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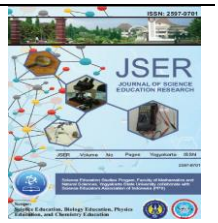

Implementation of Home-based Experiment on Photosynthesis Material to Improve Students' Science Process Skill

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Abstract

This study aimed to describe the improvement of students' science process skills (SPS) after the implementation of home-based experiment activities on photosynthesis material. This research was carried out at one of the State Junior High Schools in Garut. The sample was 26 students for the experimental classes and 25 students for the control class. The research design was Pre-Posttest Control Group Design. The sample selection technique used the convenience sampling technique. The success of the learning method/model implemented was assessed through value analysis before (pretest) and after (posttest) given treatment in the experimental and control groups. The N-Gain value of the experimental group was 0.678, while the N-Gain value of the control group was 0.52. This indicated that the N-gain value of the experimental group was higher than the control group. But, the statistical analysis using post-test scores showed that there was no significant difference between the experimental group and the control group in the students' SPS. So, the implementation of home-based experiments and ordinary practicum in the learning process has the same effect on students' SPS results. Therefore, home-based experiments should be an option for teachers in science learning because, even though the learning process is online, the practicum is the identity, and support of science learning should not be eliminated.

INTRODUCTION

Year 2019 was the beginning of the Covid-19 outbreak. The emergence of Covid-19 not only has had an impact on the public health sector but various other important socioeconomic sectors of life (Nicola et al., 2020) such as education, economy, society, culture, politics to government. Therefore, the government is required to find solutions in all these sectors. Cahyono (2020) stated, among these solutions is to provide and use technology for all sectors. Globally, one of the sectors affected by Covid-19 is the education sector of all levels (Bai, 2020). The impact on the education sector made various changes to the educational process. Educational activities have changed from the implementation of the learning process in the classroom to online learning, including in high schools (Rashid and Yadav, 2020). Online learning is the use of technology and the Internet because it is a mandatory tool to meet online. In addition, online learning often demands students' independence because of various obstacles. Changes in educational activities that are more dependent on technology are following the direction of the 4.0 industrial revolution, which is an era where various fields are integrated with technology (Rachmadtullah et al., 2020). Likewise, in line with that, the current educational context begins to focus on innovation as well as the maximum use of information, the Internet, and technology.

Online learning is an innovation in education that is synonymous with the use of technology (Whalen, 2020). Among the impacts on the education sector is a decrease in the quality of learning (Sahu, 2020). Various obstacles are caused by online learning as this makes teachers somewhat pretentious about the situation. One of the problems is that, teachers must think, select, and use the right learning methods to be implemented in online learning (Hodge et al., 2020). Thus, this clearly changes the pattern of learning that requires teachers and education developers to provide learning materials and teach students directly through remote digital tools (United Nations, 2020). During the online learning process, teachers are also required to find solutions for practicum activities and experiments so that the identity of the science learning is not eliminated. A study conducted by Bartkowiak et al. (2021), showed that even in universities, most

teachers are also unprepared and do not have innovations to carry out learning with the use of technology. Khusnah (2020) stated, only a small percentage of teachers are ready to carry out practicum during online learning. In other words, distance learning is considered less effectively implemented due to a lack of innovation and a lack of teachers' literacy with technology. The application of creative and innovative models and methods is important in the learning process (Putra, 2022). Therefore, one of the online learning methods that can be applied to increase students' activity and understanding in science learning is the home-based experiment.

The home-based experiment is part of home-based learning activities where learning is carried out at home. Home-based learning became a popular term during this pandemic. However, according to Azizan and Nasri (2020), home-based learning is not something new before the pandemic but play only as a support for face-to-face learning. Meanwhile, home-based learning must be implemented when a pandemic occurs to replace face-to-face learning. The pandemic has forced teachers to adapt and implement online learning and immediately carry out home-based learning activities (Mansor et al., 2020; Tay et al., 2021). Yuniastuti (2021) defines a home-based experiment as a practicum activity carried out by students at home and is a challenge for teachers to lower laboratory standards to home standards, but practicum activities must run as much as possible to achieve results according to the desired indicators. Meanwhile, Thompson and Thompson (2012) stated that the lack of established standards would limit the achievements carried out in practicum activities. In principle, a home-based experiment is carried out using makeshift tools that can be reached by students, both in terms of access and price. Even in pandemic conditions and with all the limitations of practicum activities, it must still be carried out. As stated by Selamet et al. (2021), even during a pandemic with the conditions of distance learning, online learning, students learning from home, and teachers teaching from home, science learning must still pay attention to the nature of science as a product and process. A form of effort to achieve and realize this goal is through practicum. But, practice activities carried out at home are not as good as those carried out in schools with the use of laboratories (Nafiqoh and Wulansuci, 2020).

The application of practice in science learning is the right way to increase students' activity and understanding in learning. Putra et al. (2021) stated that students' skill in science learning is influenced by learning activities in the classroom. Chebii et al. (2012) argued that students can get knowledge well when the learning methods are applied to allow them to participate actively. A skill that is also very important for students to have as an outcome of science learning is science process skills (SPS). Based on research conducted by Salamah and Mursal (2017) the students' SPS can be improved by applying inquiry-based experimental methods on the topic of Heat in high schools. Research conducted by Subekti and Ariswan (2016), using experimental methods on physics learning in high schools, has also been proven to improve students' SPS. Then, Ural (2016) stated that the application of experiments with lab work would improve students' SPS.

SPS are all science skills that are used to obtain, develop, and apply science concepts and theories. This skill is not only needed in the learning process but also a need in everyday life (Bell, 2010). Process skills can be interpreted as treatment carried out in the learning process by utilizing the ability to think and create effectively and efficiently to achieve the expected goals. Meanwhile, the purpose of process skills is to develop student creativity in the learning process. Thus, the student can actively develop and apply his/her abilities. In other words, students not only get results but also learn how to process the results. Nugraha et al. (2017) stated that SPS are skills in thinking, reasoning, and acting logically in research and building science concepts needed in the problem-solving process.

The observations made by researchers at Garut Public Junior High School obtained information that teachers rarely apply experimental activities via online learning during the learning process. Teachers still carry out experimental activities even though through an online platform, namely home-based experiments. Meanwhile, the obstacles found that students do not understand science learning on online learning process. Thus, based on the background, the study tried to conduct a research related to the implementation of home-based experiments in schools on science learning. This research was conducted by applying experimental activities from home with standard home tools that can be reached by students. The effectiveness of applying a home-based experiment is measured by looking at the skills of the science process. Therefore, the study entitled "Implementation of Home-based Experiment on Photosynthetic Material in Improving Students' Science Process Skills".

RESEARCH METHOD

This study was a quasi-experimental research using the pre-posttest control group design. The study was conducted via one experimental and one control groups. In the design of this study, the success of the implemented learning method or model can be known through the difference values obtained by the group before (pretest) and after (posttest) treatment. This research was carried out at a Public Junior High School in Garut. The total sample was 26 students for the experimental group and 25 students for the control group. This research was conducted by applying a home-based experiment in the school where students conducted experiments independently based on directions or guidance and information provided by the teacher.

The experimental topic in this study is related to photosynthesis material, especially in Sachs experiments, which is observing the influence of sunlight exposure on the photosynthesis process (amylum in the leaves). Photosynthesis material is one of the materials that require the implementation of experimental activities in the learning process. Moreover, one of the experiments carried out in the photosynthesis material is the Sachs experiment. It is an experiment that can be carried out by students from home because this experiment can be done using alternative materials and procedures. So it does not harm students at home even though it is outside the direct supervision of the teacher. Then, this study tried to reveal the effectiveness of the application of home-based experiments in improving students' SPS on photosynthesis material through Sach experiments.

The sample selection technique in this study used a convenience sampling technique. This convenience sampling technique was carried out in classes that had been provided by the school. The data collection was conducted by tests. The SPS test used multiple-choice objective questions, consisting of 13 questions with 4 answer choices on each question. The number of questions was adjusted to the SPS aspects observed in this study. The observed aspect of science process skills consists of 8 skills, namely observing, interpreting data, predicting, hypothesizing, communicating, planning experiments, applying concepts, and asking questions. Questions were made with the help of supervisors. Also, the question making was consulted with experts before being tested to measure the validity, reliability of the questions, the level of difficulty, and differentiating power. Data processing of the trial results was carried out with the help of Microsoft Excel software and Statistical Package for Social Science (SPSS). The reliability value of the SPS instrument in this study was 0.948, which was included in the high category.

The improvement of SPS possessed by students was determined by the calculation of the normalized gain value or its N-Gain value. This calculation aimed to avoid errors in interpreting the gain value by each student. This data was obtained from the results of pre-tests and post-tests to see the achievement of SPS in science learning with the application of home-based experiments. Then, it can be concluded that there was an increase in students' SPS regarding the photosynthesis material. The improvement of students' SPS was calculated using the N-gain formula as follows:

$$\langle g \rangle = \frac{\text{S Post} - \text{S Pre}}{\text{S maks} - \text{S pre}}, \qquad (1)$$

with S Post is the posttest score, S Pre is the pre-test score, and S maks is the maximum score.

The obtained normalized gain value was further interpreted to see the improvement of students' SPS in the learning of photosynthetic material. This interpretation is presented in Table 1.

Table 1. Interpretation of N-gain value.

Range	Category
$\langle g \rangle > 0.70$	High
$0.30 < \langle g \rangle \leq 0.70$	Medium
$\langle g \rangle \leq 0.30$	Low

Furthermore, the hypothesis was tested by conducting statistical test. Then, the posttest data were tested using normality and homogeneity tests carried out with the IBM SPSS Statistics program. The hypothesis was tested using the Mann-Whitney test where the calculations were carried out using the IBM SPSS Statistics program.

RESULTS AND DISCUSSION

This study tries to find out the students' SPS by applying home-based experiments in the experimental group and ordinary practicums in the control group. The implementation of home-based experiments is an alternative to science learning during online learning. Science learning should not be separated from practicum activities. The implementation of home-based experiments in online learning of science is to conduct practicum at home by students both individual and in groups. In this study, the implementation of home-based experiments as a treatment in the experimental group is carried out using tools that are easily accessible to students. As a control

group in this study, learning is carried out with ordinary practicum activities in the school's laboratory where the activities are carried out with full supervision and guidance of teachers.

Results

The results show that there are differences in the average pretest and posttest of SPS in the experimental and control groups. Table 2 shows the data of pretest and posttest results in the experimental and control groups. Table 2 also shows the average pretest and posttest scores in the experimental and control groups of students' SPS.

Table 2. Descriptive data of students' SPS.

No.	Test	Students	Minimum	Maximum	Range	Average	Std. Deviation
			Experimental group				
1	Pretest	26	7.69	69.23	61.54	33.73	17.68
2	Posttest	26	53.85	92.31	38.46	78.40	12.31
			Control group				
1	Pretest	25	15.39	69.23	53.85	36.61	13.36
2	Posttest	25	30.77	92.31	61.54	70.15	18.35

Table 2 shows the comparison of the difference between the posttest and pretest of the two groups. When viewed from the scores, the difference between the posttest average of the experimental group and the pretest average of the experimental group is 44.67. Meanwhile, the difference between the control group posttest and the control group pretest is 33.54. Thus, based on the difference in the average posttest and pretest scores, it can be concluded that the increase in the experimental group is higher than the control group Analysis based on the difference in posttest and pretest values is not enough to determine the criteria for improvement of each class. Therefore, N-Gain analysis of the experimental and the control groups is further carried out to determine the improvement criteria possessed by each class. Figure 1 shows N-Gain analysis results of both groups.

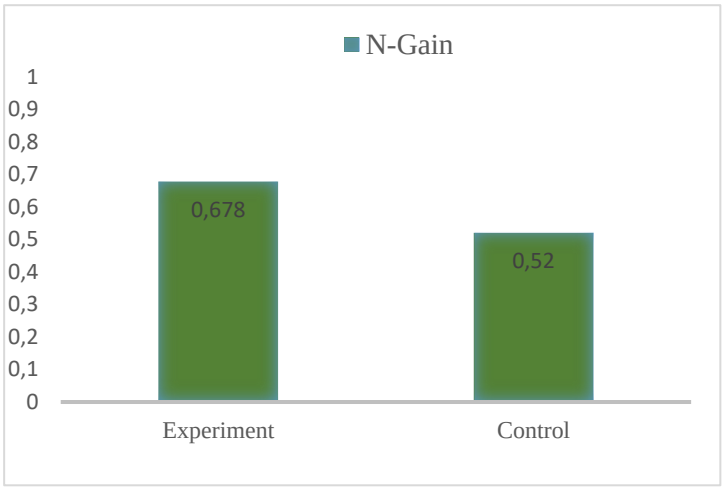

Figure 1. N-Gain of SPS.

Based on the figure, the results show that the N-Gain value of the experimental group is 0.678 while the N-Gain value of the control group is 0.52. Based on Table 1, it can be concluded that both the experimental and control groups have N-gain values in the medium category. However, viewed from the scores obtained, the N-gain value obtained in the experimental group is higher than the control group where the difference in N-gain value is quite large, i.e.: 0.158. In general, viewed from the N-gain score, it can concluded that the improvement of students' SPS with the implementation of home-based experiments is higher than the control group with conventional methods (ordinary practicum). Then, N-gain analysis for each indicators of SPS is presented in Table 3.

Table 3. N-Gain of each indicator.

No.	Indicators	N-Gain of Control	Criteria of N-gain Control	N-Gain of Experiment	Criteria of N-gain Experiment
1	Observing	0.8	High	0.95	High

2	Interpreting	0.61	Medium	0.64	Medium
3	Predicting	0.60	Medium	0.72	High
4	Communicating	0.67	Medium	0.79	High
5	Hypothesizing	0.62	Medium	0.71	High
6	Planning Experiment	0.26	Low	0.49	Medium
7	Applying concepts	0.29	Low	0.63	Medium
8	Asking questions	0.45	Medium	0.54	Medium
	Average	**0.53**	**Medium**	**0.68**	**Medium**

In Table 3, all indicators of SPS for the experimental group have higher N-gain values than the control group. Then, further analysis is conducted to see if there is a significant difference between the experimental and control group results. The follow-up analysis is a hypothesis test based on the posttest values in both groups. After a normality test, it is found that the posttest data of the experimental group is not normally distributed. So, hypothesis analysis is conducted with Mann-Whitney test. Furthermore, the decision-making for the Mann-Whitney test is seen from the Asymp sig value. (2-tailed) and obtained a value of 0.119. Because 0.119 > 0.05, it can concluded that H0 is accepted and Ha is rejected. H0 is accepted means that there is no difference in the average results of SPS in the application of home-based experiments and the application of ordinary practicum. Therefore, home-based experiments can be an alternative learning for teachers, both in online learning during the pandemic and as a variety of learning during the face-to-face learning process because home-based experiments have also been proven effective in improving students' SPS.

Discussion

SPS should become one of the priorities that students must master as a result of the learning process. SPS are not skills that can only be obtained by learning that tends to be passive, but skills that can be achieved by the application of meaningful learning. Meaningful learning means learning that makes students actively carry out the process and makes a good impression. As the impact, the process carried out in learning can be adapted by students to solve problems in their daily lives. SPS are one of the important skills that must be possessed by students in this 21st-century era. The development of technology, information, and communication brings massive changes in all aspects of life. Each individual must be able to adapt to the developments or even be part of the causes of that development. So, SPS are one of the things that are important to master so every individual can survive amid very rapid development.

The mastery of SPS by students can only be achieved with proper learning process. Skills in SPS consist of basic skills and integrated skills. Basic skills are the beginning and requirements for students to be able to master integrated skills. Many methods and models can be applied by teachers to increase student activities in learning, e.g.: project-based learning, problem-based learning, or inquiry models are among the recommended models as published in the 2013 Curriculum. The application of this model is recommended because the importance of mastering various skills by students as a result of learning. These models are considered to be able to encourage students to get used and master these skills. Especially in science learning, the use of these models should be the main choice rather than just lecturing and dictating as the science is knowledge to find out the facts, principles, laws, and theories of the phenomena that occur. Putra (2021) stated that teachers should apply creative learning to promote students' analytical abilities. So, in science learning, practicum should be an important part to be carried out by adjusting to the characteristics of the learning topic. In this study, the application of home-based experiments is a practicum activity carried out by students at home that supports the concept of active and meaningful learning. Therefore, this study tries to find out the effectiveness of the application of home-based experiments in improving students' SPS where the focus is on 8 indicators of SPS, namely observing, interpreting data, predicting, hypothesizing, communicating, planning experiments, applying concepts, and asking questions.

The N-Gain scores in both groups are adequate to illustrate that the application of learning methods in both groups provides an increase in learning outcomes for students, especially in SPS where the improvement of learning outcomes in both groups is the same in the medium category. Then, N-gain analysis for each indicator shows that the experimental group has a higher N-gain value compared to the control group for all indicators of SPS. Furthermore, based on the Mann-Whitney test on the posttest value, it concluded that there is no significant difference in posttest scores between the experimental and control groups. But, the N-gain score of the experimental group is higher than the

control group. Therefore, home-based experiments can be alternative learning for teachers, both in online learning during the pandemic and as a variety of learning during the face-to-face learning process because home-based experiments have proven effective in improving students' SPS.

The implementation of home-based experiments is an implementation of learning that demands the activeness and independence of students to carry out the practicum process in their respective homes, especially during the Covid-19 pandemic. Therefore, through the implementation of home-based experiments, students are required to carry out practicum activities independently in groups and solve every problem during the implementation of the activity. During the process of implementing a home-based experiment, students carry out activities such as formulating a problem, making hypotheses, collecting data, testing hypotheses, and formulating conclusions. Based on the N-gain value, the implementation of home-based experiments has a higher impact on improving students' SPS than the implementation of ordinary practicums. One of the things that support the improvement of students' SPS with home-based experiments is that the implementation of home-based experiments demands the independence of students in groups. Meanwhile, ordinary practicums are fully guided and directed by teachers in the laboratory. The implementation of a home-based experiment by utilizing materials and tools around students makes students more sensitive to the benefits of objects that are often encountered in their life.

The findings in the study generally show that learning by practicum can improve students' SPS. The results are in line with Sufiyanto and Hefni (2021), which is related to the analysis of the use of simple practicum to improve students' SPS during the pandemic. It was found that the application of simple practicum at home can improve students' SPS in several important aspects in the SPS indicators. Meanwhile, a similar study was also conducted by Tauhidah and Farikha (2022) in relation to the analysis of students' SPS during online practicum, i.e.: conducting practicum at home independently. It is obtained that students' SPS are in a good category. So, in general, it can be stated that home-based experiments or practicums at home are a good choice. In the end, science online learning during a pandemic can still be done meaningfully.

In relation to the practicum-based learning, many other studies have also revealed that practicum is proven to improve a SPS. A study has been conducted by Winarti and Nurhayati (2014) concerning project-oriented practicum learning to improve SPS and understanding the concepts. The research showed the practicum activities support students in mastering SPS. Meanwhile, Malik et al. (2015) conducted research related to the problem solving laboratory practicum model to improve students' SPS. The results showed that the practicum method can improve the SPS of students with a medium category. There are many other applications of practicum methods with various types of models that are proven quite effective in applying students' SPS. Therefore, in general, with a practicum, teachers can train students to perform SPS until they eventually become proficient and master the SPS.

The implementation of online practicum requires proficiency from teachers to determine methods that follow the topic being taught. Online practicum techniques during the pandemic are activities carried out by students in their homes or in groups by considering various things using tools and materials that are easily accessible to students around their environment. Also, this may be conducted with the help of practicum simulation videos. Qiang et al. (2020) stated that the practice carried out at home is only limited to safe activities and a short-term activity. Therefore, the selection of techniques may be adjusted by the teacher to the level of difficulty of the learning material and the availability of tools and materials that are easily accessible to students. Here, the skills of teachers are required in applying online learning with practicum, especially in science learning. Teachers must find alternative materials used in the practicum activities. So, by finding alternative practicum materials at home, students can do the practicum in a safe way. In addition, the use of tools and materials available at home can make students more familiar with the knowledge being studied. Then, it may become a meaningful learning process for students because it is related to the use of materials and tools that have been understood for their function and use in their daily lives. Apart from the disadvantages and advantages of implementing independent practicum at home by students, this practice should still be an option for teachers in science learning even in online learning process. Practicum, which is the identity of science learning, should not be eliminated.

CONCLUSION

Science learning cannot be separated from practicum activities. The outbreak of the Covid-19 pandemic has shifted the learning process to the implementation of online learning. Practicum activities should still be carried out to support maximum learning outcomes in science learning,

such as improving students' SPS. Based on the N-gain value, the experimental group has a higher value than the control group. So, the implementation of home-based experiments in the learning process can improve students' SPS. Therefore, home-based experiments should be an option for teachers in science learning because, even though the learning process is carried out online, the practicum should not be eliminated. Here, skills of teachers are required in applying online learning with practicum, especially in science learning. Teachers must find an alternative materials used in practicum activities so that activities can still be carried out. It is important for the government, especially related agencies, which are the main stakeholders to improve teacher competence, namely by conducting measurable programs for the development of teacher abilities so that they can adapt in all conditions.

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