisfaction, which the implementation of VR learning has impact by 76,7% to students' satisfaction. It is line to the research that conducted by Li et al., (2020), it showed that VR was effective to increase the students' learning outcome. The following chart showed the students' satisfaction and learning outcome normality data after implementing VR in learning.



(a) (b)

Fig. 4. Spreading of Students' Satisfaction (a) and Learning Outcome (b) after VR implementation

Based on the results of the study, it showed that the antecedent of VR learning facilities and infrastructure was still low. It was proven that the facilities and infrastructure in implementing VR were still limited, such as Oculus for implementing VR. Even though students and educators have planned the VR learning. Some previous research also showed the similar results, the weaknesses of antecedent (Çakıroğlu et al., 2021). Then, the results of the Transactions analysis showed that most students have the ability to implement VR. It indicates that although the VR that has been implemented well, but the implementation process has many obstacles. Some previous research also showed that the VR implementation can affect the mentality of users, because they cannot distinguish between the real world and the virtual world (Liu & Butzlaff, 2021; Onele, 2023). VR can make users feel loss of reality and isolation when interacting with the artificial world (Kwon & Morrill, 2022). Even though the ITC implementation in learning is a new breakthrough that can be utilized by educators (Huda et al., 2021).

The result analysis of three phases on VR implementation on practice learning showed the new framework finding about the combination of ICT and learning practice. Several ideas that appeared by students during learning process showed that there are students' critical thinking process when implementing VR in learning practice. Therefore, it means that ICT implementation in learning practice does not restrict the students' thinking. It is line to the previous knowledge that conducted by several researches, it showed that ICT has positive impact in learning among learning outcomes (Kaplan-Rakowski et al., 2021), problem solving and critical thinking skill (Araiza-Alba et al., 2021; Ikhsan et al., 2020) in building the ideas.

Based on the conducting research, there are two factors that influenced the VR implementation process. These factors are divided into 2, are follows; supporting factor and obstacle factor. Supporting factor, such as existing facilities and structures. There are several facilities such as oculus, the networking to access internet, and the number of computers that needed. Obstacle factor, there is less ability to develop and implement VR for learning practice. It affects to the educators; they tend to cannot design the interesting material content. So, the students are less motivation to solve the obstacle factor and increase the supporting factor. The obstacle factor can be faced by maximizing the existing resources, conduct the training that according to the ICT-based learning. Obstacle factor can be increased by maintaining the ICT-based facilities and infrastructures

The discussion of the research results obtained can be presented in the form of theoretical description, both qualitatively and quantitatively. In practice, this section can be used to compare the results of the research obtained in the current research on the results of the research reported by previous researchers referred to in this study. Scientifically, the results of research obtained in the study may be new findings or improvements, affirmations, or rejection of a scientific phenomenon from previous researchers. The results of this study will advance knowledge, particularly in the use of virtual reality (VR) in education when compared to traditional teaching methods. Particularly for a course on machining technology, the method instrument and VR-based learning materials are very beneficial for future research or teaching and learning reasons. The findings of this study imply students' learning process should be fun rather than tediously listening to lectures. Students should actively engage in learning processes, multidimensional learning activities, and other active learning techniques. Additionally, students should be engaged and motivated in order to boost their confidence and improve the efficiency of self-learning. Therefore, higher education could switch to a technology-based student-centered learning model, like VR, for teaching and learning approaches.

5. Conclusion

Machining Technology learning can be conducting virtually using a virtual reality system. But so far, the learning outcomes that can be achieved still in the cognitive aspect. In the psychomotor aspect cannot be fully implemented, but virtual reality can help students accelerate learning outcomes in the psychomotor aspect. Students who implement virtual reality systems can learn more loosely, anywhere and anytime while virtual reality equipment is available. However, the implementation of virtual reality in learning showed inconsistent impact, some have a positive effect and reverse. This study showed that the implementation of VR in learning practice has a positive effect and it is effective to be implemented. Even though the facilities and infrastructure such as Oculus was still required. This study will contribute to existing knowledge and become a reference as a learning method that can be applied by educators. This research is limited to evaluate the implementation of VR in the psychomotor domain, other variables such as the affective and cognitive domains have not been studied in this study. This is expected to be a reference for further similar research.

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