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Research Article

Implementation of Inquiry Learning through Experiments in Developing Students' Procedural Skills Aspects

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ABSTRACT

The rapid advancement of science and technology demands education to equip students with critical thinking, creativity, and problem-solving skills. Science education, particularly chemistry, plays a vital role in fostering these skills through appropriate teaching approaches. However, chemistry learning at SMA Negeri 1 Syamtalira Bayu, North Aceh, still faces challenges such as low student interest, dominance of lecture-based methods, and weak psychomotor skills. This study aims to analyze the effectiveness of the inquiry-based experimental learning model in enhancing students' procedural skills. The research employed a mixed-method approach with an exploratory sequential design, involving two classes: experimental and control. The results showed that students in the experimental class experienced significant improvements in procedural skills, such as preparation, execution of experiments, observation, and collaboration. The inquiry approach encouraged active student engagement and the development of scientific attitudes. Compared to conventional methods, this model proved to be more effective in developing students' psychomotor skills. Therefore, implementing inquiry-based experimental learning is recommended as an innovative strategy in chemistry education to foster active, skilled, and scientifically minded students.

Keywords: Guided Inquiry; Experiment; Procedural Skills; Procedural Skills Domain; Chemistry Learning

1. INTRODUCTION

The rapid development of science and technology inevitably not only produces science but also has weaknesses, such as the almost complete absence of challenges and demands. As the world becomes more complex, society needs to be more aware of science because of the frequent occurrence of work accidents that require various high skills, including the ability to learn from every change, be rational, creative, make decisions, and be able to solve problems (Klausner, 1996). Therefore, the quality of science understanding at all levels of education must always be pursued.

According to Azam and Rokhimawan (2020), science education is a type of education that aims to develop students' critical thinking, creativity, synthesis, analysis, and innovation skills in addition to transforming knowledge. The Graduate Competency Standards (SKL) contained in Permendikbud No. 20 of 2016 concerning skills subjects state that every student must demonstrate skills through critical thinking, creativity, collaboration, communication, independence, and productivity through academic research (Septikasari & Frasandy, 2018).Critical thinking skills are a reflective approach that involves assessing our ability to analyze accurate information, formulate hypotheses, make effective arguments, solve problems, and evaluate available information.(Hussin et al., 2019).

Experiments are a recommended teaching method in science education because they have many advantages over other teaching methods (Sari, 2023). The purpose of the practical exercises is to develop and apply two science process skills, such as observing, interpreting, planning experiments, applying concepts, and using tools and materials (OT Dewi et al., 2024). According to Nurwahidah (2023), practical exercises are one aspect of science education that aims to provide students with the opportunity to observe and test hypotheses based on the concepts or theories they have learned.

The results of observations and interviews with one of the chemistry teachers of SMA Negeri 1 Syamtalira in North Aceh, the author obtained information about problems in the chemistry learning process such as chemistry subjects are less interesting to students, low mastery of chemistry concepts, students pay less attention during their own teaching and learning process such as talking to friends, sleeping in class and so on, because chemistry lessons are considered difficult and boring, and teachers still carry out learning using conventional methods (lectures) and learning as usual, for example after explaining the material, they are immediately given questions. As a result of the low level of interest in learning, the use of teaching methods that are not too innovative and not in accordance with student characteristics can result in learning being less effective and making students less involved (Pratiwi et al., 2023).

Students' procedural skills are less trained because not all chemical materials are used practically. This results in students' procedural skills being below average, making them less active in class because they have not fully understood the material. Although understanding in order to improve students' procedural skills, it is not always clear that their knowledge is limited. Based on the background above, the author wants to conduct research entitled "implementation of inquiry learning through experiments in developing aspects of student skills."

2. RESEARCH METHOD

This research uses a mixed method research type or called a mixture. Mixed method is a type of qualitative and quantitative research in a series of studies to understand research problems (Vebrianto et al., 2020). This research was conducted at SMA Negeri 1 Syamtalira, North Aceh. The population in this study were all students of class XI IPAS at SMA Negeri 1 Syamtalira in the 2023/2024 academic year consisting of 7 classes with a total of 196 students. The sample was divided into 2 classes, namely the experimental class (XI IPAS 6) consisting of 28 students and the control class (XI IPA S 7) consisting of 28 students. The experimental group was given a guided inquiry model based on Experiments while the control class used conventional learning strategies. The sampling technique in this study was Non-probability sampling using Purposive Sampling. The design of this research is exploratory sequential design, namely the use of two research methods (qualitative and quantitative) sequentially, where the research stage uses qualitative methods and the second stage uses quantitative methods.

Table 1. Research Design

X	O1
	O2

Information:

X= Treatment using a guided inquiry model based on experiments
O1 = Measurement results in the group given treatment
O2 = Measurement results in the group that was not given treatment

According to Sugiyono (2021), research variables are basically anything in any form that is determined by researchers to be studied so that information is obtained about it, then conclusions are drawn. The dependent variable that influences or is the result of the independent variable in this study is the students' procedural skills. The independent variable that influences or is the cause of changes or the emergence of the dependent variable, in this study, is the chemistry learning model used, namely the implementation of inquiry learning through experiments. Data collection was carried out directly in the field by conducting tests. The test data used in this study were in the form of learning outcome tests in chemistry subjects, this data collection was obtained from 23 test instruments and observation sheets. The tests given were 20 questions in the form of multiple choices. This study uses quantitative analysis, which is an analysis technique whose analysis is carried out by calculation. The analysis was carried out by looking at the results of the control class test which in its learning used conventional methods with the experimental class using the implementation of the inquiry model through experiments.

3. RESULTS AND DISCUSSION

3.1 Results

In this study, procedural skills data were analyzed using qualitative methods because the instruments measured in the control class were different from the experimental class and were observed by two observers. Assessment of students' procedural skills in the experimental class was carried out at the second meeting of the experiment stage using an observation sheet that included four main indicators of procedural skills, namely preparation, skills in experiments, skills in observations, and the final stage. Meanwhile, the assessment in the control class was carried out during the learning process at the second meeting using an observation sheet that included four assessment indicators, namely learning preparation, learning process, understanding of the material, and ability to deliver the material. In this study, the analysis of procedural skills data was conducted using qualitative methods because the instruments used in the control group were different from those used in the experimental group and were analyzed by two researchers. Using an observation sheet that highlighted three main procedural skills indicators-preparation, skills in experimentation, skills in observation, and the final stage—the experimental study was conducted at the second practice stage. In contrast, the assessment in the control class was conducted during the learning process of both classes using an observation sheet containing three assessment indicators: learning progress, teaching process, understanding of the material, and material ability. The following is a table of students' procedural skills that includes all indicators on the final observation sheets of the experimental and control classes.

Table 2. Experimental class data

No.	Indicators and Procedural skills	Score				Percentage %			
		1	2	3	4	1	2	3	4
		Number of students							
1	Preparation of tools and materialscolloid experiment	0	4	3	21	0%	14.28%	10.71%	75.00%
2	Skills in processtest	0	0	10	18	0%	0%	35.71%	64.28%
3	Skills in Observation and Presentation of Experimental Resultscolloid	0	0	15	13	0%	0%	53.57%	46.42%
4	Cleaning tools and placesexperiment	0	11	12	5	0%	39.28%	42.85%	17.85%

Table 3. Control class data

No	Indicator and Procedural skills	Score				Percentage %			
		1	2	3	4	1	2	3	4
		Number of students							
1	Preparation for the learning process	0	7	15	6	0%	25.00%	53.57%	21.42%
2	Learning process	0	1	20	7	0%	3.57%	71.42%	25.00%
3	Understanding the material	0	7	21	0	0%	25.00%	75.00%	0.00%
4	Delivery of material	0	6	21	2	0%	21.42%	75.00%	3.57%

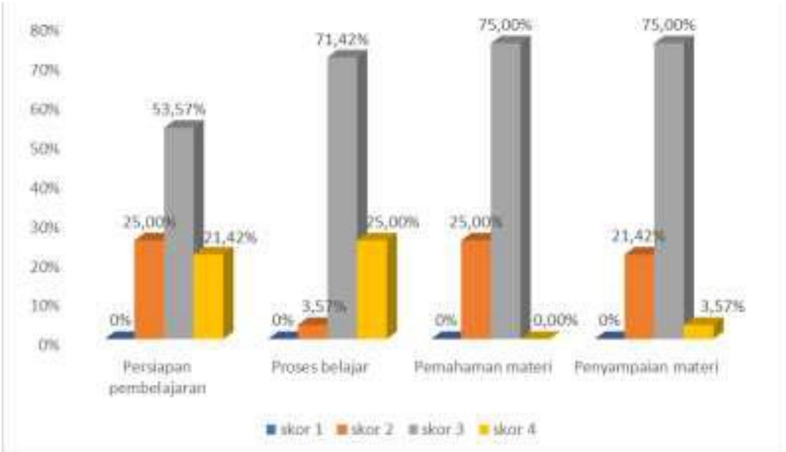

Figure 1. Procedural Skills Graph from the Control Class table

Source: Researcher (2024)

The data showed that students in the experimental group achieved higher scores on all indicators of procedural skills compared to the control group. This improvement was due to the hands-on, inquiry-based nature of the guided experimental model. Students were more engaged and took greater responsibility for their learning process, thereby improving their procedural fluency. The structure of the model, including hypothesis formulation, systematic observation, and reflective analysis, trained students in scientific thinking habits. In contrast, the control group, which used conventional methods, showed lower skill engagement and accuracy.

3.2 Discussion

Inquiry learning through experiments shows a positive influence on the development of students' procedural skills (procedural skills). The results of observations in the experimental class that implemented the guided inquiry model based on experiments showed a significant increase compared to the control class that used conventional methods. Assessment of procedural skills was carried out using an observation sheet that included four main indicators, namely: (1). Readiness of experimental tools and materials, Students in the experimental class were able to prepare tools and materials neatly and on time, showing an initial understanding of the experimental procedure. In contrast, students in the control class appeared less disciplined in preparation due to the lack of practical direction. (2). Experimental implementation skills, at this stage, students in the experimental class showed accuracy in following the experimental steps, using tools correctly, and carrying out procedures according to safety protocols. The inquiry model provides space for students to learn through direct experience, so that their skills develop better. (3). Observation and recording of experimental data, The experimental class was more active and accurate in recording observation data, while the control class tended to be passive and only copied data without in-depth understanding. The inquiry process encourages students to observe critically and record results as part of the scientific process. (4). Post-experiment cooperation and cleanliness. The aspects of cooperation and responsibility for laboratory cleanliness were also better demonstrated by students in the experimental class. This is because the inquiry model emphasizes collaboration and group reflection during the experiment. The data shows that the inquiry model not only improves the understanding of scientific procedures, but also builds students' scientific attitudes, such as discipline, responsibility, and cooperation. Structured experimental activities through an inquiry approach facilitate a more active and meaningful learning experience. This is in line with the opinion (Dewi et al. 2024) which states that experiments with an inquiry approach can train students' science process skills comprehensively. This finding reinforces that inquiry learning is not only about “discovering” concepts, but also forming essential scientific work skills in chemistry learning.

4. CONCLUSION

Based on the results of the study on "Inquiry Learning Through Experiments in Developing Students' Procedural Skills Aspects", it can be concluded that the application of the experiment-based inquiry learning model has a significant positive effect on improving students' procedural skills (procedural skills). Through this approach, students are actively involved in every stage of the experiment starting from preparing tools and materials, implementing experimental procedures, to observing and recording data systematically. The hands-on experience gained by students during the experimental process not only forms a stronger procedural understanding, but also develops scientific attitudes such as accuracy, responsibility, and cooperation. Compared to students in the control class using conventional methods, students in the experimental class showed better procedural skills, as seen from the results of observations and assessments of laboratory skill indicators. Thus, inquiry learning through experiments can be implied as an effective strategy in developing aspects of students' procedural skills in chemistry learning, especially in colloid material.

RECOMMENDATIONS

Based on the research results concluded above, it is necessary to statesome suggestions as follows: 1). Teachers are advised to be more intensive in guiding students in carrying out experimental activities, because the application of guided inquiry syntax requires a fairly high level of accuracy and understanding.in its implementation. 2). The application of guided models based on experiments requires a long time to optimize the experimental trial process.

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AUTHOR’S CONTRIBUTIONS

All authors discussed the research findings collaboratively and approved the final version of the manuscript submitted.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest in this study.

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