

The relationship between science process skills and biology learning outcome

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Abstract: The study aims to know the relationship between science process skills (SPS) and biology learning outcomes (LO) through inquiry-based learning in the class XI MIA Senior High School of State 01 Manokwari. The correlational method was employed in this research. The population in the study was students of class XI MIA High School at Manokwari. The samples in the study were class XI MIA 2 and XI MIA 4, with a total of 47 students. The sampling technique in this research was purposive sampling. Data collection techniques used tests and documentation. The hypothesis test used regression and correlation tests. The results showed a contribution of SPS to the biology LO through inquiry-based learning in the class XI MIA High School of Manokwari. The relationship of LO to biology student LO was 31%. The correlation coefficient is 0.557, indicating that the SPS level to the biology student LO was medium.

Keywords: Inquiry learning, biology learning outcome, science process skills

Hubungan antara keterampilan proses sains dan hasil belajar biologi siswa

Abstrak: Penelitian ini bertujuan untuk mengetahui kontribusi keterampilan proses sains (KPS) terhadap prestasi belajar biologi siswa melalui pembelajaran berbasis inkuiri pada siswa kelas XI MIA SMA Negeri 01 Manokwari. Metode yang digunakan dalam penelitian ini adalah metode korelasional. Populasi penelitian adalah siswa kelas XI MIA SMA Manokwari. Sampel dalam penelitian ini adalah siswa kelas XI MIA 2 dan XI MIA 4 yang berjumlah 47 siswa. Digunakan teknik purposive untuk menentukan sampel penelitian. Teknik pengumpulan data menggunakan tes dan dokumentasi. Uji hipotesis menggunakan uji regresi dan korelasi. Hasil penelitian menunjukkan bahwa ada hubungan antara KPS dengan prestasi belajar biologi siswa melalui pembelajaran berbasis inkuiri pada siswa kelas XI MIA SMA Manokwari. Kontribusi keterampilan proses sains terhadap prestasi belajar biologi siswa sebesar 31%. Koefisien korelasi sebesar 0,557 menunjukkan bahwa tingkat kaitan KPS terhadap prestasi belajar biologi siswa adalah sedang.

Kata Kunci: Pembelajaran inkuiri, Hasil belajar biologi, keterampilan proses sains

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INTRODUCTION

Improvements and developments in the learning process, especially science subjects, must be carried out, both by teachers and all parties directly involved in implementing education in Indonesia. The objectives of implementing science include other motivations, strengthening theory, developing manipulative skills, and understanding data handling (Erduran et al., 2020). Science teaching must consider the way children create and express the meaning of the learning that they get (Varelas et al., 2015). When learners are allowed to communicate scientific phenomena, it mediates the development of emerging science concepts (Larsson, 2016). Retelling investigates, documents the discovery process, and expresses understanding of science learning (Siry & Max, 2013). Teachers in the classroom can offer different conditions for students to express their knowledge (Siry & Gorges, 2020). It is because science, especially biology, plays a vital role in everyday life. Thus, student skills must be empowered. Students who have different cognitive skills will master other process skills (Ceran & Ates, 2020)

Biology is a part of natural sciences that systematically examines how natural phenomena can be discovered. It not only controls the collection of knowledge in the form of concepts, a fact, or principles but needs scientific process know-how. Global challenges must be solved, and to overcome these challenges, process skills are required (Abungu et al., 2014). Biology learning is carried out scientifically to foster the skill to think, work, and communicate and behave scientifically. The biology learning process has process skills that include observing, formulating problems, hypothesizing, communicating, and making conclusions (Damopolii et al., 2020).

Pre-existing concepts may be found by using science process skills (SPS), which are all directed scientific skills (both psychomotor and cognitive ability) that can be utilized to locate them or to refute an invention or classification; in other words, these skills can be used as a vehicle for the discovery and development of concepts, theories or principle. These concepts, ideas, or principles that have been discovered or developed will strengthen the understanding of these process skills (Trianto, 2012). Losing SPS causes students to be unable to process their knowledge and collect relevant knowledge to answer questions (Shahali et al., 2017).

According to Nunaki et al., (2020), SPS is critical to be practiced in the instruction and learning process because of the acceleration of scientific change and facing the challenges of the problem. In overcoming the problem, it is necessary to develop skills to acquire and process all facts, concepts, and principles in students so that students can practice always ask questions, think critically, develop physical and mental skills as well as a vehicle for unifying concept development with the development of attitudes and values that are important as provisions for the challenges in the era of globalization. However, the reality in schools of SPS in learning biology has not been well measured. There are still many teachers who have not trained and developed the SPS of their students.

Based on the results of our observations in class XI science of SMA Negeri in Manokwari, several obstacles were found in the biology learning process including, students' SPS have not been measured properly, there is still a lack of variation in the application of learning methods, and models, the learning process uses discussion methods more which does not facilitate students to develop SPS through discovery and direct experience. This impacts the low level of students' SPS which causes the level of concept

mastery to be reduced—lack of mastery of concepts resulted in common student learning outcomes (LO).

One of the efforts that can be implemented to develop SPS and improve student LO is to use the inquiry learning model. Inquiry learning activities are aimed at increasing students' ability to use process skills by formulating questions that lead to investigative activities, hypotheses formulate, collecting and analyzing data, and formulating conclusions (Damopolii et al., 2019; Jauhar, 2011). According to Sanjaya (2013), the inquiry learning model is a set of activities for acquiring knowledge and skill that stress analytical and critical thinking processes to explore and discover solutions to an issue of interest. The actual thinking process is often carried out via questions and responses between the instructor and the pupils. When we say inquiry model, we are referring to a set of learning activities that maximize the involvement of all students' skills to seek and examine in a systematically organized, critical, reasoning, and analytical manner, so that they may confidently articulate their discoveries (Damopolii et al., 2015).

Experiments on enzymes in biology learning make students experience conceptual changes (Vartak et al., 2013). Conventional education does not make students' SPS develop (Durmaz & Mutlu, 2017). The process of student investigation includes process skills (Lederman et al., 2013). Teachers consider that SPS is needed, such as observing and controlling variables (Molefe & Stears, 2014). The development of students' SPS leads to high student learning achievement (Diana et al., 2020). Learning activities that optimize student activities make students' SPS develop and impact students' learning achievement. There is a need to empower students' SPS (Harrison, 2014).

SPS has a relationship with student learning outcomes of 0.475, and their contribution is 22%. (Sari et al., 2018). Other researchers found that the contribution of SPS to learning outcomes was 55.7% (Damopolii et al., 2019). SPS enables students to solve problems, think critically and understand science concepts (Candrasekaran, 2014; Gillies & Nichols, 2015). Students need SPS to start the investigative process (Çakir & Sarikaya, 2010; Hodosyová et al., 2015). When students are ready with SPS, learning objectives can be achieved, and student learning outcomes improve (Ilma et al., 2020). SPS relationship to enhancing learners' understanding of the material through investigative activities (Cigrik & Ozkan, 2015; Sukarno et al., 2013).

According to the above description, it can be said that SPS is related to student learning outcomes. Optimal student learning outcomes because their SPS are well empowered. Therefore, this research aims to examine the relationship of SPS to the biology learning outcomes of students.

METHOD

The method used in the research is the correlational method because this research studies facts that already exist or have occurred. The population in this study were students of class XI MIA in one of the public high schools in Manokwari, with 319 students. The sample is 47 students. The design of the research is as follows:

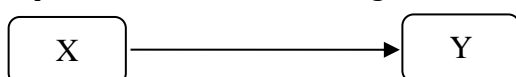


Fig. 1 Design of research

Note:

X = SPS

Y = learning outcomes

The instruments used in the research are learning outcomes tests and SPS tests. The instrument to be used was previously validated to find out whether the instrument that had been made met the validity by asking for an assessment from experts and practitioners, namely three lecturers and three people. The test is used to obtain data about student LO and SPS. Learning outcomes tests and SPS tests were given after the inquiry learning model was applied. The exam utilized is a written test consisting of a description of 12 items used to assess learning outcomes and ten items used to assess scientific process abilities. The indicators measured in SPS are observing, formulating problems, communicating, hypotheses formulate, measuring, and formulating conclusions.

The following is each indicator of basic and integrated SPS that will be investigated.

1. Observing; Observation is the use of the senses to amass data about an object or phenomena.
2. Formulate the problem; Formulating the problem is done by asking what, how, and why questions, asking for explanations, or asking questions that have a hypothetical background.
3. Develop hypotheses; A hypothesis is a proposed explanation for a series of observations or responses to a scientific inquiry (Nur, 2011).
4. Experimenting; when it comes to experimentation, it is the ability to conduct treatment, including asking the relevant questions, expressing hypotheses, identifying and controlling variables, design experiments, defining operational variables, conducting investigations, and interpreting the results of those experiments.
5. Measure; measuring is comparing an object or process against a standard.
6. Communicate; when communicating, words or visual symbols explain an action, item, or phenomena.
7. Data interpretation; Data interpretation is recording each observation, connecting the observations, finding regular patterns from a series of observations, and concluding them.

Prerequisite tests include normality tests, used to convey whether the data is normality or unnormal, which is a requirement to determine the type of statistics used in subsequent analysis—testing the normality of the data using the One-Sample Kolmogorov Smirnov Test at $\alpha = 0.05$ with the normality test if sig. < 0.05 , then the data decision is meets normality. The test was carried out using the SPSS 22 program. Based on the necessary examination, if the data were regularly distributed, a hypothesis test was conducted to see how much the contribution of SPS to biology learning outcomes in inquiry-based learning. The test uses regression analysis with the help of SPSS 20.

RESULTS

Normality data test results

To determine the contribution of SPS (variable X) to students' biology learning outcomes (variable Y) using regression and correlation tests. Before the regression and correlation tests, a prerequisite test was conducted, namely the normality test of the data

on SPS and learning outcomes using the One-Sample Kolmogorov Smirnov on the SPSS 22 for windows program. The data used is residual data.

Table 1. Result of normality

Data	Sig. (2-tailed)	α	Decision
Residual	0,808	0,05	Normal distribution

Based on the data in Table 1 above, the significance value is 0.808, where it is more significant than (0.05) than the data research was a normal distribution. Based on the decision that the data were normally distributed, it can be continued with regression and correlation tests to test the research hypothesis.

Hypothesis test

Table 2. Linear Regression Test

Model	Koefisien Unstandardized		Sig.
	B	Standard error	
Constant	3,354	8,708	0,702
Science process skill	0,700	0,156	0,000

Based on Table 2, it can be seen that the regression equation model of Y over X is = $3.354 + 0.700x$. The regression model shows that everyone increase in SPS (SPS) scores will increase students' Biology learning outcomes by 0.700 at a constant of 3.354. Based on Table 2, the significance value obtained is 0.000 where the significance value is <0.05 , meaning that the regression coefficient is significant, then the equation model of regression can still be used.

Table 3. Results of ANOVA Test

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	7696,030	1	7696,030	20,235	0,000
Residual	17114,598	45	380,324		
Total	24810,628	46			

Based on Table 3, the significance value obtained is 0.000 0.05, which means that the regression is linear. Then the regression equation model can be used to predict the biology learning outcomes of students.

Table 4. Summary of Model

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0,557	0,310	0,295	19,502

Based on Table 4, It is noticeable that SPS (variable X) has a contribution to students' biology learning outcomes (variable Y). The coefficient of determination (R square) value is

31%, indicating that SPS contributes 31% to students' biology learning outcomes and factors outside science process skills influence the other 69%. Based on the data in table 4, SPS contributes to the biology learning outcomes of students. The correlation coefficient value is 0.557, which indicates that SPS contributes to students' biology learning outcomes with moderate levels.

DISCUSSION

The research aims to see how big the contribution of SPS to the biology learning outcomes of students in inquiry-based learning. The research data consisted of data on SPS and students' biology learning outcomes on the material of the humanitarian coordination system. Data on SPS and biology learning outcomes were obtained through tests, where ten items were used to measure SPS, and 12 questions were to measure student learning outcomes. Aspects of SPS measured include observing, formulating problems, making hypotheses, measuring, communicating, and developing conclusions.

Based on the results calculated of the regression test between SPS and biology learning outcomes, the regression equation model was obtained, namely $= 3.354 + 0.700x$. The regression model is linear with a significance of 0.00, which is less than 0.05 so that the regression model can be used to foretell the biology learning outcomes of students. The regression model shows that an increase will follow each rise in a science process skill score in students' biology learning outcomes scores of 0.700 at a constant of 3.354. Specifically, it showed that learners with higher SPS scores had better results in terms of LO. However, this linear regression equation model is not significant. This model is because the significance value of 0.702 is more significant than 0.05. Although the regression equation model is not significant, variable X, namely science process skills, can still predict variable Y, namely student learning outcomes.

Furthermore, to determine the contribution of SPS to biology learning outcomes, the coefficient of determination is 31%. The K_d value shows the large influence of the X variable (scientific process skills) on the Y variable (learning outcomes), which is 31%. So it can be said that SPS contributes to the biology LO of class XI MIA students at SMA Negeri Manokwari. However, the factors that affect student learning outcomes are SPS, but other factors outside of SPS can also affect learning outcomes, affecting 69%. In line with the research that has been carried out by Anggraini et al., (2016) also stated that there is a relationship between SPS and concept mastery of 0.689, and the contribution of SPS to concept mastery is 47.5%.

The magnitude of the contribution of SPS to biology learning outcomes cannot be separated from the use of the inquiry teaching model. Because in inquiry-based learning, learners are trained to work scientifically through learning steps in the inquiry learning model. Students are introduced to observe, formulate problems, make hypotheses, test hypotheses, communicate, and formulate conclusions (Nunaki et al., 2019). Students' activities in conducting investigations can develop students' science process skills.

The first is observing, where students make observations through seeing, reading, and hearing things important from an object or object. Second, formulating the problem, students are asked to ask questions about the problem or what has been seen, read, listened to, or heard in human coordination system material. Third, make a hypothesis; a hypothesis is a temporary guess from the formulation of the problem that has been made. When asked

to make a hypothesis, a curiosity will arise whether the hypothesis that has been made is correct. Interest is what will encourage students to be active in conducting experiments. Fourth, test the hypothesis where students answer questions based on the results of experiments that have been carried out so that it can be seen whether the hypothesis that has been made is right or wrong. Fifth, namely, communicating where students write or tell the results of experiments that have been carried out to be responded to by other students—retelling the investigation, documenting the discovery process, and expressing understanding that is science learning (Siry & Max, 2013). The sixth is formulating conclusions, and students conclude the experiment results based on the objectives to be achieved in the study and conclude whether the hypothesis is accepted or rejected. A series of learning steps in the inquiry model will train and develop students' SPS.

Based on the correlation test, SPS contributes to the biology LO of class XI MIA students at SMA Negeri Manokwari. The correlation coefficient is 0.557, indicating that the level of contribution is moderate, and SPS has a positive correlation with learning outcomes. These findings are in line with the study presented by Najmah et al., (2014), which also found that SPS in the colligative properties of solutions positively correlates with learning outcomes. The same thing was also said by Khairi et al., (2016) that there was a positive relationship between SPS and student LO. Other researchers also revealed a connection between SPS and LO (Sari et al., 2017; Rizal, 2014). SPS supports student achievement in science learning, especially in biology learning. Learning activities that empower students' SPS will impact students' LO. The better the student's SPS, then the student's LO follows and vice versa.

Students with high SPS can carry out experiments well to understand the material taught through the implementation of experiments. It impacts learning outcomes; namely, learners with high SPS will have better learning outcomes than learners with low science process skills. According to Nirwana et al., (2014), inquiry-based learning is effective for growing students' SPS. If SPS increase, it will have an impact on increasing learning outcomes. Through SPS, the concepts obtained by students become more meaningful so that their way of thinking will be more developed. Students can understand biological concepts through science activities such as science process skills (Güler & Şahin, 2019). Najmah et al., (2014) also stated that SPS makes students creative, active, and skilled in acquiring abilities. Through the process skills possessed, students can hone their mindset so that they can bolster learning outcomes.

CONCLUSION

Based on the research data analysis results, it can be concluded that SPS contributes to the biology learning outcomes of students. The contribution of SPS to students' biology learning outcomes is 31%. The correlation coefficient is 0.557, indicating that the contribution level of SPS to biology learning outcomes is moderate. The empowerment of SPS must continue to be optimized because it is related to the increase in student learning outcomes. The weakness of students' skills causes their weak learning outcomes.

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