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The Instructional Media Development of Mechanical Drawing Course Based on Project-Based Learning

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Competencies changing that might be possessed by graduates of vocational education in the 21st century had encouraged the need for the revitalising of the curriculum in order to maintain the existence of the curriculum to achieve the goals of education. One part of the curriculum was instructional media. The development of instructional media which were properly attached with the learning model that will be applied as a form of the revitalisation of the curriculum. This article aimed to develop mechanical drawing instructional media based on the project-based learning (PjBL) model. The research method used was Research and development using the ADDIE model. The results of the study showed that instructional media that was developed in categories were valid, practical and effective. Instructional media assisted lecturers to create learning activities that were following the characteristics of the PjBL model. Textbooks that were one of the learning resources make students learning easier and faster to understand the competencies and assignments of projects given. Through the use of instructional media that were developed made students have good competence, so it can be concluded that learning activities with the use of instructional media were able to make students have the potential as expected.

Key words: *Project-based learning model, mechanical drawing, vocational education, instructional media.*

Introduction

Learning revitalization is urgently needed to be done in order to follow changing time. It aims to maintain the resilience of learning itself to produce graduates, according to the needs. In

education, the revitalisation can be a starting point to solve the problems that occurred (Sudrajat, 2014). Now, the learning process in vocational education tends to use learning in one-way direction with task method as the process of training, which reduce the students' creative thinking and unsurprisingly the low ability of innovation for the students (Sudarman, 2016; Jalinus and Nabawi, 2018). Vocational education as a form of education to prepares graduates that ready to work needs to examine the changing times as a basis for revitalising learning to create a creative and innovative person. One of the interesting things in the industry today is the industrial revolution of 4.0. The changing of work culture and competencies in industrial revolution 4.0 demands the vocational education graduation must be able to know the industry (Rizal, et al. 2019).

The importance of vocational education will reduce the unemployment to rating the high level of youth unemployment in Europe, the US and other parts of the world, including Indonesia, which is known as the "scarring effect" (Morrell et al., 1994.). According to the Indonesian Central Bureau of Statistics, the graduates of vocational education are not absorbed by the Indonesian labour market, which has around 6.9 million, the most experienced unemployment came from vocational graduates 11.24 % in 2018 (Usman & Raharjo, 2012; BPS RI, 2018). It should be evaluated and challenges for Indonesian Vocational education to face the industrial revolution 4.0 conditions and the Asean Economic Community (Usman & Raharjo, 2012; BPS RI, 2018). Furthermore, vocational school, especially Indonesia must be able to prepare graduates for a career in the era of industrial revolution 4.0, and vocational education must make better relations with academic elements in secondary schools, formal educational institutions, and to the industry and labour market (stakeholders) that demanding qualified and more complex human resources (Kazis, 2005).

Fuller (2015) asserted that the government as a stakeholder must strive to create national and supranational policies in creating and maintaining a vocational education system that can support and facilitate the transition of youth from education to employment in times of economic difficulties and intense global competition for available jobs. Vocational education must respond to it by developing learning models that can produce graduates who are in accordance with the needs of the industrial world. The essence of vocational education must prioritise efforts to prepare skilled workers that are in accordance with the needs of the world of work (Triyono, 2017).

Machine drawings have been of the compulsory subjects in mechanical engineering. The need for new competencies that must be possessed by graduates of vocational education, machine drawing learning activity is becoming an essential issue for revitalisation. Many of the world's leading industrial countries have invested in encouraging advanced manufacturing, innovation and design (Themes and Schaefer, 2016). Therefore, to create a mechanical drawing, learning that is qualified of creating competence,

students, the PjBL model is used to apply in the learning process, as one of the innovative learning models that can direct students to create PjBL (Jalinus, Syahril and Nabawi, 2019). The choice of PjBL teaching is justified because as stated earlier, it is a student's process that meets student's needs, and encourages them to become more involved in their learning process (Mahedo and Bujez, 2014). Project-based learning (PjBL) has been developed with two other methods that are closely related: inquiry-based learning (or problem-based) and experience-based learning (Najid, Kiong, Che'Rus & Budiman, 2019).

The PjBL is designed to recognise the importance of standards and evaluation of student learning and the focus is on the application, and perhaps the integration of the knowledge gained by previous students (Frank, M: 2003). One interesting thing is why it is important to apply PJBL model as an effort to improve the quality of the learning process (Shinde, 2014). The students found that the PJBL environment was useful for developing skills such as communication, teamwork, project and time management (Riyati & Suparman, 2019). Project-based learning is not just learning done in the classroom because PjBl is built based on cooperative principles that involve motivating students in projects, directed through assignments or experiences, explain and present the results of their projects and then how to encourage them to actively participate in learning process (independent learning) to construct their knowledge of the learning styles that they build themselves (Hu, 2006). More Ergül & Kargin (2014) states that "the most important characteristics of the PjBL are students achieving success is making available a method of teaching a student including acquisitions and teaching methods where students will be responsible for their learning reviews". Therefore, the opinions of some experts and the results of the study above become the background by selecting the PjBL model for learning machine drawing course.

Based on the above facts, the researcher wants to improve machine drawing learning by designing an instructional media that can help lecturers to create innovative, adaptive and anticipatory learning to produce students who can compete in the world of work in this industrial revolution 4.0. To create effective learning in this era 4.0, lecturers must be able to: (1) understand information and problems that are developing, (2) reflect on how this will affect on several aspects of human life, (3) compare how it fits with our own experience, and (4) think about how the information and issues can offer new ways for us to act. Learning requires more than just seeing, listening, moving, or touching to learn. The researcher developed an instructional media based on PjBL is specifically designed for machine drawing learning that integrates those sensory functions. The use of PjBL is expected to make students more creative, responsive and independent in learning so that they can improve their activities and learning outcome. The development of instructional media allows students to have competencies that are far better than before (Fathhurrokhman et al. 2017).

Method

The type of study is research and development (R&D) by using ADDIE models. The Research was conducted at the Faculty of Engineering, Universitas Negeri Padang in the machine drawing course. The type of data used in the development of instructional media based on PjBL is primary data, namely validity data that are taken from the results of the instructional media validation that is carried out by the validator, results of SLP validation and teaching materials. The data is obtained from the implementation of the trial in the form of responses of students and lecturers to instructional media after it was tested (practicality) and student competence (effectiveness) were analysed using statistical formulas.

Instruments and Data Analysis Techniques

Validation

The validation sheet is intended to determine the validity of instructional media based on PjBL model by experts. Validation has been doing by the expert validator consisting of three experts. Before conducting the research, the researchers compiled an instrument based on the latticework instrument. Validation carried out three aspects validation are content, aspects, and language. The validity analysis of developing instructional media is done by using a Likert's Scale based on the validation sheet and discussion until achieving a condition where the validators said that the instructional media that is developed has been valid and proper to use. The latticework of instructional media based on PjBL questionnaires can be seen from Table 1

Table 1: Validate Questionnaire Latticework of Instructional Media

No	Aspects	Aiken
Lesson Plan (SLP)		
1	Clarity of identity	
2	Clarity of SLP Content	
3	Approach and Learning Method	
4	Learning activities based on the PjBL model	
5	Media/ learning resource	
Text Books		
1	Format of textbooks	
2	Aspect Content/ Material	
3	Picture Aspect	
4	Language Aspect	
5	Display Aspect	

Analysis of content and products based on the result of the validator. Data obtained from questioners were analysed by using descriptive statistics. According to Azwar (2014), the steps to carry out the analysis are:

A. Give the answer of scores with the following criteria:
4 = strongly agree, 3 = Agree, 2 = Neutral, 1 = Disagree
B. Add the scores of each validator for all indicators.
C. Statistics Aiken's V formulated as
$V = \sum s / [n (c - 1)]$..... (1)

The result of Aiken's calculations ranges from 0 to 1 and 0.6 interpreted have coefficient high enough. The Values V 0.6 and above are stated invalid categories.

Practicality

The practicality instrument is used to obtain data on the level of use of instructional media. This practicality instrument consists of the practicality of the product for lecturers and students described by using a Likert Scale. The latticework of practical responses of lecturer responses can be seen in the following table 2:

Table 2: The Latticework of Practicality Instrument of Lecture Responses

No.	Aspect	Indicator
1.	Attractiveness/ the pleasure of using the instructional media	a. The attractiveness of instructional media from material b. The attractiveness of instructional media from the format c. The attractiveness of instructional media from design
2.	Easiness to use instructional media	a. Simple and Easy of instructional media b. Instructional media provide convenience and facilitate the learning process c. the students are easily understanding the instructional media
3.	Progress obtained by using instructional media	a. Improve critical thinking skills b. Improve problem-solving skills c. Increase the ability to work together / social skills d. Increase students' understanding of the concept of learning e. Understanding the relationship between material f. Understanding learning comprehensively g. Learning material can last for an infinite period of time in a student's memory
4.	Applied	a. Instructional media can be applied by expert lecturers b. Instructional media can be applied by other lecturers c. Instructional media can be developed for other learning

The latticework of practical instruments of student responses in order to develop instructional media. It can be seen in Table 3.

Table 3: The Latticework of Practicality Instrument of Student Responses

No.	Aspect	Indicator
1.	Attractiveness/ the pleasure of using the instructional media	a. The attractiveness of instructional media from material b. The attractiveness of instructional media from format c. The attractiveness of instructional media from design
2.	Easiness to use instructional media	a. Simple and Easy of instructional media b. Instructional media provide convenience and facilitate the learning process c. The students are easily understanding the instructional media
3.	Progress obtained by using instructional media	a. Improve critical thinking skills b. Improve problem-solving skills c. Increase the ability to work together / social skills d. Increase students' understanding of the concept of learning e. Understand the relationship between material f. Understand learning comprehensively g. Learning material can last for an infinite period of time in a student's memory

Effectiveness

Effectiveness of the instructional media of student learning is aspects of student's competence in making a detailed picture of a computer or machine. The effective test was carried out using none equivalent design control group post-test only by comparing competencies of students from two learning classes with different treatments. One study group is called the control class, where learning activities are carried out without using the instructional media. The other learning group is called the experimental class is learning activities are using instructional media. Furthermore, to see the differences between the competency of his students from the two research classes, data analysis was carried out by T, before the T-test data was carried out the prerequisite test analysis was the homogeneity test and normality test by using analytical data.

Result

Validity

The data will be used for the validity of machine image instructional media is data obtained from the validator using a questionnaire. The researcher, distributed questionnaires to three validates who validated the instructional media developed. The validator performs validation

of instructional media, which include aspects of the content, image aspects and aspects of language. The validation results from the instructional media are presented in Table 4.

Table 4: Assessment Validator of Instructional Media

No	Aspects	Aiken	Info.
1. Semester Lesson Plan (SLP)			
1	Clarity of identity	0.83	Valid
2	Clarity of SLP Content	0.82	Valid
3	Approach and Learning Method	0.83	Valid
4	Learning activities based on the PjBL model	0.87	Valid
5	Media/ learning resource	0.75	Valid
Average Validity of SLP		**0.82**	**Valid**
2. Learning Event Unit (LEU)			
1	Clarity of identity	0.75	Valid
2	Clarity of the contents of the learning reference unit	0.79	Valid
3	Approach and Learning Method	0.87	Valid
4	Learning activities	0.87	Valid
5	Media/ learning resource	0.81	Valid
Average Validity of LEU		**0.80**	**Valid**
3. PjBL Model-Based Machine Textbook			
1	Format of textbooks	0.77	Valid
2	Aspect Content/ Material	0.93	Valid
3	Picture Aspect	0.81	Valid
4	Language Aspect	0.80	Valid
5	Display Aspect	0.70	Valid
Average Validity of Text Books		**0.80**	**Valid**
Average Validity of Instructional Media		**0.81**	**Valid**

Table 4 shows that 3 validators assessed the average validity of instructional media at 0.82, so it can be concluded that the Learning Machine Drawing based on PjBL model for vocational education falls into the correct category.

Practicality

Practical test data for instructional media image courses machine-based PjBL models are taken from questionnaires that have been distributed to lecturers and students.

Practicality Data Based on Lecturer Response

Practical data were obtained through questionnaires which were filled by two lecturers using this instructional media. Based on the questionnaire contents, it can be seen the practicality of instructional media. The results of the lecturers' response to the practicality of the PjBL-based instructional media are summarised in table 5.

Table 5: The practicality of Instructional Media from Lecturer's Responses

No	**Statement**	**Percentage %**	**Criteria**
1	Instructional media based on PjBL machines image are easy to use because they are easy to understand	70	Practical
2	The use of the instructional media PPA model-based machine images aroused the interest of students	90	Very Practical
3	Learning by using machine image based on the PjBL model makes students more quickly understand the material	80	Practical
4	The use of instructional media model-based machine images can save time and lecturers in the presentation of learning materials	80	Practical
5	Learning by using instructional media drawing machine learning PPA-based models can be interpreted by the lecturer	80	Practical
6	The use of instructional media machine image instructional media based on the PjBL model makes learning more interesting	100	Very Practical
7	Instructional media machine drawing based on PjBL models in accordance with the curriculum	80	Practical
Average		**83**	**Very Practical**

Based on the results of the lecturer's response, data, analysis on the practicalities of the instructional media based on the PjBL model, drawing machine, the average percentage of lecturer responses to the instructional media is 83% with an efficient category. This shows that the instructional media based on PjBL are very easy to use for lecturers and create the quality of learning.

Practicality Data Based on Student Responses

The Practicality data of instructional media of students focused on product materials and students only using the textbook, but SLP and LEU are not used by students. The results of student responses to the practicality of instructional media based on PjBL summarised in Table 6.

Table 6: The practicality of Instructional Media from Student Responses

No	Questions	Percentage %	Criteria
1.	Learning activities on machine drawing by using image machine teaching material based on PJBL model, I can find the aims of the learning that I did	83	*Very Practical*
2.	I can learn machine drawings by image machine teaching materials based on the PjBL model.	82	*Very Practical*
3.	By using image machine teaching materials, the PjBL model-based machine can help me to learn independently.	80	Practical
4.	I am easy to use image machine teaching materials based on the PjBL model.	81	*Very Practical*
5.	Explanations/drawings/ tables available in Picture teaching materials Machines based on PjBL models can make it easier for me to understand the concept of learning activities.	81	*Very Practical*
6.	I can easily read the text and sentences in the machine drawing teaching material based on the PjBL model.	78	Practical
7.	I can easily understand the language used in machine drawing teaching materials based on the PjBL model.	83	*Very Practical*
8.	Teaching materials image machines based on PjBL models are designed according to the material.	77	Practical
9.	Teaching materials image machines based on the PjBL model developed can improve my reasoning for understanding learning material	82	*Very Practical*
10.	Teaching materials PjBL model-based machine helps me to understand machine drawing material.	86	*Very Practical*
11.	Picture teaching materials PjBL model-based machine motivates me to learn machine drawings.	80	Practical
12.	Picture teaching materials The machine-based PjBL model attracted my interest in learning machine drawings.	80	Practical
13.	Picture teaching materials machine-based o nPjBL model makes me more active in learning.	80	Practical

Average	**81**	*Very Practical*

The average percentage of assessment of students is 81% with a convenient category. These results indicate that the practical categories can develop the students understanding the material.

Effectiveness

To see the effectiveness of the instructional media, image engineering developed an experimental method that compares two research groups with different treatment. Data obtained by performing student competence post-test. Students in the control class and experimental class are given the same final assignment.

Table 7: Data form Assessment of Student Competencies

No.	**Without Instructional Media**		**Using Instructional Media**	
	Student	**Grade**	**Student**	**Grade**
1	M1	70,00	M1	93,33
2	M2	76,67	M2	90,00
3	M3	70,00	M3	90,00
4	M4	66,67	M4	80,00
5	M5	76,67	M5	86,67
6	M6	70,00	M6	76,67
7	M7	70,00	M7	90,00
8	M8	53,33	M8	83,33
9	M9	63,33	M9	76,67
10	M10	70,00	M10	90,00
11	M11	76,67	M11	80,00
12	M12	66,67	M12	76,67
13	M13	83,33	M13	86,67
14	M14	70,00	M14	86,67
15	M15	66,67	M15	83,33
16	M16	70,00	M16	80,00
17	M17	76,67	M17	86,67
18	M18	80,00	M18	86,67
Average		**70,93**		**84,63**

Analysis of the student's competency is to see differences of student competencies from both research classes. Before analysing the differences in student competencies with the T-test, the research data requirements, test was carried out first, namely the test for normality and homogeneity.

Analysis Test Requirements

Normality Test

The normality test is done by using the Kolmogorov-Smirnova test. The basis of decision-making in the normality test is if the Sig value is> 0.05, then the data are normally distributed and if the value is significant <0.05, then the data is not normally distributed. The results of the normality test are presented in Table 8.

Table 8: Result of Normality Test

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized Residual
N		18
Normal Parameters[a]	Mean	.0000000
	Std. Deviation	6.54204954
Most Extreme Differences	Absolute	.189
	Positive	.131
	Negative	-.189
Kolmogorov-Smirnov Z		.801
Asymp. Sig. (2-tailed)		.543

a. Test distribution is Normal.

Based on the results of the Kolmogorov-Smirnov normality test, it was seen that the results of the student competency data were significantly higher than 0.05, namely 0.543. Based on the results obtained, so that it can be concluded that the data obtained are at the normal distribution level, and analysis can be continued on testing homogeneity.

Homogeneity Test

The next requirement test analysis is the homogeneity test. The homogeneity tested aims to determine regardless of whether homogeneous data in a study. The basis for the decision-making in the homogeneity test is if the Sig value is> 0.05 then it is said that the variants of two or more population groups are not the same. If the value of sig <0.05, it is said that

variants of two or more population groups are the same. The results of processing homogeneity test data are presented in Table 9.

Table 9: The Result *of* Homogeneity Test

Test of Homogeneity of Variances			
Levene Statistic	df1	df2	Sig.
1.438	4	12	.281

The result of the homogeneity test obtained sig values. Obtained greater than 0.05, which is 0.281. Based on this, the homogeneous student competency assessment data can be collected.

3.3.2 T-Test

To see the difference in the value of student competencies between using the application of instructional media based on the PjBL model, without using instructional media, and the T-Test. The results of the T-test tests performed are presented in Table 10.

Table 10: The Result of T-test

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
x	Equal variances assumed	.073	.789	-6.688	34	.000	-13.66667	2.04355	-17.81967	-9.51367
	Equal variances not assumed			-6.688	32.149	.000	-13.66667	2.04355	-17.82849	-9.50484

The T-test results show that the sig value. (2. tailed) in both study classes <than 0.005, it can be concluded that there are significant differences in values in the two research classes.

Discussion

The learning of the drawing machine subject of instructional media based on the PjBL model was designed to improve the student's problem solving, creativity and competency skills.

Students are given a debriefing about drawing with direct learning methods and project assignment based on real-world problems related to the design of components/tools or machines. The instructional media consist of Semester Lessons Plan (SLP), Learning Event Unit (LEU) and textbooks. Meanwhile, the instructional media are proper to the engineering drawing curriculum for students of Mechanical Engineering, Faculty of Engineering, Universitas Negeri Padang.

Based on the result of three validators relating to SLP, LEU, and Textbook, It can be concluded that the instructional media is valid, feasible, and trusted to have applied in learning activities. According to the Trianto (2010) valid means that it has provided accurate information about developing the instructional media. Validation of instructional media based on the PjBL model was conducted by a validator which consists of three experts. The three validators are experts in the field of study so that the result of validation can be accounted for the validation. The results of the practical test of instructional media based on the PjBL model by lecturers and students through questionnaires showed that the level of practicality in the category was efficient. The lecturer response questionnaire was given to two lecturers to see the response in terms of the practicality of using the PjBL-based Instructional Media Image Machine. The questionnaire for student responses was given to 20 students to see the practicality of using instructional media.

The result of a practical test of instructional media by lecturers and students is very practical as categories have an average percentage of 83%. These results indicated that the development facilities of learning devices help to create a student learning environment by the characteristics of project-based learning. The practicality of learning devices based on students' responses with an average percentage of 81% with the very practical category. Furthermore, these results show that the learning device can help, the students are easier with PjBL learning patterns

The effectiveness of instructional media in this study it can be seen from the effects of using instructional media on student competencies. The results of the study with the experimental method, namely comparing two research classes with different treatments, where one class is of learning activities carried out using instructional media and one other class carried out without using instructional media. Learning activities using instructional media make students have better competencies than students with learning activities carried out without using instructional media.

The ease of students in finding the knowledge is needed through the instructional media provided textbooks, make the students learning activities, and has an effect of the goof competence. The research class using the average student competency score is 84.63. The score is higher than the students in the research class whose learning activities without

instructional media around 70.93. The effectiveness, image machine subject instructional media is based on the developmental PjBL model. It can be seen from the learning outcomes of the competencies of students who are directly involved in learning the process.

Conclusion

Based on development stage above, it can be concluded that the subject of instructional media drawing machine based on the PjBL model is valid, practical, and effective. The application learning of instructional media based on the PjBL model makes lecturers create environments in accordance with the characteristics of the PjBL model and therefore be effective in improving student competence.

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