Increasing Student's Concept Understanding and Science Process Skills Through Inquiry Training Models

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Abstract. The research aims to determine the effect of using the inquiry training learning model to improve students' science process skills and concept understanding and to determine the relationship between science process skills and students' concept understanding in implementing the inquiry training learning model. The research type is a quasi-experimental study, and the research is designed using the Two Group Pre-test and Post-test Design. The research population consists of the 10th-grade classes at SMAS PARULIAN 1, and the research sample comprises two classes selected through cluster random sampling. The research utilizes an instrument for science process skills in the form of 10 essay questions, which already encompass indicators as described by Tawil & Liliasari (2014). Meanwhile, the instrument for conceptual understanding is in the form of 10 essay questions. The results of the MANOVA test show that the inquiry training learning model has a significant effect on students' science process skills and understanding of concepts. The Pearson correlation test shows that there is a relationship between science process skills and students' conceptual understanding in applying the inquiry training learning model to physics learning.

Keywords: Concept Understanding, Science Process Skills, Inquiry Training Models

1 Introduction

The advancement of science and technology is supported by the fundamental sciences in the field of science education. Science education, or Natural Sciences (IPA in Indonesian acronym), is one of the means to cultivate high-quality human resources capable of mastering science and technology. In general, IPA encompasses three basic fields of science: physics, biology, and chemistry [1].

Physics is one of the essential subjects to study. The role of physics as a subject of interest requires more mastery and understanding rather than mere memorization, leading to the development of the ability to enhance conceptual understanding based on facts. Physics, as a process, is not effective if it only emphasizes the understanding of concepts; it should also

AISTEEL 2023, September 19, Medan, Indonesia
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DOI 10.4108/eai.19-9-2023.2341888

emphasize the mastery of skills acquired through laboratory activities [2]. Laboratory activities emphasize providing direct experiences to learners to be creative in performing the processes of science skills. These activities include aspects such as designing and conducting experiments, observing, asking questions, formulating hypotheses, identifying patterns and variable relationships, effective communication, measurement, and calculation [3].

Based on observations conducted by researchers at SMAS Parulian I Medan, it is known that the main problem in physics education is the lack of science process skills and conceptual understanding. Students predominantly struggle to grasp concepts well, making it difficult for them to construct their own knowledge from what they have learned. As a result, these students are unable to act in accordance with the principles of the scientific method, which are related to science process skills for understanding and developing concepts and acquired facts. Consequently, they are unable to engage in scientific activities. This statement is supported by an initial test conducted by the researcher, involving 20 students, where the results showed that 60% of the students found it difficult to answer questions related to designing and conducting experiments, 65% had difficulty with observation questions, 75% struggled with formulating hypotheses, and a significant 80% had difficulty with measurement and calculation questions.

In line with the initial test conducted by the researcher, which involved providing 6 fill-in-the-blank questions, it was found that 60% of the students had difficulty answering questions in the form of clarification, 70% had difficulty answering questions in the form of interpretation, 60% had difficulty answering questions in the form of exemplification, 80% had difficulty answering questions in the form of comparison, 70% had difficulty answering questions in the form of summarization, and 60% had difficulty answering questions in the form of explanation.

The low science process skills and conceptual understanding of students are further supported by the results of interviews with physics teachers at SMAS Parulian 1 Medan. These teachers have stated that students are unable to apply physics concepts in the real world, and when presented with problems different from those provided as examples, students struggle to solve the given questions. Teachers tend to employ conventional teaching methods, which are teacher-centered, resulting in students at SMAS Parulian 1 Medan being less active in learning and practical activities at school, as revealed through the interviews conducted. This is further supported by research conducted by De[4] and Maria et al. [5], which states that the use of conventional methods, such as lectures, leads to low conceptual understanding among students.

One approach to addressing the low science process skills and conceptual understanding of students is by using a student-centered learning model. Walsh & Sattes [6] state that the questions posed by students are an indicator of their engagement in learning and thinking. Previous researchers have investigated the inquiry training model. Silviana, D. et al. [7]; Muhammad, H. et al. [8]; Khaerul [9] have reported that their research findings indicate the influence of implementing the inquiry training learning model on students' science process skills.

2 Research method

The research type is a quasi-experimental study, and the research is designed using the Two Group Pre-test and Post-test Design. The research population consists of the 10th-grade classes at SMAS PARULIAN 1, and the research sample comprises two classes selected through cluster random sampling. The research utilizes an instrument for science process skills in the form of 10 essay questions, which already encompass indicators as described by Tawil & Liliasari [10]. Meanwhile, the instrument for conceptual understanding is in the form of 10 essay questions.

The data analysis technique used in this study involves the multivariate analysis of variance (MANOVA) under the conditions that the data must follow a normal distribution and be homogenous. Additionally, the N-gain test is employed to assess the improvement in students' problem-solving skills and conceptual understanding before and after the treatment. Furthermore, correlation analysis is conducted to determine the relationship between students' problem-solving skills and conceptual understanding in the implementation of a problem-based learning model supported by multirepresentation.

3 Result and Discussion

The hypothesis in this research is whether or not there is an influence of the inquiry training learning model on high school students' science process skills and conceptual understanding in the subject of momentum and impulse. The average science process skills of students when applying the inquiry training learning model are 62.25, while the average science process skills of students when applying conventional methods are 58.75. The average conceptual understanding of students when using the inquiry training learning model is 63.5, whereas the average conceptual understanding of students when using conventional learning is 52.5.

The results of hypothesis testing using MANOVA show that Sig (α) < 0.05 ($0.00 < 0.05$). Based on the MANOVA statistical test, it can be concluded that there is an influence of the inquiry training learning model on high school students' science process skills and conceptual understanding in the subject of momentum and impulse in the 11th grade at SMAS Parulian 1 Medan for the academic year 2023/2024. This is because problem-based learning can assist students in developing their science process skills through learning. As a result, not only do students' science process skills improve, but their conceptual understanding also increases.

The first phase of the inquiry training learning model involves providing an orientation on presenting a problem to the students. The researcher encourages active learning through a new teaching method by presenting real-life problems that commonly occur in everyday life. The researcher presents a problem often encountered in daily life by showing a 3-minute video and graphical representations of "A car moving at a certain speed then collides with a residential house." The researcher also asks, "What about its momentum and impulse?" Other students also provide hypotheses about the video. This phase initiates a question-and-answer process among the students. Students express their opinions on the questions posed by the researcher. This aligns with research conducted by Yohandri, which states that the inquiry training learning model can enhance learning outcomes in the science process skills of physics in the topic of temperature and heat. It also makes students more active and enthusiastic due to the change in teaching methods, moving away from traditional teacher-centered approaches.

The second phase involves organizing students for research. The researcher divides the students into 4 groups, with each group consisting of up to 5 students. The researcher facilitates the students with worksheets (LKPD) based on the inquiry training model and provides these worksheets to the students for individual work. However, the students are encouraged to discuss and find solutions together within their group. Each student in their respective group seeks information, both from books and the internet, related to the problems presented in the worksheets. They search for information about momentum and impulse, the application of the law of conservation of momentum, and collisions. In this phase, students are also trained to engage in student-centered learning and self-directed learning. Students start dividing tasks among themselves for efficiency during the investigation. They read the instructions on how to work on the worksheets, and the researcher provides opportunities for students to ask questions about anything they don't understand in the worksheets. This phase guides students to construct their knowledge, leading to a deeper understanding of the concepts.

The third phase involves students asking how to answer the questions according to the problem-solving indicators outlined in the worksheets (LKPD). The researcher responds as follows: 1) Students gather information about an event they observed or a natural phenomenon; 2) Students introduce new elements into the problem situation to explore whether different outcomes are possible when their research data is tested in different ways; 3) Students process data and formulate an explanation; 4) Students are asked to analyze the patterns in their research; 5) In the evaluation phase, students need to estimate the results obtained through the solutions they've developed. In the second part of this phase, the researcher also provides boundaries for the material to be studied, which are momentum and impulse. In the third phase of the inquiry training learning model, the focus is on assisting independent and group investigations. The researcher helps students in solving problems in the worksheets without instructing them in their investigation. Students implement their solution plans and conduct investigations according to the procedures outlined in the worksheets. They are encouraged to construct their understanding by presenting experimental data on momentum and impulse, the application of the law of conservation of momentum, and collisions. Students also conduct experiments related to these concepts as per the instructions in the worksheets. They record their observations in the worksheets and answer the questions provided.

The fourth phase in the implementation of the inquiry training model involves giving one of the groups the opportunity to present the results of their discussion in front of the class, while other students listen. When the presenting group finishes, the researcher provides an opportunity for other students to question or provide input on their classmates' discussion. The researcher encourages and invites students to actively express their opinions about the issues presented in the worksheets. Some students may have answers that align with other groups, while there may be differences of opinion among various groups. In this phase, students are already able to represent their knowledge with the assistance of the worksheets (LKPD).

The final phase in the inquiry training model of learning involves analyzing and evaluating the science process skills. The researcher reflects on and summarizes the results of the students' investigations and provides reinforcement of the material to the students. This reinforcement is given to help students connect the components of blood with real-life issues. Students also listen to the evaluation and reinforcement provided by the researcher and compare their answers with the evaluation explained by the researcher. In this phase, students are also capable of relating their knowledge to real-life issues related to momentum and impulse, the application of the law of conservation of momentum, and collisions. This phase encourages students to critically assess their learning and make connections between their knowledge and real-world problems related to momentum and impulse, as well as the application of the law of conservation of momentum in collisions.

The implementation of the inquiry training learning model in the second and third sessions resulted in an improvement in students' science process skills and conceptual understanding. This aligns with the findings of Walsh & Sattes [6], who stated that the use of the inquiry training model positively influenced students' science observation skills. During the learning process using the inquiry training model, students are encouraged to observe their surroundings during experiment.

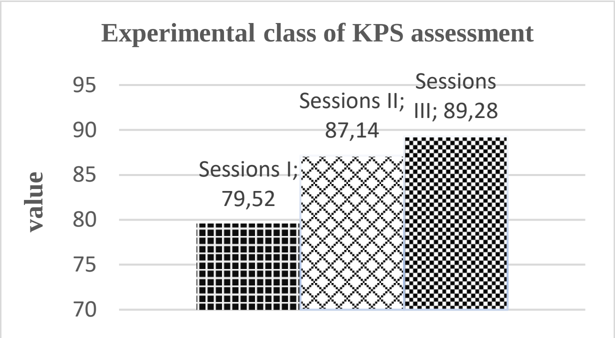

Fig. 1. Science Process Skills Assessment Diagram

The development of students' science process skills activities with observation was assessed during three sessions conducted in the experimental class by two observers equipped with observation sheets. The results were as follows: Session I had a score of 79.52, Session II had a score of 87.14, and Session III had a score of 89.28. These increasing scores indicate an improvement in students' science process skills over the three sessions.

4 Conclusion

Based on the results of research and discussions carried out by researchers, it can be concluded that; 1) The results of the MANOVA test show that the inquiry training learning model has a significant effect on students' science process skills and understanding of concepts; 2) The Pearson correlation test shows that there is a relationship between science process skills and students' conceptual understanding in applying the inquiry training learning model to PHYSICS learning with a coefficient value (r) of 0.743 in the medium category.

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