



## The Application of Multisim Software as A Learning Media in Analyzing Semiconductor Diodes Components

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Article Info	Abstract
Article History : Received October 2021 Accepted January 2022 Published July 2022	This research aimed to determine the effectiveness of using the Multisim 12 software as a learning medium to achieve the student learning outcomes in electronic engineering competency standards. In this research, the researchers used experimental research to determine the effect of a treatment in a learning process. The subject of this research was the Electronic Engineering students of the State Vocational High School 1 of Ampelgading Pemalang. The researcher involved 72 students of class X as the sample. Before data collection, the researchers conducted observations and interviews, followed by the preparation and validation of research instruments. The research instrument validation was determined by expert judgment. After that, it was tested to the students by the pre-test and post-test. In data analysis, the researchers applied the t-test using the SPSS program as a technique to analyze the learning outcomes. The results of this research showed that the Multisim 12 software was effective to be used as a learning media to analyze semiconductor diode components. It was proved by the increase in the student learning outcomes from the analysis results using SPSS. The Regression Coefficient test (t-test) result showed that the t-count of 8.713 was smaller than the t-table of 2.000.
Keywords: learning media, multisim 12, learning outcome	

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## INTRODUCTION

Learning activities in Basic Electronic Engineering at State Vocational High School of Ampelgading had been not optimal. The learning output showed that the average score did not achieve the minimum standard criteria (KKTP). Based on the percentage score of students' daily examination, the researcher saw that 80 students from 108 students in X grade did not achieve the minimum score criteria, and students' skill in mastering English was low.

Furthermore, based on students' interviews showed that most students had not to understand basic electronic engineering materials. The learning that had been done tended to be monotonous because the teacher focused on task orientation and did not use an interactive learning method. The effect of this condition was the students did not achieve the expected competencies.

Based on the observation conducted in SMK N 1 Ampelgading Pematang, many obstacles were faced in teaching and learning activities. The impediments were learning media needs, lack of tools and facilities in a practicum class, and lack of new references related to the School Operational Curriculum (KOS). Those problems needed action so that students' achievement can be improved. One of the solutions was choosing the appropriate ICT-based learning media with Multisim 12 simulation software.

Ariesto Hadi (2012) stated that Information and communication technology (ICT) was a technology that covered all technical equipment to process information. The development of ICT was marked by 'Computer Media' used as learning media both online and offline (Prawiradilaga: 2013). In the education field, technology-assisted teaching and learning processes in or out of the class. A good teaching and learning process adopted two-way communication. The teacher had to use technology that covered communication and giving information. ICT (Information, communication, and technology) was able to improve teaching process quality, learning, and management, and school standardization.

*Information and Communication Technology (ICT)* covered all technical equipment to process and give information (Sutopo, 2012: 1). ICT was identical to the computer as media, whereas many references explained that ICT was ample and was not limited to the computer. Yusudhadi Miarso in Prawiradilaga et al., (2013:16) stated that ICT included distance communication such as radio, television, telephone, and services-based internet. Rusamn et al., (2013:65) elaborated that the computer was a type of media that virtually provided an immediate response to student learning outcomes. It provided more variety in learning, especially when technology became a medium connected to the internet. Computers as learning media became a crucial source in learning program implementation at schools. Through the computer, students can run program applications that are connected to the internet (Rusman, et.al 2013: 48). ICT covered all technology that was used to save the data, process, show, and present the information in the communication process. This technology included computer technology, both hardware, and software.

Based on the explanation above, it can be concluded that ICT-based learning software was included in learning media that maximized information and communication technology. This technology became a bridge to give information, message, or materials from the teacher to the recipient (students) to enrich the effectiveness and efficiency in achieving learning purposes.

*Multisim 12 simulation software* was one media-based ICT. *Multisim 12 simulation* was software developed by National Instrument Company, Austin, Texas, USA. This company focused on producing electronic components. This software can create the standardized characteristic of analog and digital systems. This software was able to design components with various possibilities components. The user was possible to combine and create unlimited design series. *Multisim 12 simulation software* was an interactive series simulation that gave a possibility to see the circuit in the form of a temporary scheme. It was used to measure different parameters. The simplicity became the strength of this device. With just a few steps, the circuit can

be installed and used. In addition, with this application, users can create various kinds of electronic circuits and then measure the parameter like when doing an actual practicum in the laboratory. While the weakness of this simulation, it was time-consuming and difficult to generalize the results obtained from the experiment.

Angreni's research (2016) entitled Learning Effectivity used Macromedia Flash in increasing students' concept of Newton's Law. It showed that before the treatment, the average score achieved 26.74 and after getting the treatment gained 62.38.

Seta Yuliawan (2015) in his research entitled the Effectivity of Project Based Learning Model used Multisim to increase students' competency in Digital Basic Circuit Design at SMK N 1 Sedayu. The result showed that project-based learning using Multism software was more effective to increase students' competency. The increasing pretest and post-test results in the control class gained 51.7%, while the experiment class got 51.79%.

Choirun Nisa (2014) in her research entitled The Development Learning Media based ICT used Multism 10 Simulation in Basic Electronical Engineering at SMK Negeri 7 Surabaya. The result showed that learning media-based ICT was feasible to be adopted. The result was 88.66%, and students' response to the learning simulation was declared very good (88,3%).

The benefit of Multism software as learning media became one of the solutions for the teacher to advance students' learning output. Multism was a simulation program that was easy to be understood and used in designing electronic components (Daniel, 2007). The simulation was appropriate in the real world. Furthermore, various measuring instruments can be used as well as measurement results that can be directly seen, including multimeter, wattmeter, oscilloscope, and others.

Based on the background and literature review, the researcher chose "The Implementation of ICT-based learning used Multism Software in analyzing Semiconductor Diodes Components". The purpose of this study was to determine the effectiveness of using

Multisim 12 Simulation software as a learning media to improve learning outcomes in Basics Electronics Engineering.

## RESEARCH METHODOLOGY

### Research Design

This present research used an experiment model. The research adopted pre-test and post-test control group design. The population was an object/ subject that qualified and had certain characteristics to be studied and be concluded (Sugiyono, 2012: 117). The research population was X-grade students of Electronic Engineering at SMK N 1 Ampelgading Pematang. The research sample used two classes, one class was the control class, and the other was the experiment class. The researcher applied a random sampling system proposed by Sugiyono (2012). X TE.3 was the experiment class and X TE.2 was control class. The data collection techniques used tests and observations, while the data analysis technique applied descriptive analysis and t-test.

### Place and Date of the Research

The research was conducted in SMK Negeri 1 Ampelgading Kabupaten Pematang on January 2022. The learning process adopted an operational curriculum (KOS). In addition, the infrastructure consisted of the classroom, practical room, tool practicum, computer, LCD, and students' sanitation.

### Research Subject

The research subject was X Electronic Engineering, and it consisted of a control class and an experiment class (72 students).

### The Data Analysis and Collection Techniques

Based on the research design, there were two collecting data, namely pre-test and post-test, and observation. The researcher organized a test to gain the cognitive competencies data. The result of the pre-test and post-test were compared. The purpose was to measure cognitive competencies development. The collecting data was conducted by involving an observer to fill observation form based on students' observations in learning activities. This method was used to gain the data that consisted of students' behavior in communicating with teachers and friends, and

assessment of students' activities in the learning process both individually and in the group. The data collection was conducted in two classes with similar materials. The researchers compared the average score of cognitive and affective competencies between the control and experiment classes.

### Research Instrument

This research applied two instruments namely test and non-test. The test instrument used for the two groups was pre-test and post-test, while the non-test instrument was the observation rubric. The research instruments were pre-test and post-test instruments (cognitive), observation checklist instruments (affective), and Observation checklist instruments (psychomotoric).

#### 1. Pre-test and Post-test Instrument (Cognitive)

Pre-test and Post-test were the instruments used to measure students' knowledge. A pre-test was used to measure initial students' ability before giving the treatment. Post-test was applied to measure how successful the student in the learning process after being given treatment. The question of pre-test and post-test was created based on a sub-element in Basic Electronic Engineering. The step in constructing questions was to create a grid to identify what students need to master in these competencies.

#### 2. Observation Checklist Instrument (Affective)

The observation checklist had the function to measure collecting data related to students' affective competencies by observing behavior, interaction, and activities in the learning process.

#### 3. Observation Checklist Instrument (Psychomotor)

The observation checklist in the form of a rubric had the function to measure the students' psychomotor competence in the learning process that applied the Multisim software learning media.

### Normality and Homogeneity Requirements Test Data Distribution Normality Test

The distribution normality test had a function to measure the distribution data. In this research, a normality test applied the Kolmogorov-Smirnov theory. Nurgiyantoro, et al

(2004: 118) in Sulistyarningsih, et al (2012: 3) stated that if the sign was more than 0,05 ( $\alpha$ : 5%), it meant the data was normally distributed. Furthermore, the data can be monitored whether it was normal or not by using the SPSS application.

### Homogeneity Test

The data can be stated as homogeneity if the significant score in lavene statistic test of the SPSS program showed  $>0,05$ . After conducting the homogeneity test, the researcher got a significant score  $>0,05$ . This data can be stated that come from a homogeneous population (Trihendradi, 2005:145 in Syarif 2017:44).

### Research Steps

The present research consisted of three steps, namely preparation, implementation stage, and collecting data.

#### 1. Preparation Stage

In this stage, the researcher completed all equipment needed such as:

- a. Completing letter of permission.
- b. Doing consultation with the supervisor and school stakeholders about the research techniques.
- c. Making learning scenarios in the class (modular) based on the material given
- d. Making research instruments.
- e. Validating learning instrument and research instrument to the two experts

#### 2. Implementation Stage

This stage was the implementation stage in conducting research, and giving treatment became the key point of it.

### Experiment Class

The researcher did some activities in this stage, those were: (1) first stage, instruction between teacher and students. (2) In the Second stage, the teacher gave treatment by using software multism 12 simulations as learning media. The teacher informed the material title, learning attainment (CP), learning purpose (TP), and learning plot purpose (ATP) to the students. Then, the teacher divided the students into six groups. Each group had a computer to do a

practicum simulation in analyzing semiconductor diode components. The teacher gave students a worksheet to strengthen the students' understanding which became an afterthought. The last, the teacher gives result test in the last learning process.

### Control Class

In the control class, several activities were conducted: (1) The first stage was the introduction between teacher and students. (2) The second stage was the learning process, this learning process was similar to the control class but the difference was control class did not apply software multism 12 simulation. The control class applied practicum equipment to practice directly.

The third stage was collecting data: (1) Collecting the data was the data-taking process through a learning result test. (2) Analysing research result data. The technique of analyzing data was the descriptive quantitative method. The learning result data covered concept mastery,

thinking skills, and process skills. It was taken by using a daily assessment instrument such as a quiz-test. The learning outcomes category was adjusted to the KKTP (Criteria for Achievement of Learning Objectives) in the Basics Electronic Engineering subjects (75).

## RESULT AND DISCUSSION

### Research Result

#### The Data Description

The research data were obtained from the experimental class and the control class. In each group, the data of research results were taken from learning outcomes in the cognitive, affective, and psychomotor domains.

#### 1. The Cognitive Domain

The results of the cognitive aspect pretest between the control class and the experimental class on learning outcomes, which refer to the assessment system at SMK Negeri 1 Ampelgading can be seen in Table 1. Summary of Pretest Experiment Class and Control Class.

**Table 1.** The Result of Experiment Class and Control Class Pre-Test

Scoring Standardise	Frequency		Qualification
	Control Class	Exsperiment Class	
$X \geq 75$	0	0	Competent
$X < 75$	36	36	Incompetent
Total	36	36	

Based on the cognitive pre-test in the control class and experiment class, it can be categorized into two qualifications. Those were competent and incompetent. If the learning result was  $< 75$ , the student was included in the incompetent category, while if the student's learning result was  $\geq 75$ , it can be stated as competent. Based on this qualification, the students were included in the incompetent

category was 100% (36 students). It meant that no students were competent (0%).

The post-test learning outcomes of cognitive aspects between the experimental class and the control class on learning outcomes that refer to the assessment system at SMK Negeri 1 Ampelgading can be seen in Table 2. The Distribution Summary of Cognitive Aspect Categories of the Experiment Class and Control Class.

**Table 2.** The Result of Experiment Class and Control Class Post-Test

Scoring Standardise	Frequency		Qualification
	Control Class	Exsperiment Class	
$X \geq 75$	0	24	Competent
$X < 75$	36	12	Incompetent
Total	36	36	

Based on the experiment and control class post-test result, it can be categorized into two qualifications (competent and incompetent). If the learning result is  $< 75$ , the student can be categorized as incompetent. If the student's learning result is  $\geq 75$ , it can be stated as competent. Based on this qualification, in the experiment class, the students included in the incompetent category were 38,7% (12 students). It meant that 77,41% of students were competent (24 students). Compared to the control class,

there was 100% of students (36 students) were incompetent.

**Gain Score Result**

The increase of learning outcomes in the experimental class (using the Multisim 12 learning media) and the control class (direct practice) can be seen by calculating the gain score. The summary of the gain score calculation in the experimental class can be seen in Table 3.

**Table 3.** Gain score of Pre-test and Post-test results in Control and Experiment Class

Gain Score	Score	Category	Frequency	
			Control Class	Exsperiment Class
Pre-test Post-test	$g \leq 0.3$	Low	11	-
	$0.3 < g \leq 0.7$	Medium	25	28
	$g > 0.7$	High	-	12
	Total		36	36

2. Affective Domain

The researcher got the research result data to form a control and experiment class through a questionnaire. The questionnaire aimed to know the students' responses and interests through the

software multism 12 simulation. The affective domain result of the control and experiment class can be seen in Table 4. The summary of affective domain score in control and experiment class.

**Table 4.** The Result of Affective Domain Score in Control and Control Class.

Field	Score	Category	Frequency	
			Control Class	Exsperiment Class
Affective	$x < 78.17$	Low	16	9
	$82.5 > x \geq 78.34$	Less	9	4
	$79.17 > x \geq 75.00$	Sufficient	4	8
	$x \geq 86.66$	High	7	15
	Total		36	36

Based on the data, the control class had 16 students who gained low category, 9 students were less category, 4 students achieved sufficient, and 7 students were high category. Based on the average result of the data, the control class was included in the less category. On the other hand, the experiment class showed only 9 students were in a low category, 4 students got less category, 8 students were sufficient, and 15 students achieved high category. Based on the presented data, it can

be concluded that the average score of the affective domain in the experiment class was a sufficient category.

3. Domain Psychomotor Domain

In the psychomotor domain, both participants were given a worksheet and observation checklist. The scoring was conducted in learning class activities. The data can be shown in the summary of the psychomotor domain in the control and experiment class (Table 5).

**Table 5.** The result of psychomotoric domain in control and experiment class.

Field	Score	Category	Frequency	
			Control Class	Exsperiment Class
Psychomotoric	$x < 70.83$	Low	9	4
	$75 > x \geq 70.83$	Less	23	7
	$86.66 > x \geq 82.50$	Sufficient	0	9
	$x \geq 86.66$	High	4	16
	Total		36	36

Based on the data, the control class had 9 students who gained low category, 23 students were less category, no students achieved sufficient category and only 4 students were high category. According to the data, it can be concluded that the average score of the psychomotor domain in the control class was in the less category. On the other hand, the experiment class showed only 4

students were in a low category, 7 students included in less category, 9 students were categorized as sufficient, and 16 students achieved high category. Based on the presented data, it can be concluded that the average score of the psychomotor domain in the experiment class was a sufficient category.

**Table 6.** The post-test result in the control and experiment class

Scoring Standardise	Frequency		Qualification
	Control Class	Experiment Class	
$X \geq 75$	0	24	Competent
$X < 75$	36	12	Incompetent
Total	36	36	

Post-test result in control and experiment class was divided into two qualifications, competent and incompetent. If the learning result is  $< 75$ , the student can be categorized as incompetent category, while if the student's learning result is  $\geq 75$ , it can be stated as competent. Based on this qualification, in the experiment class, the students included in the incompetent category were 38,7% (12 students). It meant that 77,41% of students were competent (24 students). If it was compared to the control class, there were 100% of students (36 students) were incompetent.

class. The result of the normality test can be seen in table 7.

**Table 7.** The Normality Test Result in Post-test Normality Test of Kolmogorov-Smirnov

Gain Class	Asymp. Sig (2-tailed)	Description
Control	0.839	Normal
Experiment	0.913	Normal

Table 7 showed the data were normally distributed. Based on the data, the normality test from Gain Score had *asympt. Sig* and it was more than 0.05. The score got 0.839 in the control class and 0.913 in the experiment group.

**DISCUSSION**

**The First Hypothesis**

In conducting normality tests by using *Kolmogorov Smirnov* through SPSS software 20 version. The normality test result was bigger than 0,05 (5%), so  $H_0$  can be accepted, and the data frequency distribution declared normal. Normality test in cognitive domain applied post-test result data in both control and experiment

The normality test was also conducted in the affective domain by using the result data of affective scores in both categories. The data were normally distributed since the normality test was bigger than 0.05. The score gained 0.864 in the control class and 0.328 in the experiment class. The data can be seen in table 8.

**Table 8.** The Result of Normality Test in Affective Domain

Normality Test of Kolmogorov-Smirnov			
Gain Class	Asymp. Sig (2-tailed)	Description	
Control	0.846	Normal	
Experiment	0.328	Normal	

The normality test also was conducted in a psychomotor domain in both groups. The normality score in the control class got 0,060 while the experiment class gained 0,348. The result of the normality test in each class was more than 0,05 or it can be declared as the data normally distributed.

**Table 9.** The Result of Normality Test in Psychomotor Domain

Normality Test of Kolmogorov-Smirnov			
Gain Class	Asymp. Sig (2-tailed)	Description	
Control	0.060	Normal	
Experiment	0.348	Normal	

### Homogeneity Test

To find out the similarity of the data variance, a homogeneity test was conducted. The test used the Levene test through SPSS 20 software. The data homogeneity can be seen from the significance of the homogeneity test results. The homogeneity test criteria were:

1. If the significance level  $> 0.05$ , the data can be declared homogeneous.
2. If the significance level  $< 0.05$ , the data can be declared not inhomogeneous.

The homogeneity test in the cognitive domain used post-test results in both groups. The homogeneity result showed that post-test results in the two groups were homogenous.

These results were because the homogeneity significant test in the post-test was higher than 0,05 (0,185). The homogeneity test result of post-test scores can be seen in Table 10.

**Table 10.** The Homogeneity Test Result of Post-Test Score

Levene Statistic	Significant	Description
1.799	0.185	Homogenous

In the affective domain, a homogeneity test was also carried out using the data from the affective values of the control class and the experimental class. The following were the results of the homogeneity test in the affective domain.

**Table 11.** The result of Homogeneity in Affective Domain

Levene Statistic	Significant	Description
275	0.263	Homogenous

Table 11 showed the homogeneity test significance of affective values for the control class and the experimental class, which was 0.263. The significance was greater than 0.05 which meant homogeneous.

Homogeneity test was also carried out on psychomotor scores. The results of the homogeneity test of the control class and experimental class data can be seen in Table 12.

**Table 12.** The Results of Homogeneity Test in Psychomotor Values

Levene Statistic	Significant	Description
2.495	0.120	Homogenous

Table 12 showed that the homogeneity test result of psychomotor values in the control and experiment class. The significance got 0.120, or it was higher than 0.05, and it can be declared homogenous.

### CONCLUSION

1. Learning Media using Multisim 12 Simulation software was more effective to increase students' competence in designing electronic circuits. It was proofed from the results of the pretest and posttest in the control class. There was an improvement of 38.70%, while in the experiment class there was an improvement of 51.79%. The N-Gain test in the control class was 0.38 (low category), while the experimental class got 0.63 (sufficient category).
2. The Independent-Samples t-Test result in the cognitive domain obtained a t-count



value got 8.713 with a significant 0.00. The affective domain gained a t-count of 2.565 with a significance of 0.013. The psychomotor domain achieved 2.823 in a t-count value with a significance of 0.006. So, it can be stated that there were significant differences in the cognitive, affective, and psychomotor domains of the experiment and the control class. In other words, the data in this study were distributed effectively and significantly.

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