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Development of Kirchoff's Law Drawing Tools to Improve Student's Science Skills in Learning Process of Direct Flow Circuits

Nur Ainun[1], Jefriyanto Jefriyanto[2]

Universitas Serambi Mekkah[1], Universitas Negeri Padang [2]

Correspondence Email: nurainun@serambimekkah.ac.id[1]

Abstract

This research develops a teaching tool for Kirchoff's law on the concept of direct current circuits, which is motivated by the minimal number of tools and the lack of tools available in schools as learning media and to improve science process skills. The development of the tool lies in replacing the input source with an adapter because the energy does not run out quickly, resulting in a more stable value. The research method used is development research from Akker with the type of development research model, which consists of introduction, prototype, summative evaluation, systematic reflection, and documentation. The purpose of this research is to test the feasibility, effectiveness and practicality of the developed teaching aids. The research subjects were 100 students from two classes. The instruments used were non-tests (guidelines for interviews, observations, and questionnaires) and multiple-choice tests. The results of the assessment of Kirchoff's legal aids were declared feasible, effective, and practical.

Keywords: teaching, kirchoff law, prototype, students.

INTRODUCTION

Teaching aids are a tool used to assist the teaching and learning process and act as a support for teaching activities carried out by the teacher. The teaching aids contain the characteristics and forms of the concept of teaching materials that are used to demonstrate material in the form of depictions of mechanization, events, and activities so that the material can be more easily understood by students. Utilization of visual aids in the learning process is a function of explaining physics concepts and supporting the development of knowledge, skills, and basic needs for delivering material, concepts, and physics information. Teaching aids really support physics learning because each physics material contains a number of concepts that students must understand, so in learning physics, a medium is needed in the form of teaching aids to convey the physics concept. Furthermore, physics subjects are considered difficult for most students because they consider physics to be full of formulas that are not applicable.

In an effort to hold these props, teachers and students can carry out development by designing and making simple (self-made) props. The product of the development of teaching aids, although simple in physical appearance, can support the working principles and science material being taught. The availability of teaching aids in schools is very minimal, and even a lot of them are missing or no longer complete, so they are rarely used and are no longer used to support learning in class. There are many teaching aids that can be developed, but in this development research, the researcher is interested in developing Kirchoff's Law teaching aids. Regarding this, the researcher is interested in changing the input source by using an adapter because when the input source uses a battery, the energy produced quickly runs out and the value that appears on the multimeter becomes unstable (stable) and changes frequently. The advantage is that when the input source (voltage source) is replaced by using an adapter, practical learning becomes more optimal because the power doesn't run out quickly, so it can be used repeatedly without having to replace a new input source when we use a battery that runs out quickly, and the value shown in the multimeter is more stable if you use an input source with an adapter.

This development research is expected to be a solution to improving science process skills because it is a basic competency for developing students' scientific attitudes and skills in solving problems so as to form an active personality. The indicators of science process skills used include observing, classifying, interpreting, predicting, asking questions, hypothesizing, planning experiments, using tools and materials, applying concepts, and communicating. The results of the interviews conducted by the researchers indicated that the teachers at the school said that the students' science process skills were still relatively untrained. In addition, several reasons underlying the need for science process skills in teaching and learning activities are that students more easily understand concepts when accompanied by examples through real objects and that students learn actively by developing skills to find information. The topic that is considered difficult in direct current dynamic electricity material is in the sub-discussion of Kirchoff's Law because students still do not understand the sign agreement and determine the direction of the current, as well as the rotation of loops in the circuit and the lack of availability of props in schools regarding the sub-discussion of direct current dynamic electricity.

The students' science process skills were still relatively untrained in the preliminary studies conducted by researchers in several schools. One of the reasons is that students are not trained enough to find a concept through scientific activities. By developing science process skills, students will be able to find and develop their own facts and concepts, which will become cogs in growing and developing the attitudes and values demanded. One of them is using media in the form of props as a tool to find a concept. In previous developments, tools developed using batteries as input sources caused energy to run out faster and were more wasteful, so the values that appeared on the multimeter were less stable. Therefore, researchers are interested in developing previous tools by using an adapter because the energy produced is more durable and the polarization can be changed so that the resulting value on the multimeter is quite stable.

METHOD

This research uses the Akker development method with model development studies. In this method, there are two models: validation studies and development studies. The stages of research in model development studies include preliminary research, prototyping, summative evaluation, and systematic reflection and documentation. The research instrument used in the study was a non-test instrument, and the test aimed to determine the feasibility, effectiveness, and practicality criteria of the tool being developed. The non-test instruments used included interview guidelines, media and material expert test questionnaires, student and teacher assessment questionnaires, and test instruments (pretest-posttest). The test used in this research is a science process skills test in the form of multiple choices, and the indicators to be achieved consist of classifying, interpreting, predicting, submitting hypotheses, planning experiments, applying concepts, and communicating. Posttest results can show the effectiveness of the tool developed. The results of the pretest and posttest will be processed so that researchers can see an increase in students' science processing skills through the n-gain score.

RESULT AND DISCUSSION

In this development research, the authors developed a product from previous research that discussed about the effect of using acrylic box electrical barriers on the learning outcomes of high school students on the concept of direct current circuits. Previous studies have made a product using the input of a battery, and the author is interested in developing this product by replacing the input with an adapter. Give students direct experience trying to retrieve data by using dynamic electric props that can implement series and parallel arrangements of Ohm's Law and the application of loops from Kirchoff's Law, which can be seen from the numbers coming out of the multimeter as well as positive and negative signs that can be changed from the adapter. This development research uses the Akker development model, whose stages consist of preliminary research, prototyping, summative evaluation, and systematic reflection and documentation.

The first stage is preliminary research, and based on preliminary field studies conducted by the author, it can be concluded that Kirchoff's Law teaching aids at the school are rarely used because the components of the equipment are incomplete and the condition of the equipment is not suitable for reuse. And for the results of student responses that are interested in using teaching aids as a support for learning on the concept of direct current circuits, with a total of 46 students, the total number of students is good with a percentage of 34%. Because by using teaching aids, students can visualize and practice

directly related theories, and to be able to train science process skills in students obtained by carrying out laboratory activities in a room that has facilities in the form of learning media, namely teaching aids.

The second stage is the prototype stage, which at this stage begins to design and manufacture teaching aids that will be tested on formative evaluations, including media and material expert tests, each of which consists of five experts, one-on-one evaluations, small group evaluations, and field tests. The media expert test was tested on five media experts, and there were eight assessment aspects consisting of linkages with teaching materials, tool durability, accuracy, efficiency, safety in tool use, aesthetics, tool completeness, and storage space. There are four aspects that result in an assessment percentage above 90%: aspects of the relationship with teaching materials, safety in the use of tools, completeness of tools, and storage areas. Four other aspects that get percentages below 90% are tool durability, tool accuracy, efficiency, and aesthetics.

The aspect of linkage of teaching materials obtained a percentage of 98%, which is included in the very good category, where the teaching aids developed are already related to learning material on the concept of direct current circuits because the purpose of making tools is to support learning in accordance with teaching material guidelines that apply in schools. The durability aspect of the tool obtains a percentage below 95%, namely 92%, which is still in the very good category. The tool is made of plywood, where the material used in making the tool belongs to a material that is relatively strong and durable as long as it is not exposed to water, and the plywood has been coated with plywood paint so it is not easily damaged, can be used repeatedly, and the maintenance is also easy to do. The accuracy aspect of the tool obtains a percentage of 90%, which is still classified as very good. The drawback of this tool is that the percentage error is still relatively large, especially in the Kirchoff's Law experiment, which can reach an error percentage of 17%, which shows that the measurement results that approach the true value are very weak. The efficiency aspect of the tool obtains a percentage of 88%, which is included in the very good category. Indicators on the efficiency aspect of the tool consist of easy-to-assemble, easy-to-operate, and easy-to-carry props, showing a very good category. The safety aspect of using the tool obtained a percentage of 97%, which is included in the very good category. The teaching aids that are made are included in the criteria for safe use because they do not contain toxic or hazardous materials, and the design of the tools is as sturdy as possible so that there are no dangerous parts when used. The aesthetic aspect gets a percentage of 80%, which is included in the aspect with the lowest percentage but is still in the very good category. The neatness of the teaching aids has been made as much as possible; the teaching aids are designed in a shape that suits the material requirements, and there are a few red and black colors on the DC socket box, which aim to make it easier to distinguish the + and - poles of the electronic components. The completeness aspect of the tool gets the same percentage value as the safety aspect of using the tool, which is 97%, which is included in the very good category. The teaching aids are equipped with a manual book that contains the tools and materials used in making the tools and guidelines for using the tools. There is an LPKD that contains learning objectives, theories regarding the concept of direct current circuits, work guides for students in assembling tools, and columns of experimental data that students will later practice. The storage aspect has the highest percentage of all aspects, namely 100%, which is included in the very good category. The storage area for the tool is made of the same material, namely plywood with a thickness of 15 mm, which is quite durable and has an iron handle that makes it easier to carry the tool from one place to another. The storage area aims to store other small components so that they are not easily lost.

After completing the validation stage by media experts and getting suggestions related to improving the tool, the tool is repaired or revised according to the suggestions given and is ready to be tested at a later stage. The results of all aspects of the assessment of media experts with a total score of 463 are good with a percentage of 93%, which is included in the very good category, and the teaching aids developed can be concluded to be feasible to use. The material expert test was tested on 5 experts who stated that the teaching aids were relevant to the concept of direct current circuits with a percentage of 100%, which consisted of several indicators, namely the relevance of the material content on the tool referring to KI/KD, can help visualize the material in learning that involves science process skills, student worksheets are prepared based on indicators of science process skills, can apply the concept of series and parallel circuits of resistance in Ohm's Law, can apply the concepts of series and parallel circuits to light bulbs in Ohm's Law, and can demonstrate Kirchoff's Laws I and II.

The next formative evaluation stage is testing out students in the one-on-one evaluation stage.

One-on-one evaluation requires a sample of three people, which the authors group in the category of high academic ability. The mean value of the posttest is 82.3, which indicates a completeness percentage of 100%. The posttest questions given consisted of 13 questions, which on average they answered correctly as many as 11 times. Questionnaire assessment consists of four indicators: material, learning design, implementation, and technical quality. Technical quality is an indicator that gets the highest percentage of 97%, which includes teaching aids that are easy to use, do not contain hazardous materials, and can be used repeatedly. The results of the questionnaire obtained a total indicator value of 133 with a percentage of 92%, which is included in the very good category, which means that the teaching aids are feasible to use. When using the tool, a student named Bayu scored high on almost all indicators compared to two other students, especially in the indicator of carrying out experiments, because practicing science process skills is an important effort to obtain optimal student learning success. Subject matter will be easier to learn and remember in a relatively longer time if students gain direct experience of the learning event through observation or experimentation.

In the evaluation of the small group of test subjects, there were 15 students who had studied the concept of direct current circuits in five categories of high, medium, and low ability, which were grouped based on the results of the pretest they had worked on. The average pretest score is 53.5 with the highest score of 69 and the lowest score of 23, both with a completeness percentage of 0%, which means that no one has completed the pretest questions, and the average posttest score is 81.6 with the highest score of 92 and the lowest score of 69, which indicates the percentage of completeness is 87%, where there are two students who do not complete. The incompleteness of the posttest results is due to students who are not serious when answering questions, lack of interest in the proposed discussion, and lack of participation during practicum, causing a lack of understanding of the material proposed. Based on the completeness of the posttest results, it shows a percentage above 50%, namely that teaching aids are still classified as effective as learning support media. The questionnaire assessment indicator is the same as the one-to-one evaluation in which technical quality gets the highest percentage, namely 88%, with a total score of all indicators reaching 87%, which is included in the very good category. The results of the small group evaluation questionnaire assessment indicated that the props were practical when used.

The assessment of science process skills on the four indicators that obtained the highest percentage was in the high-ability academic category because when they tried the tool, they were active in assembling or discussing between groups, and there were some who were already a little familiar with the components contained in the teaching aids because their teacher had shown the topic of direct current circuits in the form of pictures and explained a little information about the components related to direct current circuits. But the indicators using tools and materials that get the highest percentage are academics with moderate abilities. The field test requires 30 test subjects who have not studied the concept of direct current circuits in 10 categories of high, medium, and low ability, which are grouped based on the results of the pretest they have done. The information obtained from the field test indicates the effectiveness of the tool, as seen from the posttest results. The average pretest result obtained was 54.9 with the highest score of 85 and the lowest score of 38, both with a completeness percentage of 7%, where there were 2 out of 30 students who completed the pretest questions, while the average posttest result obtained was 95.4 with the highest score of 100 and the lowest score of 92, both with a completeness percentage of 100%, where there were 30 students (overall) who completed the posttest. Teaching aids can improve student's ability to understand material concepts because students can directly observe the processes that occur in them so that they can improve learning outcomes. Learning outcomes are not only assessed by mastery of concepts but can also be seen in the skills of the learning process. The results of the posttest completeness scores show that the teaching aids we have developed are effective for use.

The questionnaire assessment given in the field test consisted of five aspects: ability to be implemented, sustainability, efficiency, compatibility with the environment, and acceptance and attractiveness of the tool. The aspect of acceptance and attractiveness of the tool obtains the highest percentage of 90% consisting of indicators: teaching aids are designed in a form (design) that is in accordance with material requirements and can support active and non-monotonous learning, and the aspect of continuity obtains the lowest percentage of 77% consisting of Indicators: potential use in the future, easy maintenance, and being made of strong materials. The overall result of the field test questionnaire assessment was 1104 out of 1320 good, with a percentage of 84%, which was included

in the very good category. The results of the small group evaluation questionnaire assessment indicated that the props were practical when used. The assessment of science process skills in the field test that obtained the highest percentage was the indicator applying concepts with a percentage of 72%, which was in the very good category, and for the lowest percentage, the indicator asked questions with a percentage of 47%. In the field test science process skills graph, it was shown that academics with high and low abilities excelled in proposing hypotheses and using material tools, while academics with moderate abilities excelled in conducting experiments. In the indicator of applying high-ability academic concepts, it reaches 83%. And for the indicator of asking low-ability academic questions, it reached the highest percentage, namely 63%, in which category they asked more often about the relationship between tools and concepts. After going through the final stage of the prototype, namely formative evaluation (field testing), the next step is the summative evaluation stage, which requires 3 test subjects from 2 different schools and 15 students who have not studied the concept of direct current circuits with 5 categories each capable of high, medium, and low based on the results of the pretest they have done.

The information obtained from the summative evaluation is about the practicality and effectiveness of the tool. Assessment of practical indicators includes ease of assembling and using the tool (according to the instructions in the manual book), ease of moving and carrying the practicum tool, ease of implementation, and ease of maintenance. The indicator with the highest percentage is the ease of implementation (92%), with other indicators obtaining the same score of 83%, while for the aspect of effectiveness, the indicator that obtains the highest percentage is the ability to assist teachers in explaining the concept of direct current circuits and the ability to support learning to be more active and not passive, which is equal to 92%, and for the lowest percentage on the indicator of achievement of learning objectives, which is equal to 75% but still included in the very good category, The results of the questionnaire assessment by 3 teachers showed that the practicality and effectiveness scores were the same, namely 41 out of a total score of 48 good with a percentage of 85%, which was included in the very good category.

The assessment of science process skills in the summative evaluation consists of five assessment indicators that are the same as in the previous evaluation: proposing hypotheses, using tools and materials, carrying out experiments, applying concepts, and asking questions. The indicator with the highest percentage is the indicator proposing a hypothesis of 72%, in which academics with high ability obtain the highest percentage of 83%, while those with moderate and low abilities obtain percentages of 70% and 67%, respectively. And for the other four indicators, academics with high abilities obtained the highest percentage compared to medium and low academic abilities, especially in the indicator of carrying out experiments, with a percentage difference of 20% for academics with moderate abilities and 26% for academics with low abilities. The results of the assessment of science process skills in the summative evaluation show that different categories of academic ability affect students' science process skills. The overall average result for science process skills is 64%, which is included in the very good category.

CONCLUSION

Kirchoff's law teaching aids were declared appropriate for use in learning the concept of direct current circuits based on the validation of media experts and material experts, who obtained the final grades in percentage form with 93% and 100%, respectively. The average of the two validators is 97%, which is included in the very decent category. According to Kirchoff's law, teaching aids are declared to be effectively used in learning and can improve students' processing skills on the concept of direct current circuits based on the completeness of the posttest results given to students and the summative evaluation questionnaire assessment given to teachers on indicators of effectiveness.

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