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PROJECTION SIMULATION MEDIA IN TECHNICAL DRAWING FOR VOCATIONAL STUDENTS

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Abstract

Image projection is an abstract concept in technical drawing material, especially if the learning process is manual. Vocational high school students find it difficult to understand the projected image because they cannot observe objects in real terms. To solve this problem in this study, simulation learning media was developed to make it easier for students to understand projection material. The purpose of this study is to produce simulation learning media to improve student learning outcomes and to find out students' responses after using learning media on projection material. The media development method follows the steps of Analysis, Design, Development, Implementation, Evaluation (ADDIE) followed by the implementation of simulation media using a quasi-experimental method with a one-group pre-test – post-test design. The increase in learning outcomes was measured using *N-Gain*, while the feasibility of the media and the user's response to the simulation media were obtained using a questionnaire. Based on the results of the material and media expert testing, it was found that the simulation learning media produced was declared feasible, while the increase in learning outcomes was in the medium category. Likewise, students' responses to the simulation media used are at high criteria.

Keywords: Image projection, Learning outcomes, Simulation media, Students' responses, Technical drawing.

1. Introduction

Projection is a basic competency in engineering drawing subjects. Projection is one of the important materials in technical drawing at vocational high schools because it is used to help produce 2D and 3D images. This competency must be possessed by all vocational students so that students can understand and be able to make technical drawings.

Student learning outcomes in technical drawing, especially projection material is still low so far. Learning technical drawing generally still uses visual aids in the form of limited space nets. It is difficult for the students to use nets to visualize real objects into 3D technical illustration drawings, it is also difficult to make 2D images from 3D images. This causes, before drawing, students must imagine real objects to become 3D images or vice versa, students must first imagine the views on 3D images so that they become 2D images according to the provisions.

Based on this problem, an alternative solution is needed in learning engineering drawings. Innovative media in the form of multimedia is one of the solutions that can be offered because according to the existing theory it has advantages that can be used in the learning process such as sound, animation, simulation, video [1-4]. Likewise, multimedia can be considered a relatively effective method that can improve the quality of the learning process in the classroom [5, 6].

Based on this description, a learning process requires good and appropriate learning media, so that students can more easily recognize and understand the basic material of technical drawings that have been delivered by the teacher. Also, materials that require visualization such as projection images, both related to the type, presentation, and manufacturing process, require media to visualize them [7, 8].

This study aims to (1) produce simulation media on projection material, (2) determine the feasibility of the developed media, (3) determine students' responses to simulation media projection learning material, and (4) determine the increase in student learning outcomes in projection learning material with using simulation media.

2. Method

In developing simulation media, the ADDIE model was used. The ADDIE research method consists of 5 steps, namely: Analyse, this stage is carried out to analyse the needs of material, software, hardware, determine student competencies be achieved, user analysis, and material analysis to find out what material will be displayed on simulation media. Design, the design stage, namely designing the flowchart, interface, and storyboard. Development, this development stage is based on the results of designing the media based on the framework of the previous stage. In this step, media development is carried out in terms of appearance such as colour, background, type of writing, and font size. Besides, additional descriptions and audio, coding on the storyboard, and interface were also carried out.

Implementation, the stages of implementing the learning program by applying simulation media to find out how the response and student learning outcomes in the learning process using the developed simulation media. Implementation to students was carried out through an online learning process. The instrument used when conducting research was a test instrument in the form of questions, while to determine student responses using a questionnaire. Evaluation, this stage tests the

simulation media based on the opinion of material and media experts. The assessment is carried out using a judgment sheet which contains statement indicators regarding the material and media. The results of the judgment from the material and media experts were used as the basis for media improvement and justification of the feasibility of the media being developed.

Furthermore, to implement multimedia that has been developed, it was continued using the one-group pretest-posttest design. The media was implemented to 30 vocational school students. Initial ability was measured from the results of the pretest, then given treatment using simulation media, and post test to determine the increase in learning outcomes. The *N-Gain* test refers to Eq. (1) is used to determine the increase in student learning outcomes with the Gain test criteria as shown in Table 1.

$$N\text{-}Gain = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Maximum Score} - \text{Pretest Score}} \quad (1)$$

Table 1. *N-Gain* criteria [9].

Score	Criteria
***N-Gain*> 0,7**	High
0,3 ≤ *N-Gain* ≤ 0,7	Middle/moderate
***N-Gain*< 0,3**	Low

The instrument was used to reveal the feasibility of the media from media experts and material experts and students' responses were using a questionnaire. Analysis of the data from media experts, material experts, and student responses refer to Eq. (2).

$$P = \frac{RealScore}{Idealscore} x100\% \quad (2)$$

with: P = Percentage and Ideal Score = Highest score x number of respondents, while the qualification measure uses the criteria as in Table 2.

Table 2. Conversion level of achievement.

Level of Achievement (P)	Qualification	Information
90% - 100%	Very good	No Need to Revise
75% - 89%	Good	No Need to Revise
65% - 74%	Enough	Need to Revise
55% - 64%	Less	Need to Revise
0% - 54%	Very less	Need to Revise

3. Results and Discussion

The implementation of simulation media was carried out to students at vocational high schools. The target students in this study are students who are taking technical drawing lessons on projection material. Under the method used in this study, the process of developing simulation media begins with the analysis stage. The analysis stage is to determine the needs in the development of simulation media. The first step taken was conducting field observations and unstructured interviews with vocational students who had studied projection material. The results of this observation obtained a description of the problems encountered in learning engineering drawings. In the subject of technical drawing, projection material, students often experience

difficulties in visualizing real objects into 3D technical illustration drawings and difficulties in making 2D images from the given 3D images.

Based on this problem, the alternative solution is to make simulation media on the material being taught, which includes what is the projection, forms of projection, and how to make projections. The material was presented in the form of an audio-visual simulation, where it would simulate how to draw a line accompanied by an explanation of the changes that occur in the lines visually with simulation, then proceeded with the main material descriptively and accompanied by audio that would help students in understanding the process of drawing projections. The results of the analysis of hardware requirements showed that the hardware needed to develop and use simulation media were: (a) Processor: AMD E2-7015 APU with AMD Radeon R2 Graphics 1.50 GHz; (b) RAM: 4 GB, (c) Screen: 14", while the software requirements were Windows 10 64-bit operating system, (b) Adobe Flash CS6, (c) The action script used was action script 2.0; and (d) Balabolka, which is an application that can convert text into audio. The software specification used when implementing simulation learning media was Adobe flash player 11, which is an application to help open and use simulation media that has been exported to flash movies.

At the design stage, a flowchart was created to determine the process flow on the simulation media to be developed, the storyboard, and interface as shown in Fig. 1.

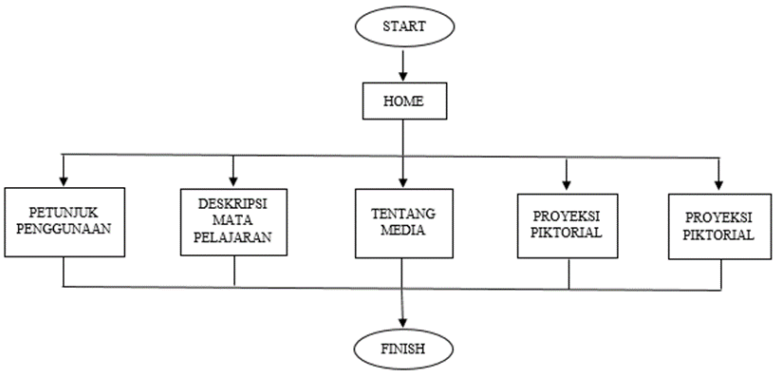
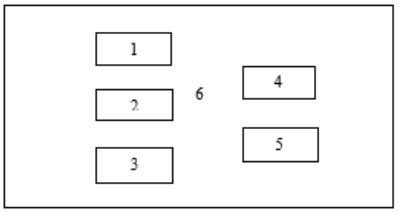
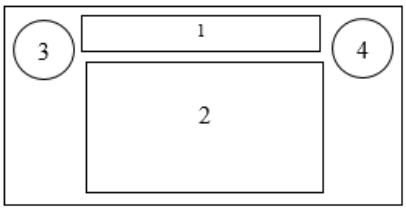


Fig. 1. Flowchart of simulation media process.

The structure of the media flow diagram to be developed is shown in Fig. 1. The flow of media begins with the home menu. In the home menu display, there are several options, namely: instructions for use, material descriptions, about the media, pictorial projection, and orthogonal projection. Each menu will direct the user to the next skill according to the menu title.

Furthermore, in this step storyboard from the developed media was designed as shown in Table 3. This storyboard is a flowing design for the simulation media to be developed. In this part of the storyboard, there is a plan for the required buttons, what function of each button is, and the layout of the buttons on each interface. The storyboard is made for all the required views on the simulation media to be created. The storyboard also makes the developer have a benchmark so that the media being developed does not go anywhere, but according to plan.

Table 3. An examples of simulation media storyboards.

No.	Design *Interface*	Description
1.		Main course 1. Navigation button “Instructions for use” contains a scene about instructions for using buttons on the media. 2. Navigation button "Subject Description" contains a scene to describe the material on the media. 3. Navigation key "About Media" contains a scene explanation of applications used in creating multimedia. 4. Navigation button "Pictorial Projection (3D)" screen contains the definition of projection, projection methods, how to make cylindrical objects, and sample problems. 5. Navigation button "Orthogonal Projection (2D)" scene contains the definition of projection, projection methods, and sample problems. 6. Background.
2.		Material screen 1. Title of material. 2. In the form of animation and writing. 3. Navigation button "Back" to go to the previous page 4. Navigation button "Next" to go to the next page. Or the navigation button "Home" to go to the menu page.

An example of interface design was made as shown in Table 4. In Table 4, there are 2 interface displays on the simulation media, namely the initial display and the second display of the simulation media. In these two views, some menus can be selected by the user, including a menu of instructions for use, subject descriptions, about media, and material choices in simulation media.

At this stage of development, media was made based on the framework that was planned in the previous stage. In this case, the media was developed in terms of appearance such as colour, background, type of writing, and font size. In addition, creating animation, adding descriptions and audio, and coding on the storyboard and interface were carried out. The results of the media judgment carried out by material and media experts are used as a reference for media improvement. Then after the

media was declared feasible based on the results of the judgment of the media and material experts, the media was used in learning to students. After the learning process using simulation media, the students were asked to fill out a questionnaire to find out their response to the use of simulation media. The questionnaire consists of 15 questions with a rating scale with a score range of 1-5. The following are the results of user responses to simulation media as shown in Table 5 and Fig. 2.

Table 4. Layer interface design.

No.	Information	Display Name & Visualization
1.	The home screen displays the title of the material	
2.	The second screen displays the main menu containing material, sample questions, instructions for use, about media, and subject descriptions.	

Table 5. Student response results.

No	Aspects of Assessment	Student Response Scores
1.	***Usefulness*** • Learning media	85,6%
2.	***Ease of use*** • Display presented • Operation of learning media • Flexibility in study time	87.4%
3.	***Ease of learning*** • Ease of understanding the material • Accuracy • Problem-solving learning • Animation and audio presented	87.4%
4.	***Satisfaction*** • Interest in learning media • Motivation to learn	92%
	Average	**88%**

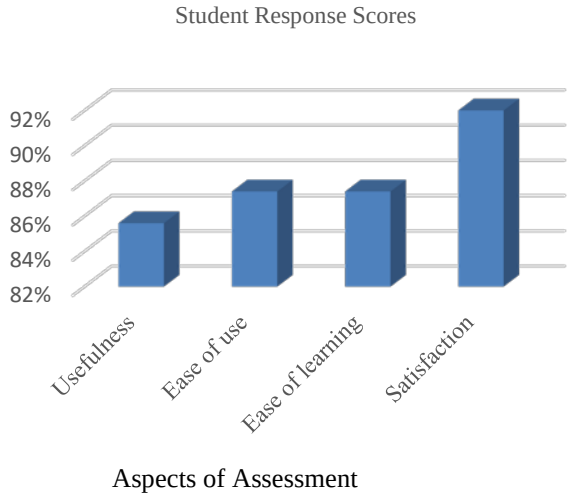


Fig. 2. Students response results.

Based on the results of student responses in Table 5 and Fig. 2., it can be seen that the level of student interest in simulation media is in the average range of 88%. This value is obtained from the average results of the statements given to students. The results of student responses indicate that students respond well and there are changes related to the positive use of media from students in studying projections in engineering drawing subjects. The results in Table 5 show the aspects of usability, ease of use, ease of learning, and student satisfaction using simulation media.

The simulation media was then tested on students in learning. The increase in learning outcomes can be seen through the pretest and post test results obtained by students as presented in Table 6. The test instruments used were 30 multiple choice questions and 1 essay question taken by 30 students.

Table 6. Data results for the pre-test, post-test, and *N-Gain*.

Subject	Pre-test	Post-test	*N-Gain* Score	Criteria
		Cognitive		
Highest	90	97		
Lowest	43	60	0,40	Middle
Average	70	81,2		
		Psychomotor		
Highest	56	75		
Lowest	31	63	0,43	Middle
Average	44,6	68,5		

Based on Table 6, it is known that the *N-Gain* value for cognitive aspects is 0.40, while the *N-Gain* value for the psychomotor aspect is 0.43. This explains that the increase in learning outcomes both in cognitive and psychomotor aspects of students after learning using simulation media is included in the moderate category.

The results of simulation media testing by media experts were obtained following the software engineering aspect of 91.43% and the visual communication aspect of 96.66% as shown in Figs. 3. and 4. This shows that the average percentage of media feasibility is 94,04% are categorized as very good and do not need to be revised.

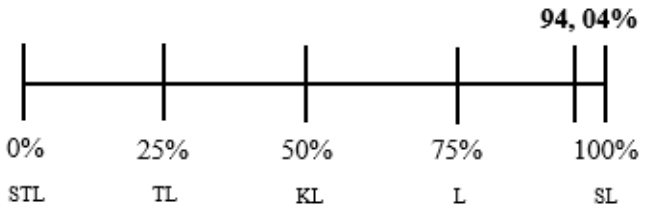


Fig. 3. Feasibility area for simulation media result of media expert judgment.

The results of testing the simulation media by material experts obtained an average score of 4.56 and a percentage of the learning design aspects of 91.25%. So that the simulation media is categorized as very good and does not need to be revised.

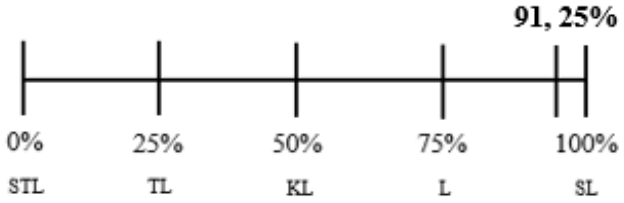


Fig. 4. Feasibility area for simulation media result of material expert judgment.

This simulation media is designed for projection learning aids which are expected to improve student learning outcomes in projection material and increase student learning motivation. This simulation media presents interesting audio and visuals. It is hoped that it will help students visualize real objects into 3D images and convert 3D images into 2D images. Edgar Dale's experience cones [10] states that learning that is presented visually and audio simultaneously will make students' ability to remember by 50%.

The researchers found problems in projection learning, namely, students find it difficult to visualize real objects into 3D illustrated images or change images from 3D to 2D images. Therefore, the researchers designed simulation media to assist students in studying projection material.

Testing by material and media experts is carried out to determine whether the media developed is suitable for use as projection learning media. Media experts test based on a questionnaire that has been provided with some indicators to test the feasibility of the media. After testing, it turns out that the media was declared feasible because it was considered to have met the criteria, namely that the media developed is effective and efficient in its use, can be managed or maintained properly, is easy to operate, right in the selection of applications for media production, can be run on existing computer devices, creative in pouring ideas, clear audio, very attractive visuals, animation that is very clear and easy to understand, and choosing the right layout. This underlies that the simulation media

is suitable for use as a learning medium [11, 12]. According to Hasni et al. [13] and Cairncross and Mannion [14] the benefits of learning media are to generate enthusiasm for learning, which causes students to interact more directly, where students interact with the real environment, they can learn independently according to their abilities and interests. Rahmatullah [15] stated that media is a means of connecting information from teachers to students. Information conveyed in the form of presentations, namely: writing, pictures, sound, animation, and video.

Thus, the use of media certainly contributes positively to the learning process and student learning outcomes [16, 17]. The results of the material expert's judgment for some indicators show that this media, based on the material presented is declared feasible by meeting the following criteria: relevant and clarity with learning objectives, accuracy in selecting learning strategies, providing learning motivation, depth of material, discussion of the material, and sample questions on the media clear to understand, the material is arranged systematically, coherently, and the flow of logic is clear, the completeness of the material, the relevance of images and animation to the material. This underlies that the material in this media is declared appropriate. According to Rahmatullah [15] the learning process that occurs is determined by several aspects of learning, including learning objectives, teaching materials, methods and media, evaluation, students, teachers). Noer [18] stated that the student learning process is influenced by the family social environment, the school social environment, the social community, the natural environment, and instrumental factors (school buildings, learning tools, learning facilities, curriculum, regulations school, guidebook).

The media was implemented to 30 vocational school students who learned projection material. In the implementation of this media using a quasi-experimental method, the researcher conducted a learning outcome test using the experimental research method. The research design used by the researcher was a one-group pre-test –post-test design. This design was developed into three stages in the learning process. This stage was carried out to determine whether the animation media would affect student learning outcomes at each stage. Student learning outcomes data with the application of simulation media in the learning process are as presented in Figs. 5 and 6.

Figures 5 and 6 show that the students learning outcomes before the application of simulation media in the cognitive domain of students based on the pre-test results, the number of students who are below a score of 75 is 11 students, while those who are above the score of 75 are 19 students. Meanwhile, the post-test results have increased. It is known from the *N-Gain* value of 40% with moderate criteria below the score of 75 as many as 9 students, while students who are above the score of 75 are 21 students. The students learning outcomes before the application of simulation media in the psychomotor domain of students based on the pre-test results, the number of students who are below the score of 75 is 30 students, while those who are above the score of 75 are 9 students.

Meanwhile, the post-test results have increased. It is known from the *N-Gain* value of 40% with moderate criteria below the score of 75 as many as 9 students, while students who are above the score of 75 are 21 students. This shows that the simulation media has a positive influence on students in cognitive aspects. Prayogo et al. [19] stated that learning media and teaching methods are very important in the learning process because the use of appropriate learning media will be able to help students absorb the

subject matter easier. The use of suitable and adequate learning media can improve student learning outcomes, generate enthusiasm for learning, and is not boring, while in the psychomotor aspect there is a decrease in the pre-test and post-test scores compared to the previous teaching and learning process, because of the distance research process, the researcher cannot observe the image-making process, researchers can only judge from the results of the image. However, the increase in pre-test and post-test learning outcomes has increased which is known by the *N-Gain* value on moderate criteria. According to Rohendi [5], multimedia-based learning media significantly contributes to improving student skills. Simulation media can improve student learning outcomes as evidenced in the learning outcome diagram.

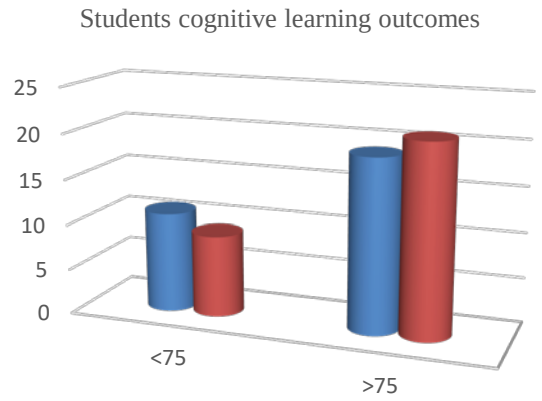


Fig. 5. Diagram of student learning outcomes in the cognitive domain.

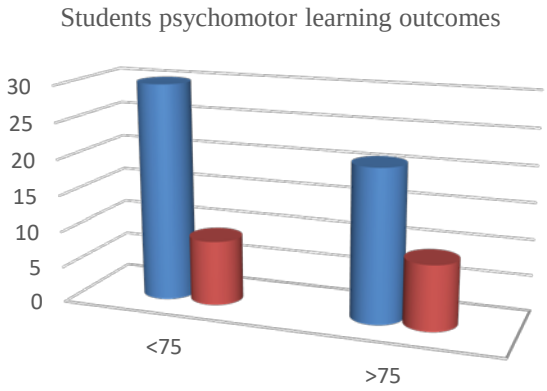


Fig. 6. Diagram of student learning outcomes in the psychomotor domain.

After conducting the pre-test and post-test, the researchers distributed a questionnaire about the response to media use, which had to be filled in by students who had used the simulation media. The questionnaire consisted of 15 statements containing usefulness, ease of use, ease of learning, and student satisfaction with the use of simulation media. In the first statement, the percentage result is 84.67%,

indicating that the media can be used as projection learning media. Statement 2 of the percentage result of 86.67% indicates that the media can help students in obtaining information about projection learning and Statement 3 of the percentage result is 90.67% which shows that the media can be used by students anywhere and anytime without time limitation. Statement 4 of the percentage of 84.67% shows that the media can be run in only one application, namely flash. Statement 5 of the percentage of 88% shows that the media is easy to operate. Statement 6 of the percentage results 86% indicates that the buttons on the simulation media make it easier for users to move the material.

Statement 7 of the percentage of 87.33% indicates that with the media students are able to understand learning material through learning media. Statement 8 of the percentage of 89.33% indicates that learning media can attract the attention of the students. Statement 9 of the results of the presentation 89.33% indicates that the media can make students learn independently and Statement 10 results 88.67% indicates that the selection of letters in learning media is correct because it makes reading easier. Statement 11 shows that the percentage of 90% shows that learning media can solve problems in projection learning while Statement 12 percentage results 82.67% shows that the clarity of animation and simulation in learning media. Statement 13 percentage results of 92% indicates that the audio contained in the simulation media is clear. Statement 14 results percentage 92% shows that the use of simulation media makes students learn to be interesting. Statement 15 of the percentage of 88% shows that the use of simulation media makes students motivated in terms of learning. From the results of the questionnaire that there is a positive influence generated from the media, it can be said that because the average result of each indicator is 88%. The student response is a positive response resulting from the use of media. The existence of a positive response in learning and being able to increase student motivation shows that there is a good influence on learning caused by the use of media.

Based on the results of this analysis, the delivery of projection material using simulation media can improve student learning outcomes. Simulation media can be used to help students visualize images so that they can be observed more realistically than still image media [20]. Motivation is needed to improve learning outcomes [21]. The teaching and learning process in schools will not be effective if there is no student readiness to learn. Learning readiness includes learning motivation in students so that all lessons given can be received well [22].

4. Conclusion

In accordance with the objectives of this study, a projection material simulation media has been produced. Based on the material and media expert's justification, it is concluded that the simulation media is suitable for use in learning process. Simulation media projection material in technical drawing lessons can improve student learning outcomes both in cognitive and psychomotor aspects. The application of projection simulation media in the learning process can improve student learning outcomes with moderate criteria, while student responses to the use of simulation media show positive results. In this case, it means that the developed simulation media is declared suitable for use in engineering drawing subjects and effectively improves student learning outcomes.

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