# The Effectiveness of Project-based Learning Model using Circuit Maker Media Simulator on the Topic of Power Amplifier Circuits

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# The Effectiveness of Project-based Learning Model using Circuit Maker Media Simulator on the Topic of Power Amplifier Circuits

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*Abstract*—The aim of this study is to describe the effectiveness of project-based learning model using circuit maker media simulator on the topic of power amplifier circuits. This research used pre-experiment with The One-Group Pretest-Posttest design. The results showed the effectiveness of the project-based learning model in the normality test using Chi-square that the learning achievement scores from the test items in both pretest and posttest were normally distributed with $X^2_{count} = 0.142$. F-test results also showed that the learning achievement between the pretest and the posttest had a homogeneity value with $F_{count} = 0.213$. Testing the hypothesis was with a significance level of 5%, and $t_{count} = 10.987$ was obtained. These obtained results showed that the effectiveness of the project-based learning model was in a good category. The activities with a degree of ability to use also obtained a good average score. To conclude, there is a significant difference in the learning achievement between the experimental group and the control group of the Electronic Engineering Education study program in the project-based learning.

*Keywords*—*effectivity, project-based learning, media simulator*

## I. INTRODUCTION

Learning focuses on student learning activities that must be designed by lecturer so that the potential of students can be maximized to achieve the teaching goals. Their potential is certainly in the domains of knowledge, skills, and attitudes that must be optimized so that students can solve problems faced in their learning process appropriately. Hence, optimization must be based on the learning stages that fit the characteristics of student learning.

Learning effectiveness is an activity that must be done in the learning process. An indicator of effectiveness that is considered appropriate is the achievement of learning goals as the reference for success in teaching and learning. The lecturer can, thus, use various strategies or methods of teaching that are considered effective to achieve learning objectives. Therefore, it is necessary to look for specific learning strategies which are able to construct knowledge and skills in line with the characteristics of the education [1]. Based on the constructivist view, lecturer not only gives information, but he or she must also be able to encourage students to exploit their world; to find, to use, and to think critically [2], [3]. It aligns the vocational education goal that is to develop and produce mechanical and electronic systems either in factual or virtual (simulated) in the form of an interpretive visual that describes the relationship between theoretical and abstract symbol systems [4].

Project-based learning is not the only superior strategy for vocational learning, but whose components are capable of optimally providing learning activities for students, such as: (1) able to share knowledge and group work, (2) able to deliver project results in the form of concept and principle presentations, and (3) able to design products based on the topics that have been set in learning activities. To achieve these, effective learning strategies and activities, as well as the degree of student learning speed, are required to be formulated in the learning objectives [5].

Besides the aforementioned advantages of the project-based learning model, its shortcomings need to be noticed, such as: (1) it requires a lot of equipment, (2) students who have weaknesses in experiments and information gathering will have difficulty in collecting data in the field, (3) there is possibility of students being less active in group work when the topics given to each group are different, that might make students cannot fully understand the topics presented. These three shortcomings can be overcome by facilitating students in dealing with problems, limiting time allocation for students in completing projects, minimizing and providing simple equipment in the learning environment, choosing easily accessible research locations that do not require a lot of time and cost, creating an enjoyable learning atmosphere that makes lecturer and students feel comfortable and fun during learning. In this case, it is highly recommended to provide a set of media simulator that is appropriate for teaching materials.

### A. The use of circuit maker media simulator

There are a number of characteristics of student participation in learning. In order to facilitate different characteristics of students, it requires instructional media that can clarify abstract teaching materials to be concrete so that students can learn well, and time allocation for learning can be accelerated. In learning Analog Electronics, especially on the topic of Power Amplifier Circuits, this should be presented from abstract to concrete. This means analysis on power amplifier circuits uses component symbols, such as the symbol that represents the flowing current is abbreviated I and the voltage is abbreviated V. Between the current and the voltage are there active and passive components that become the focus of analog electronic circuit analysis.

Circuit maker simulator is software for electro-technical circuit learning made by Protel Technology, Inc. It is a circuit learning media simulator that provides real/ concrete virtual features. The circuit maker media simulator serves two functions, namely as an editor of electronic circuits and a simulator. Students can arrange electronic circuits based on the assigned projects that ease them to construct and change electronic circuits correctly [6], [7]. Circuit maker simulator in learning electronics allows students to accelerate, to replace circuits, to build new circuits if errors occur and to fix them through circuit simulation. Activities such as remembering and finding the right circuit can arise student curiosity through a sequence of experiments and simulations. As a result, students are continuously able to correct their mistakes without intervention or lecturer assistance.

### B. Analysis of power amplifier circuits

Power amplifier circuit has many types, but this research focused on the operating frequency amplifier group consisting of: (1) wide waves (audio, video and radio frequency amplifiers), (2) narrow waves (tuned amplifiers) with circuit installation method, (3) AC installation: on low frequency components (including dc) not forwarded to the amplifier circuit, (4) DC installation: some of its types are a chopper amplifier, the input signal that is split becoming pulse series then amplified, AC amplifier. (5) bias points on amplifier: class A, class B, class AB, and class C, voltage, current and circuit, refraction of class A, class B, and small-signal quiescent power, (6) power amplification with small input signal below 10 kHz [8]. These six subtopics were taken as the topics of teaching materials in the project-based learning activities using circuit maker simulator.

## II. RESEARCH METHOD

This research was pre-experiment with the One-Group Pretest-Posttest design. The students with odd ID numbers were included in the experimental group while those with even ID numbers belonged to the control group. They were taken randomly. This research was conducted from February to April 2018 within 6 meetings. The meeting took 50 minutes. The meetings consisted of 50 minutes of face-to-face, 50 minutes of structured assignments, and 60 minutes of independent assignments. In this case, one-semester credit was 160 minutes. Thus the total time allocation needed was 960 minutes. Besides, the pretest and the posttest were held one time in 2x45 minutes for each [9]. The stages of research are as follows.

- The lecturer gave an orientation on the use of Circuit Maker software and the topic of Power Amplifier Circuits to all of the students who were in the odd semester of the academic year 2017-2018.

- The lecturer divided the students into two working groups consisting of 18 respondents for each by taking them randomly based on the student ID numbers. The students with the odd final number belonged to Group A (experimental class), and those with the even final number were in Group B (control class).

- The lecturer presented materials about the power amplifier circuits for all groups using circuit manual book. After the teaching presentation was finished, the students (respondents) were given the opportunity

to take a power amplifier circuit as a project. Group A used a circuit maker simulator while group B used a circuit manual book. Then the lecturer gave an initial test of achievement before learning.

- The material of the project was Radio Frequency Power Amplifier (RF) which functions to strengthen high frequency (RF) signal and is received by the antenna to be transmitted. This RF amplifier is designed using special features and with the ability to amplify signals with the magnitude of radio frequency from 17 kHz to 20 kHz.

- Each of Group A and B worked on the project material and solved the problems that have been identified through experiments.

- Each group compiled a report related to their activities and observations, as well as the preparation of their project.

- Each group presented the project results and paid attention to the inputs and suggestions from other group friends.

- Both groups returned to the main class to discuss the project that has been done. The lecturer observed the activities during the discussions between Groups A and B.

- The lecturers administered an achievement test at the end of the research.

This research occupied several types of statistical testing, including quantitative descriptive analysis and inferential statistical analysis. Quantitative descriptive analysis was used to determine learning activities with the converted numbers in percentage form. Meanwhile, inferential statistical analysis was to process the data to test for differences between the experimental group and the control group. The statistical test used was the t-test to find out the differences between the two groups by consulting to t-table. Prior to the t-test, the normality test and homogeneity test were firstly carried out. In this case, the results of the t-test were used as an analysis of the achievement test results of the power circuit amplifier. Analysis of the quantitative descriptive data was processed by compiling the final test scores systematically in the form of percentages. The reference used to determine predicate or category decision of each subject is as follows.

TABLE I.          REFERENCE FOR DECISION

| Achievement Level (%) | Number | Letter | Reference for Categoy Decision |
|---|---|---|---|
| <90 - 100 | 4 | A | Very Good / Effective |
| <80 - 89 | 3 | B | Good / Effective |
| <65 - 79 | 2 | C | Fair / Effective |
| < 55 - 64 | 1 | D | Poor/ Effective |

## III. RESULT AND DISCUSSION

The analysis results of the effectiveness of project-based learning model from the normality test using the Chi-Square constant equation showed that the achievement scores in the pretest were normally distributed with $X^2_{count} = 0.142$. Further, the normality test with Chi-Square formula showed that the achievement scores in the posttest were also

normally distributed with $X^2_{count}$ = 0.142. In addition, the results of the homogeneity test using F-Test recorded that the learning achievement scores gained from the pretest and the posttest had a homogeneity with $F_{count}$ = 0.213. Testing the hypothesis using t-test with a significance level of 5% obtained $t_{count}$ = 10.987. In other words, there was a significant difference in learning achievements between the experimental group and the control group in the project-based learning for the Electronic Engineering Education students. Regarding the activities during project-based learning, two main activities were obtained, namely (1) activity of using, and (2) activity of finding.

TABLE II.    LEARNING ACTIVITIES IN THE PROJECT MATERIALS

| No. | Project Materials | Learning Activities | |
| --- | --- | --- | --- |
| | | Use | Find |
| 1 | Wide waves (audio, video, and radio frequency amplifiers) | 67 | 58 |
| 2 | Narrow waves (tuned amplifiers) circuit installation method | 73 | 68 |
| 3 | AC installation, low frequency components (including dc), amplifier circuit | 87 | 89 |
| 4 | DC installation: some of the types are chopper amplifier, the input signal, and AC amplifier | 90 | 84 |
| 5 | The bias points in the amplifier: class A, class B class AB and class C. voltage, current and circuit refraction of class A, class B, small-signal quiescent power, | 92 | 96 |
| 6 | Power amplification with signal and small input signal below 10 kHz | 92 | 94 |

Table 2 shows the presentation of the project teaching materials and the activities that the students could perform during learning, and the mean score for activities that students could do for the ability to use is 68.5 while the mean score for activities of the students for the ability to find is 81.5. Further, the results of the average activity scores in the project teaching materials showed that the ability to find is more effective than the ability to use. These results are in accordance with the learning hierarchy used in vocational education that the ability to find is the highest value of all activities. This is because in such activity the ability to remember and to use in learning have been accumulated. Thus, the ability to find is a student capability that should always be improved when setting a learning strategy. Therefore, the selection of learning strategy should always refer to the learning objectives by paying attention to the highest level of ability that can be achieved during learning. Hence, the results of this research contribute to the effectiveness of the implementation of learning using the project-based learning model.

There are some advantages to this model in the learning process. The project-based learning provides students with freedom and learning experiences to increase learning acquisition based on the expected objectives [10]. The effectiveness of learning is based on how much learning objectives that students can actualize into learning capacities during learning [11], [12]. Therefore, the effectiveness of learning is seen in how many items of learning objectives that students can produce through a sequence of learning strategies used in project learning [13]. Thus, the more items of learning objectives are achieved by students; the more effective is the learning. Such an indicator becomes the cornerstone in this research.

## IV. CONCLUSION

Based on the results of the research, a number of conclusions are drawn and described as follows.

- The effectiveness of project-based learning model using circuit maker media simulator can ease the students and can accelerate changes in the design of electronic circuits on the topic of Power Amplifier Circuits. This result is obtained based on the average data analysis results of the learning assessment that was in the good category. The average activity assessment is in the ability to use procedures, to design the circuit and to change the circuit within a short time if some errors were found.

- The circuit change when there is an incongruity with the project design and with the categories that have been set in the learning objectives can be accelerated, then the time allocation and learning loads for students can be achieved well.

- The learning activities performed by the students during the project-based learning showed that their ability to use circuit media simulation was better than the ability to find. It can be concluded that project-based learning makes a good contribution to meet the achievement of the competency to find, especially on power amplifier circuits in Analog Electronics course.

- The use of project-based learning model will be effective if, since the beginning of learning design, the characteristics of students are analyzed, and the stages of project-based learning are used consistently. Thus lecturer knows the suitability of the stages of project-based learning model to support developing vocational learning in the ability to use and to find the function of power amplifier circuits.

- The use of circuit maker media simulator is effectively used to achieve learning objectives which are categorized in the dimension of high order thinking skill.

- The strength of the circuit maker media simulator is providing attractive, good learning, making students have enough time to study without interference or pedagogical assistance from the lecturer. Such activities show that project-based learning focuses on students (student-centered). This strength should be pursued in vocational learning in order for students with high motivation can find their learning potential

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