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Project-Based Learning Interactive Multimedia: Improving Basic Electrical and Electronics Learning Outcomes

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Abstract: This study aimed to (1) determine the feasibility of PjBL-based interactive multimedia in improving learning outcomes of basic electricity and electronics. (2) Determine the effectiveness or feasibility of PjBL-based interactive multimedia in improving basic learning outcomes of electricity and electronics. This research method is R & D research with the ADDIE development model. The subjects of this study consisted of two material experts, two learning media experts, two learning design experts, and 50 grade X students of SMK Negeri 1 Bandar Masilam. The results showed that: (1) PBL-based interactive multimedia products were feasible to use in the learning process of basic electricity and electronics for vocational students from several experts and trials were carried out on students; and (2) indicated by the results of data processing on the results of the posttest obtained t count = 6.63 At a significant level ($\alpha = 0.05$) with dk 48 obtained $t_{table} = 1.648$ so that $t_{count} > t_{table}$. The average effectiveness of learning outcomes in the use of PjBL-based interactive multimedia is 73%, while the group of students who do not use media is 36%. From this data, it proves that the use of PjBL-based interactive multimedia is more effective in increasing students' knowledge and competence in basic electricity and electronics learning than without using PjBL-based interactive multimedia.

Keywords: interactive multimedia; project based learning; electric base; electronics

1. INTRODUCTION

SMK plays a very important role in preparing students to be able to work or enter the world of work according to their field of expertise. One thing that must be considered in vocational education is market needs. Firdausi and Barnawi [1] explain that vocational education must be oriented to market needs (world of work) or demand-driven, vocational education must always keep abreast of the latest technological developments, learning must be directed at improving the quality of skills (skills), and assessing students' abilities. must refer to the standards of the world of work. For SMK students, mastery of information and communication technology can support and facilitate work in their field of expertise in the future. Whether working in the world of business and industry or entrepreneurship, basic skills in information and communication technology will help them.

The use of technology has become an integral component of work, education, communication, and entertainment [2]. The integration of technology is designed to suit the needs of teachers and students as shown through experience and content in forming knowledge. The content used in learning is a reflection of the knowledge students need [3].

The fact that technology plays a much bigger role in the digital age than it did in previous generations has made the current generation have a high level of technological literacy. This increase in literacy coupled with recent technological advances has led to the expansion of technology in the field of education. From millennials to Gen-Z, this is the generation that has stepped into today's class and they share the unique characteristics that define their generation. According to Bencsik, Csikos, and Juhez [4] it shows that generation Z is the generation born between 1995 – 2010. If traced, currently generation Z is the generation aged 12 – 27 years. So it can be said that those who sit start from class VI of Elementary School up to students who study in the Undergraduate Program.

Berkup [5] describes several characteristics of Generation Z, namely in socializing in cyberspace, students use the internet very quickly, with smartphones they can use the internet efficiently and innovatively, and they like games that challenge creativity. Generation Z is very comfortable with social communication via Telegram, Whatsapp, Instagram, Twitter, and others. They are also able to use technology and the internet with all their creativity and innovation. This generation also hopes to be involved in their learning instead of just being passive learners.

Trilling & Fadel [6] explain that students are expected to have: (1) Information literacy skills, students can reach various information effectively (through the right sources) and efficiently (actual and fast information) which are developing very rapidly, can filter critically received information and process it properly, be able to utilize and process information effectively and accurately to solve various problems; (2) Media literacy skills, students can determine and even develop media for communication; (3) ICT literacy skills, students can analyze appropriate information media and are even expected to be able to create new media that are more efficient, effective and attractive for use in communication.

In this era of globalization of digital technology, the problem being faced is the lack of educators who master ICT in utilizing the use of technology as a learning medium [7]. A monotonous learning process can make students not enthusiastic about learning activities. According to Dewi, et al [8], a lesson will attract the attention of students if there is integration between the selection of learning strategies or methods and teaching materials that are appropriate to the subject matter presented.

That is, learning strategies must be packaged in such a way that the material presented is easy to accept and remember along with increasing new knowledge from the learning activities carried out.

1.1 The Nature of Basic Electrical and Electronics Learning Outcomes

Basic Electricity and Electronics (DLE) is the study of the application of basic analog and digital electronics techniques which includes material on electrical theory, introduction to various electronic components, and use of electronic components, so this material is also important as a support in practice.

This DLE subject is in the 2013 curriculum studied by SMK students with competence in Industrial Electronics Engineering. The purpose of studying this subject is to know the basic components that exist in electronic circuits, both analog electronics and digital electronics. The DLE subject matter developed in the form of interactive multimedia in this study does not cover all basic competencies but takes one basic competency.

Sudjono [9] revealed that learning outcomes are an evaluation activity that can reveal aspects of the thought process (cognitive domain) and can also reveal other psychological aspects, namely aspects of values or attitudes (affective domain) and aspects of skills (psychomotor domain) that are inherent in each individual. learners. This means ough learning outcomes can be revealed holistically depiction of student achievement after going through learning.

Meanwhile, Benjamin Bloom in (Nana Sudjana [10]) explains that learning outcomes are divided into 3 domains, namely: (1) Cognitive domain, which is related to intellectual learning outcomes which consist of 6 aspects namely knowledge, memory, understanding, application, analysis, synthesis and evaluation; (2) The affective domain, which is related to the attitude which consists of 5 aspects, namely acceptance, response or reaction, research, organization, and internalization; (3) The psychomotor domain, which is related to the results of learning skills and the ability to act. There are 6 aspects of the psychomotor domain, namely reflex movements, basic movement skills, perceptual abilities, harmony or accuracy, complex movement skills, and expressive and interpretive movements..

The three domains stated by Benjamin Bloom above are domains that can be carried out by students. These three domains can be obtained by students through teaching and learning activities. The DLE learning outcomes that will be measured and used in this study are the cognitive and psychomotor domains.

1.2 Project-Based Learning (PjBL)

Project Based Learning (PjBL) is a learning model that has been widely developed in developed countries such as the United States. Translated into Indonesian, PjBL means project-based learning. A more comprehensive definition of PjBL according to The George Lucas Educational Foundation [11] is as follows: (1). PjBL asks a question or poses a problem that each student can answer, PjBL is a learning model that requires teachers and/or students to share guiding questions. Given that each student has an asynchronous learning style, PjBL provides opportunities for students to explore content (material) in various ways that are meaningful to them, and conduct experiments collaboratively. This allows each learner, in the end, to be able to answer the guiding question; (2). PjBL asks students to investigate issues and topics addressing real-world problems while integrating subjects across the curriculum, PjBL is a learning approach that requires students to produce "bridges" that connect various subject matters. In this way, students can see knowledge as a whole. More than that, PjBL is an in-depth investigation of a real-world topic, and it will be valuable for students' attention and effort.

Global SchoolNet [12] reports on the results of the AutoDesk Foundation's research on the characteristics of PjBL. The results of this study state that PjBL is a learning approach that has the following characteristics: (1) Students make decisions about a framework; (2) There are problems or challenges posed to students; (3) Students design processes to determine solutions to problems or challenges posed; (4) Students are collaboratively responsible for accessing and managing information to solve problems; (5) The evaluation process is carried out continuously; (6) Students periodically reflect on the activities that have been carried out; (7) The final product of learning activities will be evaluated qualitatively; (8) The learning situation is very tolerant of mistakes and changes.

Based on this opinion, it can be said that PjBL-Based learning is a learning method that uses projects/activities as media. Learners explore, assess, interpret, synthesize, and information to produce various forms of learning outcomes.

Project-Based Learning is a learning method that uses problems as a first step in gathering and integrating new knowledge based on experience in real activities. Project-Based Learning is designed to be used on complex problems that students need to investigate and understand.

1.3 Interactive Multimedia

Multimedia according to experts can be seen from different perspectives, multimedia is a tool that presents information in which there is more than one media component. Mayer [13] argues that Multimedia in nouns refers to technology for conveying material in visual and verbal form, also called technology - a tool used to convey material verbally and visually. Munir [14] clarifies Mayer's opinion that Multimedia is a combination of various media (file formats) in the form of text, images (vector or bitmap), graphics, sound, animation, video, interaction, and others that have been packaged into digital files (computerized), used to convey or deliver messages to the public. The general understanding of multimedia relates to the use of more than one type of media to present information.

According to Sulilana and Riyana [15] that interactive multimedia is a tool or means of learning based on material, methods, limitations, and ways of evaluating that are designed systematically and attractively to achieve the expected subject competencies/sub-competencies according to the level of complexity. Bambang [16] argues that multimedia is a message delivery tool that combines two or more media elements, including text, images, graphics, photos, sound, films, and animations in an integrated manner.

According to Daryanto [17], multimedia is divided into two, namely linear multimedia and interactive multimedia. The definition of linear multimedia is multimedia without a controller to be used by users. Linear can be interpreted as running sequentially or sequentially, for example, TV and movies. The definition of interactive multimedia is multimedia

that has a controller to be used by the user, so it depends on the user to be able to decide or choose the process of running the multimedia.

According to Sutopo [18], multimedia consists of two kinds, namely linear multimedia and non-linear multimedia. Multimedia that runs straight or sequentially is called linear multimedia, examples of linear multimedia types are TV and movies. However, if the multimedia can be controlled by the user, it is called non-linear multimedia which is often known as interactive multimedia, an example of interactive multimedia is a learning presentation where the user can choose which topic he wants to study without having to wait for the entire presentation to be broadcast.

The research problem is formulated as follows: (1) Is the developed PjBL-based Interactive Multimedia suitable for improving learning outcomes in basic electricity and electronics?; (2) Is the PjBL-based interactive multimedia developed effectively used to improve basic electricity and electronics learning outcomes?

2. METHOD

This research is a type of development research or research and development (R&D). Research and development is a process or steps to develop a new product or improve existing products, which can be accounted for. The product in question is a simple tool as a learning medium. This type of research was chosen because the procedures contained in it are very appropriate for developing a media that has the goal of developing a product. The development research model used is the ADDIE model. The ADDIE model is a learning design model that involves the basic stages of a simple and easy-to-learn learning system. This model uses the Analysis, Design, Development, Implementation, and evaluation development stages. This model was chosen because it is a model for developing educational and learning products.

This research was conducted at SMK Negeri 1 Bandar Masilam, Simalungun Regency. The research time is carried out in the even semester of the 2022/2023 academic year. All students of class X TEI semester 2 SMK Negeri 1 Bandar Masilam T.P 2022/2023 which consists of 2 classes, namely class X TEI 1 and X TEI 2. The subjects in this study consisted of 2, namely the first validity test subjects were 2 media experts and 2 material experts. The two subjects of implementing interactive multimedia as learning media are class students who will be selected by random sampling.

The development research procedure in this study uses the ADDIE development model. The steps for developing the PjBL-based Interactive Multimedia are:

1. Analysis Phase. The analysis phase is the initial stage of development research. In the analysis stage, the researcher identifies the problems that underlie the development of instructional media. In the analysis stage, several activities were carried out, namely needs analysis, material analysis, and literature assessment studies for the products being developed. Activities at the analysis stage are described as follows: (a) Needs Analysis; and (b) Material Analysis.
2. Planning Stage. The design stage is the initial stage of development planning according to the analysis. The design stage is the planning stage in making PjBL-based Interactive Multimedia as a PjBL-based ADDIE learning medium in digital electronics material in SMKs.
3. Development Stage. The development stage is the PjBL-based interactive multimedia development stage by implementing the product framework that has been made at the design stage. The steps taken are (1) Pre-production; (2) Production; (3) Post-production & Quality inspection. At this stage, the quality inspection process will be carried out by conducting expert validation and product revision. (a) Expert validation; (b) Product Revision.
4. Implementation Stage. Product trials are carried out in three stages, namely: (1) Individual trials; (b) Small group trials; and (c) Field trials.
5. Evaluation Stage. The evaluation phase is carried out to obtain PjBL-based Interactive Multimedia assessments developed by experts and students. Assessment is done through a questionnaire or questionnaire. Experts consisting of media experts, material experts, and learning design experts provide assessments, suggestions, and input on whether the media being developed is feasible or not. Media that has been assessed by experts then goes through a revision process.

Data collection was carried out using a questionnaire distributing questionnaires to the respondents, namely material experts, media experts, design experts, and student responses. The respondents assessed the quality of PjBL-based Interactive Multimedia with the provisions of the research criteria in Table 1 below:

Table 1. Scoring Rules

No	Category	Score
1	Very good	5
2	Good	4
3	Pretty good	3
4	Not good	2
5	Not good	1

Table 2. Interpretation of Media

No	Interval Mean Score	Interpretation	Acceptance
1	1,00 – 2,49	Not feasible	Low acceptance
2	2,50 – 3,32	Less feasible	Acceptance is sufficient
3	3,33 – 4,16	Decent	High Acceptance
4	4,17 – 5,00	Very decent	Acceptance is very high

(Source: Sriadhi, [19])

Based on the quantitative data from the results of the validator by material experts, media experts, and student response questionnaires, the next step is to analyze the data and calculate the percentage level of achievement based on the formula:

$$P = \frac{\sum x}{\sum xi} \times 100\ \%$$

Information:
x : The answer score from the validator
x_i : Score the highest answer
P : Presentation of eligibility level

The eligibility and effectiveness criteria achieved are used in the development of PjBL-based Interactive Multimedia described in Table 3 below.

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Table 3. Product Validation Criteria

Percentage %	Validity Level	Information
81,00 – 100,00	Very valid	Can be used without revision
61,00 – 80,00	Valid	Usable with minor revisions
41,00 – 60,00	Less valid	It is recommended not to be used because it is heavily revised
21,00 – 40,00	Invalid	Shouldn't be used, needs major revision
00,00 – 20,00	Totally invalid	Should not be used

The PjBL-based Interactive Multimedia that was developed received a positive response from students if the percentage obtained from the student response questionnaire reached a score of ≥ 60%, then the PjBL-based Interactive Multimedia learning media was categorized as feasible and effective.

Product Eligibility:
Ho : μ < μo; Ho = null hypothesis; μ = criterion with a value of 70.00; μo = score from a material expert, media expert, and respondent.
So it can be concluded that PjBL-based interactive multimedia in this study is said to be inappropriate if it is less than 70.00 from material experts, media experts, and respondents.
Ha : μ > μo; Ha = Alternative hypothesis ; μ = criterion with a value of 70.01; μo = score from material expert, media expert and respondent
So it can be concluded that PjBL-based interactive multimedia in this study is feasible if it is greater than 70.01 from material experts, media experts, and respondents.

Product Effectiveness:
To test the ability of interactive multimedia in improving learning outcomes, the N-Gain effectiveness formula is used. The normalized gain test (N-Gain) is calculated to see an increase in learning outcomes after being given treatment. Calculating the normalized N-Gain score is based on the formula according to Archambault [20], namely::

$$N - Gain = \frac{Posttest\ Score - Pretest\ Score}{Maximum\ Score - Pretest\ Score} x100$$

The obtained N-Gain calculations that have been normalized are then interpreted based on the appropriate N-gain interpretation table (Hake, [21]) can be seen in Table 4 below.

Table 4. Criteria for Grouping N-Gain

No	Percentage of N-Gain	Classification
1	100 – 71%	High
2	70 – 31%	Moderate
3	30 – 1%	Low

The mean normalized gain score (N-Gain) between the experimental class and the control class is used as data to compare students' literacy abilities. Testing the difference in the mean of the two experimental classes and the control class uses the t-test. As for the t-test requirements, the data between the experimental class and the control class must be normally distributed, and have the same (homogeneous) variance. The formula is as follows:

$$Efektivitas = \frac{N - Gain\ Experimental\ Class}{N - Gain\ Control\ Class}$$

The criteria used to determine which type of learning is more effective between learning that uses PjBL-based interactive multimedia and learning that does not use interactive multimedia are as follows:

1) if effectiveness > 1 then there is a difference in effectiveness where learning with interactive multimedia based on PjBL learning is stated to be more effective than learning without interactive multimedia
2) if effectiveness = 1 then there is no difference in effectiveness between learning with interactive multimedia based on PjBL learning and without interactive multimedia.
3) if effectiveness < 1, then there is a difference in the effectiveness of learning without PjBL-based interactive multimedia which is stated to be more effective than learning with PjBL-based interactive multimedia.

Furthermore, to test the hypothesis, the two-party test formula is used. The t test is used if the alternative hypothesis reads "bigger" or above (>). For research data that is normally distributed and homogeneous, the hypothesis testing uses the t-test with the formula:

$$t = \frac{\overline{x_1} - \overline{x_2}}{S\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

Where S is the root of the combined variance calculated by the formula:

$$S^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}, dimana\ S = \sqrt{S^2}$$

Where :
$\overline{x_1}$ = average score of the experimental class
$\overline{x_2}$ = average score of the control class
n_1 = the average number of experimental classes
n_2 = the average number of control classes
S_1^2 = variance of the experimental class group
S_2^2 = variance of control class group
S = combined variance
t = calculation price

The test criteria are accepted Ho if tcount > ttable is obtained from the t distribution list with dk = (n-1) with a significant level of α = 5%, then the teaching material is effectively used..

3. RESULTS AND DISCUSSION

3.1 RESULTS

The results of the assessment by media experts, material experts, individual trials, small group trials and limited field trials for all aspects of the assessment are determined by the average score. The results of the assessment will then be analyzed and determined whether or not it is appropriate to develop PjBL-based Interactive Multimedia. The average percentage of the results of the assessment of media experts, material experts, individual trials, small group trials and field trials is shown in table 5 below:

Table 5. Average Percentage of Assessment Results for PjBL-based Interactive Multimedia

No	Categorization	Percentage of average score%	Criteria
1.	Material Expert Validation	90,00	very feasible
2.	Media Expert Validation	89,20	very feasible
3.	Learning Design Validation	92,20	very feasible
4.	Individual Trial	91,70	very feasible
5.	Small Group Trial	92,40	very feasible
6.	Field Test	92,30	very feasible
Rata-rata		91,30	very feasible

Based on Table 5 above, it can be concluded that the PjBL-based interactive multimedia product developed includes very feasible criteria, thus it is known that the average rating (μo) from experts and field trials is 91.3% while the eligibility threshold value criteria (μ) is 70%, then μo > μ. So it can be concluded that PjBL-based interactive multimedia in this study is said to be very feasible to use and can meet the needs of implementing basic electronics learning.

The analysis requirements test performed is the normality and homogeneity tests. Testing was carried out using the Liliefors test. A summary of the normality of the two samples can be seen in Table 6 below:

Table 6. Summary of Data Normality Test with Liliefors

No.	Class	L_{count}	L_{table}	Conclusion
1	Pretest student learning outcomes that do not use PjBL-based interactive multimedia (control class)	0,080	0,173	Normal
2	Posttest student learning outcomes that do not use PjBL-based interactive multimedia (control class)	0,141	0,173	Normal
3	Pretest student learning outcomes that do not use PjBL-based interactive multimedia (experimental class)	0,097	0,173	Normal
4	Posttest student learning outcomes that do not use PjBL-based interactive multimedia (experimental class)	0,131	0,173	Normal

Homogeneity test analysis using the F test is to prove the largest variance and the smallest variance with the formula:

$$F = \frac{Varian\ terbesar}{Varian\ terkecil} = \frac{S_1^2}{S_2^2}$$

A summary of the homogeneity of the two samples is seen in Table 7 below:

Table 7. Summary of Data Homogeneity Test with Fisher's Test

Class	F_{count}	F_{table}	Conclusion
Posttest student learning outcomes that do not use PjBL-based interactive multimedia (control class)	2,94	4,24	Homogeneous
Posttest student learning outcomes using interactive multimedia based on PjBL (experimental class)			

From Table 7 above it is known that after the F test was carried out on the data on student learning outcomes in the control class and the experimental class, Fcount = 2.94, and it was known that Ftable = 4.24 at a significance level of 0.05 with n = 25 and dk = 2- 1 = 1. The results of the calculation above state that Fcount < Ftable which means that the learning outcomes of students in the control class and the experimental class have homogeneous variances, which means that the sample from each treatment group in this study has the same empirical character for the problem researched.

N-Gain Score test results To test the ability of interactive multimedia in improving learning outcomes, the N-Gain effectiveness formula is used. The normalized gain (N-Gain) test is calculated to see an increase in students' literacy skills after being given treatment. The results of calculating the n-gain score in this study are presented in Table 8 below:

Table 8. N-Gain Score Results

Class	Ideal Score (100-Pre)	N-Gain Score	N-Gain Score (%)
Posttest student learning outcomes that do not use PjBL-based interactive multimedia (control class)	36,52	0,36	36%
Posttest student learning outcomes using interactive multimedia based on PjBL (experimental class)	43,30	0,73	73%

Based on Table 8 above, it can be concluded that the use of PjBL-based interactive multimedia can improve basic electronic learning outcomes with a percentage of 73% in the high category.

Product Effectiveness Hypothesis
The results of the product effectiveness hypothesis test are known through the differences in the post-test results of control and experimental class students. The differences in learning outcomes are presented in Table 9 below.

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Table 9. Post-Test Calculation Results for Hypothesis Testing

Statistics	Class	
	Control	Experiment
N	25	25
Mean	77,23	88,37
Sd	7,26	2,81
S^2	52,73	17,88
t_{count}	6,63	
t_{table}	1,648	
Status	H_a accepted	

Based on Table 9 above, it is obtained that the value of t count = 6.63 At the significant level (α = 0.05) and dk = n1 + n2 – 2 = 48 it is known that for the level (0.05; 48) is 1.648, the price of tcount is compared with ttable turns out tcount > ttable, namely (6.63>1.468). Then Ha is accepted so that it can be concluded that PjBL-based Interactive Multimedia has a higher effectiveness compared to previous media in terms of learning outcomes.

(a) (b) (c)

Figure 1. Display of PjBL-based Interactive Multimedia; (a) Opening Page Display; (b) Display Menu Page; (c) User Guide Page Display Page 1

Figure 2. The learning process using PjBL-based Interactive Multimedia for students in Basic Electricity and Electronics subjects

3.2 DISCUSSION

The results of this study are in line with research conducted by Pramitasari, Mustaji & Harwanto [22] in their research that interactive multimedia on basic subjects of electricity and electronics, the results of this study are said to be very valid and feasible and can be used as alternative media in learning in the form of android applications, Which means that the developed learning media is very feasible to use without revision. Based on the results of the assessment by the material expert validator, the results obtained were 80.95% in the strong category. This means that the floating media is feasible to be applied in learning with a little revision. Based on the results of field trials, the results obtained were 96.87% in the very strong category.

In the process of teaching and learning several factors influence the achievement of learning objectives including educators, students, environment, methods/techniques, and learning media. Arifin [23] said that the media when understood in general is human, material, or events that build conditions that enable students to acquire knowledge, skills, or attitudes. In this sense teachers, textbooks, and the school environment are media. More specifically, the notion of media in the teaching and learning process tends to mean graphic, photographic, or electronic tools for capturing, processing, and reconstructing visual and verbal information.

Selection of the right media can certainly help to optimize the learning process carried out. Arsyad [24] suggests three characteristics of the media which are an indication of why the media is used and what media can do that the teacher may not be able to (less efficiently) do, namely: (1) fixative characteristics; (2) Manipulative traits; (3) Distributive Characteristics.

The results of Fui-Theng's research [25] on Interactive Multimedia Learning: Innovating Classroom Education In A Malaysian University. The results of the study put forward the conclusion that a significant increase was found in the test results as evidence that a good learning process had been carried out. The use of learning media brings changes in students' positive attitudes, they become more active and motivated in the learning process.

Sadiman [26] argues that media is anything that can be used to channel messages from senders to recipients so that they can stimulate thoughts, feelings, concerns, and interests as well as students' attention in such a way that the learning process occurs. The media also has related software containing educational messages which are usually presented using the equipment.

Kemp and Dayton in Kustandi [27] argue that learning media can fulfill three main functions if the media is used for individuals, groups, or large groups, namely in terms of (1)

motivating interest or action, (2) presenting information, and (3) giving instructions. To fulfill the motivational function, learning media can be realized with drama or entertainment techniques. As for information purposes, learning media can be used to present information in front of a group of students. The content and form of the presentation are very general, serving as an introduction, report summary, or background knowledge. Presentations can also take the form of entertainment, drama, or motivational techniques.

Hamalik (in Arsyad, [28]) also revealed that the use of learning media in the teaching and learning process can generate new desires and interests, generate motivation and stimulate learning activities, and even have a psychological influence on students. The selection of learning media must be adjusted to the material being taught and the conditions of the students. So it is hoped that the learning media can help students understand the concept of the material being taught, and can create a fun learning atmosphere.

The results of Akhtar Naz's research [29] regarding the Use of Media for Effective Instruction and its Importance: Some Consideration. The results of the study suggest that the media helps educators to transmit knowledge impressively by diversifying classroom teaching and making learning more effective. Instructional media provide teachers with powerful tools to make their teaching effective to achieve specific classroom goals.

Based on several opinions and research results stated above, it can be concluded that the role of the teacher will be very influential in helping and determining the success of their students. The teacher is the main actor as a facilitator of the implementation of the learning process. The teacher's task is to convey subject matter to students through communication in the teaching and learning process carried out at school. Therefore, the success of a teacher in conveying subject matter to students also depends on the learning media he uses.

4. CONCLUSION

After carrying out the process or stages of developing PjBL-based interactive multimedia, the following conclusions can be drawn:

1. PjBL-based interactive multimedia developed on the basic subjects of electricity and electronics is feasible to use because it has gone through the expert/expert validation stage in the fields of material, media, and instructional design and has also gone through individual, small group and field trial stages for SMK students.
2. PjBL-based interactive multimedia developed on the basic subjects of electricity and electronics is used effectively because it has gone through several requirements tests and carried out tests of basic learning outcomes in electricity and electronics by comparing it to the control class using different learning media.

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