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ANALOGY STRATEGY: IMPROVING PROCESS SKILLS AND UNDERSTANDING SCIENCE CONCEPTS OF ELECTRIC CIRCUIT MATERIALS

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Abstract: The electricity and magnetism course consists of combined conceptual material from the concepts of electricity and magnetism and has a broad coverage. Theoretically explaining that electrical phenomena and their properties is an important part of teaching physics at various levels, then electricity is an area of physics that students find much more difficult to understand than mechanics. This electricity material, especially the dynamic electricity sub-topic, is one of the mandatory subjects which is classified as difficult and has abstract characteristics. Analogy is considered a way that can help students visualize abstract concepts and assimilate new knowledge to existing cognitive structures. In education, where research on analogies should focus on their role in the learning process rather than emphasizing cognitive transfer between unfamiliar and familiar domains. Understanding by utilizing analogies is included in higher level thinking compared to direct memorization. This is one of the higher order thinking skills, namely scientific process skills, because in an effort to improve them, students need to find, interpret and assess evidence in various conditions encountered and are known as procedural, experimental skills and scientific investigation abilities. The aim of this research is to train analogy strategies in practicing science process skills and students' understanding of concepts in electrical circuit material. The trial was carried out on a limited basis on prospective science teacher students at one of the universities in Indonesia with data collected in the form of implementation of the use of analogy strategies in practicing science process skills and students' understanding of concepts.

Keywords: analogies; electrical circuits; science process skills

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INTRODUCTION

In this century of revolution 4.0, students must master basic skills. According to[32]important skills that must be mastered in the 21st century (critical thinking and problem solving, creativity and innovation, collaboration, and communication), a person must also master the technological, information and communication literacy needed in various aspects of life. The world of education has carried out various learning innovations to develop various skills that support this. The main aim of science education in Indonesia is to help students develop higher order thinking skills to enable them to face

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the challenges of everyday life through activities using higher order thinking skills such as critical, reasoning, reflective and scientific process skills.[2]. Science Process Skills (KPS) are defined as logical and rational thinking skills used in science[10]. Science process skills can maximize students' active involvement in learning, helping students understand how the rules of learning should be carried out permanently[12].

The urgency of the science process skills that students must have is not matched by the reality in the field. In line with several journals which show that Indonesia's 2018 PISA for science performance is ranked 71st, with results below the average score of OECD countries and several partner countries such as Peru and Brazil, and experiencing a decline from the average score for Indonesia's science performance in PISA 2015[38]. These results are in accordance with the facts in the field that indicators of process skills have not been developed as competencies that must be honed among students, so it is rare to find students solving problems in learning. Based on the National Science Education Standards (NSES), inquiry involves observing, proposing answers, explaining, predicting, and communicating results.

Science Process Skills, identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations[30]. One study also reported that students' critical analysis power is still low because students are still trapped in mere memorization and memorization[2]. This causes the information received by students to be easily forgotten and lost, so methods or strategies are needed to train these skills in students in the learning process.

Reasoning is one of the most significant components of science process skills. In previous research, it was known that an image can influence a person's reasoning abilities. A drawing can be seen as a tool to promote reasoning abilities of a solution and communication skills[16]. Reasoning explains concepts with models and relationships, making predictions or drawing results supported by data[33]. From the explanation above, it is known that the use of analogies in the form of images or human activities can make it easier for students to analyze an event.

Based on the description above, it is necessary to carry out research to determine the effect of analogy strategies which can improve conceptual understanding and train students' science process skills. Apart from that, this research aims to produce an article published in reputable indexed international seminar proceedings.

METHOD

Science process skills cannot be separated from science practice and play a role in learning in both formal and informal science content[29]. Broadly speaking, science process skills are students' skills in understanding and mastering science which involves mental, physical and social skills to develop concepts, principles or theories.[19]. Science process skills are science skills in carrying out scientific methods that involve thought and creativity. Science Process Skills are very important because students carry out the process of finding, interpreting and assessing evidence in various conditions they face, so

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that learning can continue throughout life and become a provision for students' future.[7]. The way to measure students' Science Process Skills is that it can be done in the form of written, oral and observation tests[31]. This is in line with[34] In his research, efforts to determine the level of students' Science Process Skills required a process skills assessment rubric as a guide in performance assessment.

Assessment of science process skills must also be assisted by providing visualizations that are close to students, so that concepts that are abstract and difficult to understand can become easier. According to[26]The application of analogies, especially abstract concepts, is easier to assimilate with students' previous knowledge and allows students to develop a more scientific understanding of concepts. Analogies can help learning by providing visualization of abstract concepts, by comparing similarities in the real world with the actual concept[13]. When learning to use analogies, care is needed to ensure that students remember the concept of the material, not the analogy, by noting that analogies are only an aid to understanding the concept, not content or process and not the actual concept.[25]. It is hoped that the use of this analogy strategy can help students when carrying out practical work on arranging parallel series electrical circuits, so that it can help students' processing skills and increase their understanding of the concept.

This research uses a mixed methods method, with a concurrent embedded research design[11]. The main product resulting from this research is the use of analogy strategies. The concurrent embedded model method is presented in Figure 1[11]:

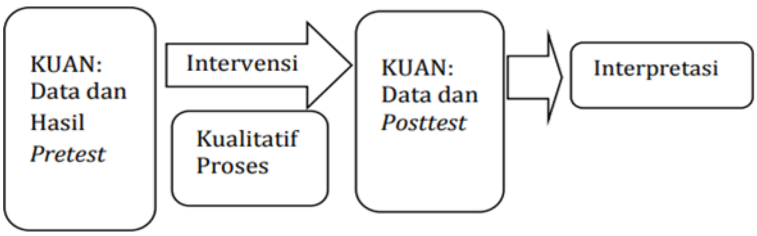

Figure 1 Concurrent embedded model method

RESULT AND DISCUSSION

Implementation of Learning

The learning process that has been carried out in the Electricity and Magnetism lectures in the odd semester of the 2022/2023 academic year is offline. For three meetings on the topic of Electrical Circuits, recapitulation data on the comparison of the mode of score results for each aspect of the learning process are presented in Figure 2 below.

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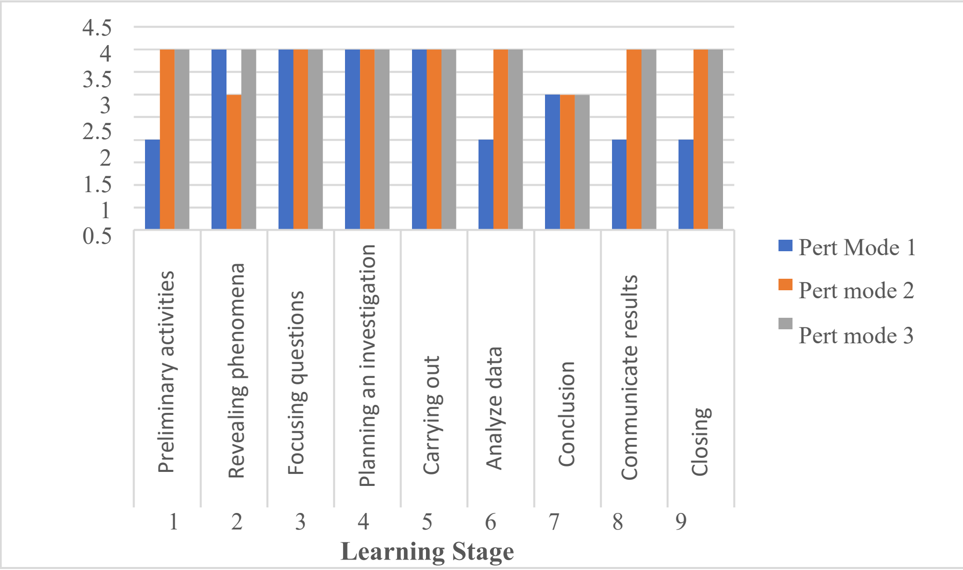

Figure 2 Comparison of Score Result Modes for Each

Based on Figure 2, the comparison of learning implementation modes at each meeting shows that there was an increase in the learning implementation score for 3 meetings. The overall learning implementation mode for each aspect is dominated by a score of 4. Based on the scores obtained at the second meeting in the second stage, the score decreased while in the 7th stage the score remained the same. This shows that the learning at 3 meetings has changed for the better.

Overall, at the first meeting the learning process was not fully implemented according to the stages due to the lecturers' lack of ability to master class conditions and lack of preparation. This results in students not being able to participate in learning well, apart from that, another influencing factor is that students are not yet familiar with the learning being applied. This is in line with[14], that a learning process that has not been fully implemented and is not yet used to being accepted by students can cause students to lack focus in the learning process. The implementation of learning that was less than optimal also had a negative impact on student activities, as shown by the results of the work on the student activity sheet (LKM) at the first meeting which was not optimal, there were several sections that were not filled in. The aim of using LKM is as a medium that supports learning activities. Aligned with[42], media use is an important component of the learning process. Students' failure to complete worksheets is due to the limited time available. This is in line with the weaknesses of learning according to[1], that the freedom given to students is not always utilized optimally. Therefore, at the next meeting the lecturer will condition the students to make optimal use of their time.

In the second and third meetings, all indicators observed in the learning process were fully implemented. Overall, the average score for the second meeting was 4. However,

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at several stages there were several implementation indicators that were not coherent. So in Graph 5.1, at the second meeting there were two stages of the learning process with a score of 3, while at the third meeting there was one learning stage that had a score of 3. This was due to the lecturer's lack of ability to master class conditions. The implementation of all indicators of learning implementation supports the role of students in participating in the ongoing learning process. Aligned with[36], one way to increase student KPS is to carry out a learning process that actively involves students in understanding concepts, not just memorizing them. So that ongoing learning should be able to facilitate students to be actively involved.

Data from observations of the implementation of the learning process at the first, second and third meetings showed that there was an increase in the role of students in implementing learning using analogies and the role of lecturers was in accordance with the learning steps used. The learning stage used is the inquiry step according to[22] includes uncovering phenomena, focusing questions, planning investigations, carrying out investigations, analyzing data, making conclusions, and communicating results. The implementation of this inquiry model is in line with relevant research[35]regarding the application of inquiry using analogy strategies, it is concluded that it is effective in increasing KPS, apart from that it can also be useful in improving reasoning abilities, understanding and scientific thinking. Applying inquiry, educators need to know some of the weaknesses of this learning. This is in line with[35]that educators need to be vigilant in implementing inquiry learning to minimize obstacles during learning activities.

Students' Science Process Skills

The results of students' science process skills based on learning using analogy strategies are as follows:

Table 1 Data from observations of students' science process skills

Skills science process	Student Activities	Percentage			
		4	3	2	1
Formulate the problem	Provide a formula appropriate problem	19.2	69.2	11.5	0
Formulate a hypothesis	Provide hypotheses correctly	11.5	57.7	30.8	0
Formulate variables study	Write down the variables according to the problem formulation	30.8	57.7	11.5	0
Collecting data	Collect data from problems found	76.9	23.1	0	0
Analyzing experimental data	Analyze data according to experimental results have been done	69.2	30.8	0	0
Conclude	Write the final conclusions from the results of the experiments that have been carried out	76.9	23.1	0	0

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Based on data from table 1, the indicator of science process skills that is still difficult for students to do is formulating hypotheses. The activity carried out by students is formulating hypotheses correctly, because there are still those who get point 2 at 30.8%. Another indicator is in formulating problems and formulating variables regarding MFI activities, which still has point 2 at 11.5%. The percentage obtained for point 2 shows that students' science process skills in the aspect of formulating hypotheses, formulating problems and formulating research variables are less well-honed, especially in the aspect of formulating hypotheses. Based on data from table 5.1, the results of observations of science process skills, the percentage of students getting 3 points in several aspects of science process skills, namely formulating problems, 69.2%, formulating hypotheses and formulating research variables, 57.7% of students. Apart from that, the data shows that there is a high percentage of results obtained in point 4, namely the aspect of collecting data and concluding at 76.9% while analyzing data at 69.2%.

Based on this data, it is in line with relevant research[36]that the learning strategies implemented can hone students' science process skills as proven by the results of observations of aspects of the science process skills obtained which are in the high category. Education through science by carrying out scientific processes through problem-solving learning is part of developing learning in understanding science[13]. Scientific thinking is characterized by two main features, namely concepts and processes[17], so that the development of students' understanding can also be facilitated through these learning strategies.

Concept Understanding

After carrying out the learning process, the conceptual understanding of students who have taken part in learning using analogy strategies in practicing students' science process skills regarding Electrical Circuits is as follows:

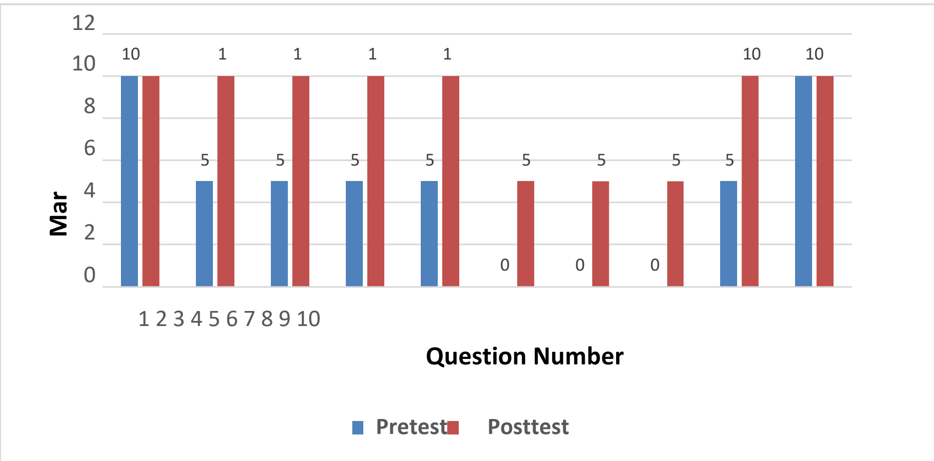

Figure 3 Pretest and Posttest Results Per Question

Based on the data in Figure 3, the average pretest results per question number were still many who answered incorrectly and when the posttest increased, most of the scores were

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10. These results show that all students can carry out learning using analogy strategies well. It can be seen that for each question number during the posttest the score exceeded the pretest score, although there were still those who answered incorrectly with a score of 5 on questions 6, 7 and 8. Following are the results of the t test analysis of the students' pretest and posttest results, which are presented in table 2,

Table 2 Table of significance of student pretest and posttest results

	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Concept Understanding Pretest - Understanding Posttest Draft	- 26,757	8,299	0.965	-28,679	-24,834	- 27,735	73	0,000

Based on table 2, the output of the t test results, the sig value is obtained. = 0.000, which means ≤ α 0.05. Sig value. It can be concluded that there is no significant difference before and after the analogy strategy is applied, so it is accepted that there is a significant difference before and after the analogy strategy is applied [36]. Thus, it was rejected and accepted, thus showing that there was a difference in student scores before the lecture using the analogy strategy and after using the analogy strategy.

These results are in line with the analogy strategy that frees students to develop a variety of innovative responses to support increased understanding of science[8]. Through the strategy of studying various scientific phenomena that are investigated, students can increase their understanding, argumentation and reasoning effectively by assuming the functional structure of arguments to foster students' understanding of a concept.[24, 41]. Based on education through science related to oral, written, or symbolic/tabular/graphic formats, it supports the development of understanding of the background or concepts of a science [29]. In line with literacy as an important multidimensional concept[23]. Therefore, the analogy strategy facilitates students to provide a variety of innovative responses to support increased understanding of scientific concepts.

CONCLUSION

Based on the results of the research conducted, it can be concluded that:

1. Implementation of the use of analogy strategies in learning experienced an increase in the first, second and third meetings with the learning steps carried out by the lecturer in accordance with the learning steps.
2. Students' science process skills have reached the high category, thus indicating that students' ability to apply science process skills in learning is good.
3. Students' understanding of concepts when the analogy strategy was applied increased from pretest to posttest, so there was a significant difference in scores

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