Improving The Students Science Process Skills through 5E-Based Student Worksheets

Hidayatussakinah
sakinahuimuda@gmail.com

Universitas Pendidikan Muhammadiyah Sorong

ABSTRACT

This research aims to determine the improvement of students' science process skills through 5E-based student worksheets (STUDENTS' WORKSHEET) and to observe the interaction between science process skills and 5E-based students' worksheets. This is a quasi-experimental study with a non-equivalent pretest-posttest control group design. The research was conducted from July to June 2022. The research population was all seventh-grade students of SMP Muhammadiyah Aimas, while the research sample consisted of two classes, namely VII A and VII B, taken using purposive sampling technique. The instruments used for data collection were the learning objectives, syllabus, lesson plans, 5E-based students' worksheet, science process skills observation sheets, and test items on science process skills. The data analysis techniques used were validity, reliability, homogeneity, normality tests, and hypothesis testing using ANCOVA. The results showed that the research instruments were valid and reliable, and the data was homogenous and normally distributed. The hypothesis testing results showed that there was an improvement in students' science process skills through 5E-based students' worksheet, and there was an interaction between science process skills and 5E-based students' worksheet.

Keywords: Science Process Skills; 5E-based Student Worksheets

INTRODUCTION

Based on the Ministry of Education and Culture Regulation in 2016, the 2013 curriculum emphasizes student learning processes using a scientific approach. This approach is characterized by the use of a scientific process during the learning process, which can be interpreted as providing an understanding to students in recognizing and understanding various materials using a scientific approach. The scientific process involves activities such as observing, questioning, collecting data, associating, concluding, and communicating (Diella et al., 2019).

These scientific activities are closely related to science process skills (SPS). Science process skills are the abilities of students to observe, interpret, measure, communicate,

formulate hypotheses, and conduct experiments to obtain, develop, and apply concepts, principles, laws, and theories of science (Sultan, 2011). Science process skills can also be defined as a skill that includes scientific steps to solve a problem presented in the form of student activities. According to Tawil and Liliasari (2014), science process skills include observing, classifying, formulating questions, formulating hypotheses, planning experiments, selecting experimental tools and materials, using experimental tools and materials, predicting, interpreting, and communicating.

The use of appropriate teaching materials in biology education to package learning into scientifically structured and interesting activities and to measure the science process skills of students can be presented in student worksheets based on the 5E approach. The 5E-based student worksheet is a student worksheet that is designed based on five learning activities, namely (1) Engage (stimulating curiosity by asking questions about objects or events in the environment), (2) Explore (planning and conducting simple investigations to gather relevant data), (3) Explain (using data and scientific knowledge to produce explanations), (4) Elaborate (developing strategies, concepts, principles, and explanations for new problems and questions), and (5) Evaluate (evaluation and assessment as a process of collecting learning outcomes) (Bass et al., 2009).

The 5E-based on the student worksheet integrated with science process skills is expected to help teachers in planning practical and measurable learning, conducting effective and efficient learning, connecting learning materials with real conditions in the environment easily, enabling students to easily carry out learning, enhancing cognitive abilities and science skills, facilitating students in connecting science processes with the learning concepts taught, and enabling scientific approaches to be well-implemented.

The above objectives are in line with the opinion of Nurina (2013) who stated that the 5E-based student worksheet can facilitate active student participation in creating new knowledge to develop their cognitive structures directed through environmental exploration and collaboration, able to explain acquired concepts, and apply new knowledge in other situations. The 5E-based student worksheet can also stimulate students' curiosity, make acquired knowledge long-lasting, and improve students' learning outcomes. Some research results also show that the 5E-based student worksheet has a positive effect and can improve students' learning outcomes (Lestari et al., 2017).

LITERATURE REVIEW

The skills of the Scientific Process are the ability to understand and apply the principles of science in a process or experiment. The skills of the Scientific Process consist of several abilities, namely: Observation: The ability to systematically and accurately observe objects or phenomena. Formulating Questions: The ability to formulate

relevant and answerable questions in an experiment or scientific process. Designing Experiments: The ability to design and organize a systematic and controlled plan for an experiment or scientific process. Collecting Data: The ability to accurately and reliably collect data or information from the results of an experiment or scientific process. Analyzing Data: The ability to analyze and interpret data or information obtained from the results of an experiment or scientific process. Drawing Conclusions: The ability to draw conclusions based on data or information obtained from the results of an experiment or scientific process. Communicating Results: The ability to communicate the results of an experiment or scientific process clearly and accurately to others. The skills of the Scientific Process are very important for every scientist, researcher, or practitioner of science. By having these skills, they can conduct experiments or scientific processes more effectively and efficiently, and produce more accurate and valuable findings for the development of science and technology.

Students' worksheet is a document given to students as a guide and learning material in a learning activity. It can be in the form of a series of questions or tasks that students must complete related to a learning material, or it can be a worksheet that contains information or instructions about a topic or concept. The purpose of the students' worksheet is to help students develop independent learning skills and responsibility in mastering the learning material. With the students' worksheet students are expected to hone their critical thinking, creativity, and independence in solving problems or answering questions related to the learning material. In addition, the students' worksheet can also be a means for teachers to evaluate students' ability to understand and master the learning material, as well as to provide feedback or input that can help students develop their learning skills. The students' worksheet is usually given by the teacher at the beginning of a learning activity or when starting a new topic or concept, and students are expected to work on it independently or in groups, depending on the instructions given by the teacher. In this study, the students' worksheet used is based on the 5E instructional model.

PREVIOUS RESEARCH

First research by Nurlina (2014) conducted a study on improving Science Process Skills (KPS) by applying Problem-Based Learning (PBL) model on students in class VIIIB of SMPN 1 Lapariaja, with the results of the study showing that learning with the PBL model can improve KPS in students of class VIIIB at SMPN I Lappariaja. Second research by Hartono et al. (2013) titled their study "Analysis of KPS Process of Students Based on Thinking Styles and Multiple Intelligences in Modern Physics Practicum at Muhammadiyah University Makassar", and the results showed that students with intrapersonal intelligence had good KPS, with percentages of 79%, 80%, and 72% respectively.

Third research by Diella et al. (2019) conducted a study titled "Training of Science Process Skills (KPS) Based on Skills Development Students' Worksheet and KPS Assessment Instrument Preparation for Science Teachers". The results of the training showed that the ability to integrate types of KPS into Students' Worksheet were as follows: (1) observation 88.9%; (2) classification 22.2%; (3) interpretation 100%; (4) prediction 55.5%; (5) communication 88.9%; (6) formulating problems 88.9%; (7) hypothesis 100%; (8) planning experiments 100%; (9) using tools and materials 100%; (10) applying concepts 88.9%. Fourth research by Mahjatia et al. (2020) conducted a study on the development of STEM-based students' worksheet to train students' Science Process Skills through guided inquiry. The results showed that the achievement of KPS through STEM-based students' worksheet was very good overall and showed improvement in each meeting.

Scientific Process Skills

The skills of the scientific process are the entire scientific skills (cognitive and psychomotor) that can be used to discover a concept, principle, or theory to develop previously existing concepts or to refute a discovery or clarification (Said, 2012). Science is not just about mastering a set of knowledge in the form of facts, concepts, or principles; science is also a process of discovery through investigation or experimentation (Manalu, 2023). The skills of the scientific process are skills that can be used to discover and develop a concept in fostering knowledge through scientific activities. When this potential develops, a person can quickly and habitually solve a problem they are facing (Nurhudayah, 2016).

According to experts, some indicators of scientific process skills are as follows: according to Bass et al. (2009), (1) observing, collecting information using all appropriate senses and developing observation instruments, (2) classifying, grouping objects or organisms according to one or more common characteristics, (3) inferring, drawing temporary conclusions about an object, organism, or event based on previous observations and knowledge, (4) measuring, measuring variables using various standard or non-standard instruments and units, (5) communicating, recording observations, measurements, conclusions, experiments, etc., in various ways, and conveying them to other learners, (6) predicting, making likely estimates of investigation results based on known patterns in data, (7) hypothesizing, making a statement of a question to guide investigation, and (8) planning and conducting controlled investigation experiments, intentionally manipulating one variable at a time and observing its effect on a response variable, while keeping other variables constant. Based on the experts mentioned above, the indicators of scientific process skills investigated in this study are 5 indicators, namely observing, formulating problems, hypothesizing, conducting experiments, applying concepts, and drawing conclusions.

Students Worksheet Based on the 5E

The student worksheet based on the 5E is a learning source designed based on the 5 stages of learning, namely engage, explore, explain, elaborate, and evaluate. According to Bass et al. (2009), the stages of students' worksheet based on the 5E include Engage (fostering curiosity by asking questions about objects or events in the environment), Explore (planning and conducting simple investigations to collect relevant data), Explain (using data and scientific knowledge to produce explanations), Elaborate (developing strategies, concepts, principles, and explanations for new problems and questions), and Evaluate (evaluation and assessment as a process of collecting learning outcomes). Students' worksheet based on the 5E can facilitate active learning for students in creating new knowledge to develop their cognitive structures directed through environmental exploration and collaboration, able to explain the acquired concepts, and apply their new knowledge in other situations.

METHOD

Design and Sample

This research is a type of experimental research with a quasi-experimental design aimed at finding the effect of a certain treatment on the variables being studied. The quasi-experimental design used is a pretest-posttest control group design. The population in this study is all seventh grade classes at Muhammadiyah Aimas Junior High School, while the research sample consists of two classes, namely VII A and VII B. Sampling technique was done using purposive sampling technique.

Instrument and Procedures

The research instruments used in this study include the validation sheet for experts, analysis of learning objectives and competencies, syllabus, lesson plans, 5E-based students' worksheet, science process skills questionnaires to measure the initial and final abilities of students, and an observation sheet for assessing the implementation of science process skills. The data collection techniques used in this study are divided into two types: (1) pre-research data, which include information about the research object such as the number of participants, the population and research sample, obtained by directly asking the subject teacher, as well as data validation results from learning tools and research instruments, and (2) post-research data, which includes science process skills data obtained from pretest and posttest as well as observation data on the implementation of science process skills.

Data Analysis

Research data is divided into two categories, namely pre-research and post-research. There are several data included in the pre-research data, namely: first, data obtained

from expert validation tests related to the research instrument with 4 assessment categories, namely: category 1.00 - 1.75 is not feasible (cannot be used yet, requires consultation), category 1.76 - 2.51 is quite feasible (can be used with many revisions), category 2.52 - 3.25 is feasible (can be used with few revisions), category 3.26 - 4.00 is very feasible (can be used without revisions) (Ratumanan and Laurens, 2011). Second, data from the validation of test items to measure the level of science process skill ability, which was analyzed using MS Excel 2010 program with the criteria that if r_xy < r_table, the test item is said to be "invalid", and if r_xy 〖≥r〗 table, the test item is said to be "valid". Third, data from the reliability of test items, which were determined using Croanbach's alpha technique in SPSS version 22. Significance testing was performed at the 5% significance level, which means the instrument can be said to be reliable if alpha > r critical product moment.

Post-research data includes: first, pre-test and post-test data of science process skills obtained from test instruments and calculated using the formula score = obtained score divided by maximum score multiplied by 100%. Second, data from the homogeneity test using Levene's test and normality test using the Kolmogorov-Smirnov statistical test with the help of SPSS version 22, which aims to determine whether the analyzed data is normally distributed and spread homogeneously or not. The data is said to be normally distributed and spread homogeneously if the probability value is greater than 0.05 at the 5% significance level (Sugiyono, 2015). Third, N-gain test data to determine the average increase in science process skill scores of students in pre-test and post-test as well as the average score of science process skill indicators calculated using the formula N-gain (%) = post-test score minus pre-test score divided by maximum score minus pre-test score multiplied by 100%. The results of N-gain calculation are interpreted based on the N-gain score criteria, namely N-gain score ⟨g⟩, ⟨g⟩> 70% for the Increased Score Acquisition category, 30% <⟨g⟩ ≤ 70% for the Moderate Increased Score Acquisition category, and ⟨g⟩ ≤ 30% for the Low Increased Score Acquisition category (Hake, 1999). Fourth, data from the hypothesis test using ANOVA test with the help of the SPSS version 22 application. ANOVA test is used because this study consists of two types of student values, namely pre-test and post-test.

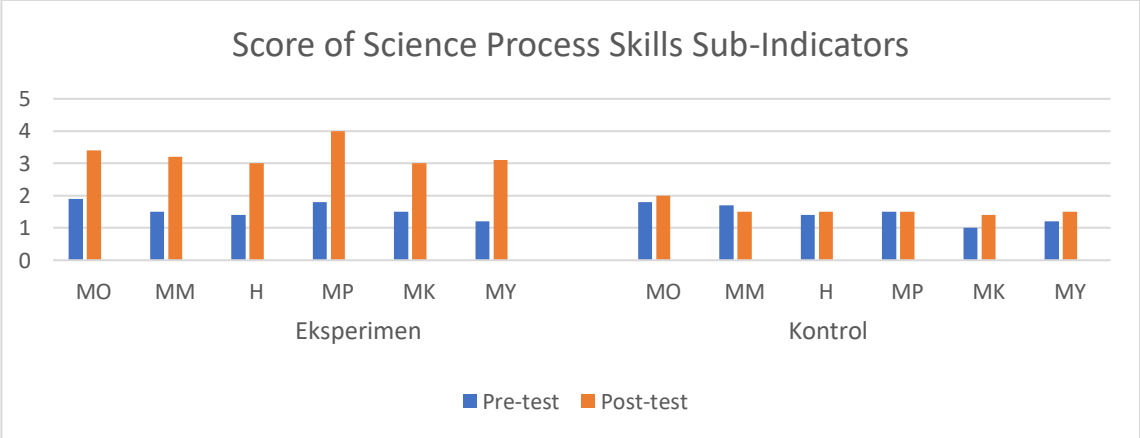
RESULTS AND DISCUSSION

The research results obtained are in the form of pre-research and post-research data. The expert validation results for the research instrument are in the range of 2.52-3.25, indicating that the research instrument is in the appropriate category (can be used with minor revisions). The validation results for the science process skills test items show that out of 15 tested items, 10 are declared valid (r_xy ≥ r_table), while 5 are declared invalid (r_xy < r_table). The reliability test results show that the science process skills

test instrument is reliable because the alpha value is greater than the r_table value, which is alpha 0.738 > r 0.374.

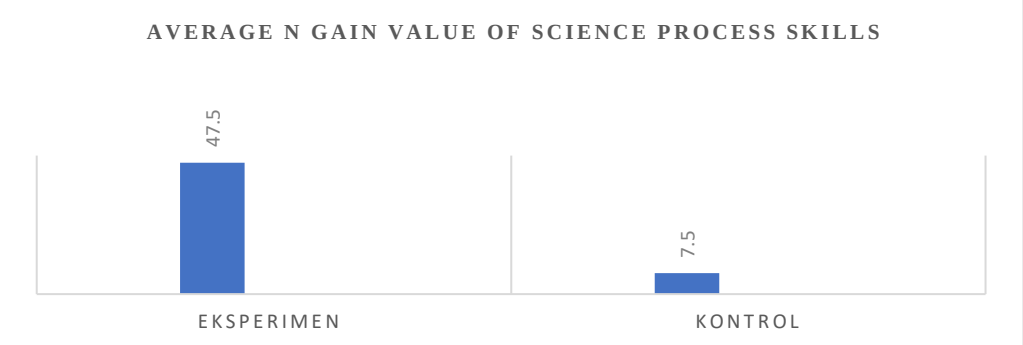
The post-research data begins with homogeneity and normality tests on the pre-test and post-test data. The results show that the data are normally distributed and evenly spread because the probability value is greater than 0.05 with a significance level of 5%, which means that the homogeneity test is 0.05>859 and the normality test is 0.05>200. The average pre-test score for science process skills of the students before the intervention was the same in both classes, which was 35. This result falls within the range of 30-39, indicating that the students' science process skills are very low. The post-test results for science process skills show a significant improvement in the experimental class and a less significant improvement in the control class. The average post-test score for the experimental class is 89, which falls within the range of 80-100, indicating a significant improvement in the students' science process skills, while the average post-test score for the control class is 55, which falls within the range of 40-55, indicating a less significant improvement in the students' science process skills.

The difference in the improvement of science process skills in the class is due to the use of 5E-based student worksheets integrated with science process skills, which was only provided in the experimental class and not in the control class. The measurement of the sub-indicators of Science Process Skills using N-gain test showed that the average value of the sub-indicators increased in the experimental class and did not show a significant increase in the control class. As shown in the graph below, the sub-indicator that showed the highest increase was the fourth indicator, which is conducting experiments. Students felt happy and motivated to conduct experiments because of the many learning experiences they gained, which became one of the significant factors in the improvement.



Explanation: MO= Making Observations; MM= Formulating a Problem; H= Hypothesizing; MP= Conducting Experiments; MK= Applying Concepts; MY= Drawing Conclusions.

The N-gain test results to determine the comparison of the average N-gain score of students' KPS in the experimental and control classes showed that the N-gain in the experimental class was much higher than in the control class. In the experimental class, the average N-gain score was 47.5, while in the control class, it was 7.5. Based on the N-gain score criteria, the average N-gain score in the experimental class was categorized as moderate, while in the control class, it was categorized as low.



The results of the hypothesis test using ANOVA show that the use of 5E-based students' worksheet integrated with science process skills has a significant effect on the ability of students' science process skills. Based on the ANOVA test results, it also shows that there is an interaction between the use of 5E-based students' worksheet and the science process skills of students. The ANOVA results for science process skills can be seen in the following table.

Dependent Variable: Science Process Skills

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
KPS	0956.401	1	0956.401	80.543	.001
STUDENTS' WORKSHEET 5E	1995.523	1	1995.523	159.769	.000
KPS * STUDENTS' WORKSHEET 5E	704.672	1	704.672	04.489	.001

a. R Squared = .796 (Adjusted R Squared = .788)

The results of the above research are in line with the research conducted by Mahjatia (2020) which showed an improvement in science process skills through STEM-based students' worksheet in each meeting.

CONCLUSION

Based on the objectives of this research, there are two conclusions: there is an improvement in science process skills integrated with 5E-based students' worksheet, and there is an interaction between science process skills and 5e-based students' worksheet. The main factor for the success of this research is the use of 5E-based students' worksheet integrated with science process skills, which is very appropriate in learning and can help teachers in planning practical and measurable learning, implementing effective and efficient learning, connecting learning material with real conditions in the environment easily, enabling students to easily implement learning, improving cognitive and science skills, facilitating students in relating science processes to the taught learning concepts, and facilitating a good scientific approach.

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