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The effectiveness of Problem Based Learning Model on Virus Material of Senior High School on Science Process Skills and Student Learning Outcomes

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Abstract

Student learning outcomes at Pemalang 2 High School are still low students are less actively involved in learning activities. This is because Biology learning applied by the teacher still uses the lecture model. In this learning model, the teacher has not developed science process skills (SPS). One learning model that can be applied to improve SPS and student learning outcomes is problem-based learning. The purposes of this study are to determine the differences in student learning outcomes in virus material, to determine the effect of the application of problem-based learning models to student SPS, and to test the effectiveness of problem-based learning. This research is a quasi-experiment with nonequivalent control group design. The research sample is determined by purposive sampling. Data collection is done by test, observation, and questionnaire methods. The results show that the percentage of students classical completeness in the experimental class reach 88% while the control class is 72%. The results of the t_{test} show t_{count} = 2.80> t_{table} = 1.99 so that there is a difference in learning outcomes increase in the experimental class. The N-gain test shows the N-gain value of the experimental class 0.62 and the control class 0.52. The improvement of students' understanding in the experimental class was better than the control class. Student's SPS increase is directly proportional to student learning outcomes. Based on the results of the study, it is concluded that there are significant differences from the learning outcomes of the control class and experimental class. The application of problem-based learning has a positive influence on student SPS and problem-based learning is effective in student learning outcomes.

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INTRODUCTION

Curriculum 2013 is a curriculum that applies to the current education system and is designed to improve the quality of education in Indonesia. The basic view of the 2013 curriculum is that students are subjects who have the ability to actively seek, process, construct and use knowledge on an ongoing basis. Learning like this is better known as the scientific learning method. In this approach, students are required to play an active role in the learning process and the teacher as a facilitator (Hosnan, 2014).

Through preliminary observation, Biology learning activities at SMAN 2 Pemalang uses the varied lecture learning model. However, the teacher has not invited students to develop science process skills. Science teachers are suggested to emphasize student learning on science process concepts and skills rather than just memorizing facts or information (Wirda et al. 2015). In line with this, the 2013 curriculum can be implemented using science process skills that have the objective, factual, systematic, accurate, logical, actual and verified characteristics (Zaim, 2017). Science process skills are a process that is able to develop a number of certain skills in students so that they are able to process the information received, thus helping students develop their own facts and concepts and foster attitudes and values in the learning process (Lete et al. 2016).

Virus material is closely related to life and everyday problems. Basic competencies regarding virus material require students to be able to analyze the structure, replication, and role of viruses in life and to campaign about the dangers of viruses in life, especially the dangers of AIDS based on virulence levels (Permendikbud No. 24, 2016). The selection of learning models is one of the most decisive parts in creating innovative learning that can improve students' science process skills. According to Fauziah et al. (2013) in problem-based learning, students are required to actively get concepts that can be applied by solving problems, students will explore the concepts they must master, and students are activated to ask questions and argument through discussion, sharpen their investigative skills, and undergo other scientific work procedures. Research on Hardiyanto et al. (2015) explains problem-based and expository learning can improve science process skills and student learning outcomes in MTSN 1 Mataram.

Learning is said to be effective if the learning process goes well, in accordance with the learning objectives and learning outcomes. Learning outcomes are one indicator of the success of students to achieve the wanted goals because in each learning will definitely produce learning outcomes (Sutrisno & Siswanto, 2016). Learning outcomes are focused on cognitive aspects that are determined through the results of the pretest and posttest values. Assessment of cognitive aspects of learning outcomes is an assessment conducted by the teacher to measure the level of achievement or mastery of students in aspects of knowledge including knowledge, understanding, application, analysis, evaluation, and creation. Student learning outcomes are said to be optimal if the experimental class learning outcomes are higher than the control class with classical completeness ≥85% of KKM 70 (Trianto, 2011). Based on the background above, the study is conducted to determine the effectiveness of the problem-based learning model of high school virus material on science process skills and student learning outcomes.

RESEARCH METHOD

The method is quasi-experiment with nonequivalent control group design research design. The population of this study is all students of class X MIPA SMAN 2 Pemalang 2018/2019 which consisted of six classes. The research sample is determined by purposive sampling and is based on the choice of the teacher, which are class X MIPA 2 as the control class and class X MIPA 6 as the experimental class. The data of this study are student learning outcomes that are focused on cognitive domains, scores of students' science process skills and supported by student response data and teacher responses. The pretest and posttest data of experimental and control classes are used to analyze differences in learning outcomes. Based on the initial data (pretest) that have been obtained then analyzed by the average difference test (t_{test}). Before calculating the t_{test}, the homogeneity test and the normality test are carried out as a pre-test. After problem-based learning is carried out and the final data (posttest) is obtained, the same test is carried out with the initial data. Process skill score data are obtained through observation activities based on the observation sheet and the rubric that is done when the learning activities take place. Student response data and teacher responses are obtained by questionnaire.

RESULTS AND DISCUSSION

The differences of Learning Outcomes on Virus Material between the Control and Experimental Classes

The results of the analysis show that the pretest data values of the two classes have the same or homogeneous variants. Then the normality test is carried out in both classes which showed normal distribution data. The data is presented in the following table 1

Table 1 The results of homogeneity and normality test of experimental and control classes pretest score.

No	Classes	Pretest	
		Sig. Homogeneity	Sig. Normality
1.	Control	0,855	0,077
2.	Experimental	0,855	0,057

After completed the prerequisite test, proceed then with the t_{test} which can be seen in table 2

Table 2 The results of t_{test} of pretest experimental and control classes pretest score.

Classes	Mean	Df	α	t_{count}	t_{table}
Control	44,67	70	0,05	0,716	1,99
Experiment	43,67	70	0,05		

From the results of the t_{test}, there are no significant differences between the control class and the experimental class. This is in accordance with the goal that the control class and experimental class depart from the same starting point or in other words have the same knowledge-ability. After conducting the analysis of the initial data, the final data analysis (posttest) is carried out then. The results of the analysis show that the posttest value data of both classes have the same or homogeneous variant. Then the normality test is carried out in both classes which showed normal distribution data. The data is presented in the following table 3.

Table 3 The results of homogeneity and normality test of experimental and control classes pretest score.

No	Class	Posttest	
		Sig. Homogeneity	Sig. Normality
1.	Control	0,244	0,068
2.	Experimen	0,244	0,119

After completed the the prerequisite test, proceed then with the $t\text{-}_{test}$ which can be seen in table 3.

Table 4 The result of $t\text{-}_{test}$ of experimental and control classes posttest score.

Class	Mean	Df	α	T_{count}	t_{table}
Control	73,67	70	0,05	2,802	1,99
Experimental	78,67	70	0,05		

From the results of the t_{test} of the experimental class learning outcomes are higher than the control class. This proves that learning virus material with a problem-based learning model gives a significant difference to student learning outcomes. In line with the results of research by Farisi et al. (2017) that applying problem-based learning has a significant influence on student learning outcomes.

Learning outcomes obtained are closely related to problem-based learning activities that have been applied. Problem-based learning activities can develop students' thinking skills because students are faced with contextual problems that are often encountered in everyday life as the initial concept of learning. By presenting contextual problems as the focus of student learning such as cases of diseases caused by viruses, the method of transmission of the disease and how to prevent it can make it easier for students to apply what is obtained in the classroom and associated with everyday life. Johnson (2007) states that in contextual learning students use facts in the learning process so that the benefits of the process are obtained. The use of contextual problems in learning activities can help the original learning only the transfer of knowledge from teacher to student into student-centered learning.

The role of the teacher is only as a facilitator when students experience difficulties. According to Agung (2017) argues that the role of the teacher as a facilitator is to help students who have difficulty understanding their learning so that they can achieve learning goals. In addition to helping students who have difficulty, the teacher also gives students the opportunity to build their own knowledge while utilizing their knowledge to solve actual problems that exist in the surrounding environment. Learning carried out in the control class tends to be teacher-centered, meaning students gain knowledge from the transfer of knowledge delivered by the teacher during learning. Such learning makes students lack learning experience. According to Aqib (2013), the lecture method can be used by the teacher to provide direction at the beginning of learning, but it needs to be varied with other methods. This is one of the causes of student learning outcomes in the control class is lower than the experimental class. The success of the implementation of problem-based learning in virus material is also evidenced by the completeness of the classical experimental class that exceeds the classical completeness standard delivered by Trianto (2011) that a class is said to be thoroughly studied if ≥ 85% of students in the class have completed their learning classical completeness (70). The results of classical student learning completeness can be seen in table 5 below.

Table 5 The result of Students Classical Completeness

Criteria	Control Class	Experiment
Students Number	36	36
Highest score	88	92
Lowest score	60	64
Completed	26	32
Incompleted	10	4
Classical Completeness (%)	72	88

The classical completeness of the experimental class in learning virus material reached 88% of 36 students, meaning that there are 32 students in the experimental class who had completed their studies and 4 other students had not yet finished their studies. Factors that are thought to be the cause of some students do not complete their learning outcomes, which is students are still not familiar with the problem-based learning model. Students are also still having difficulty in finding problem-solving solutions and the many scientific terms that exist in virus material. This is because the biology learning that they have experienced so far tends to be more centered on the handbook and is merely a transfer of knowledge from teacher to the student so that students are less actively involved in the learning process.

Student Science Process Skills

Data collection for the analysis of science process skills was carried out in the experimental class with 36 students. Assessment activities use the observation method when learning activities take place. The assessment of science process skills is divided into two, namely basic science process skills and integrated science process skills. Assessment of basic science process skills is carried out in two meetings of learning activities. The aspects of basic science process skills that are assessed include the skills of observing, interpreting, classifying, predicting and communicating.

Based on the results of observations that have been made during the first learning meeting and the second learning meeting there is an increase in students' basic science process skills. This can be seen in figure 1.

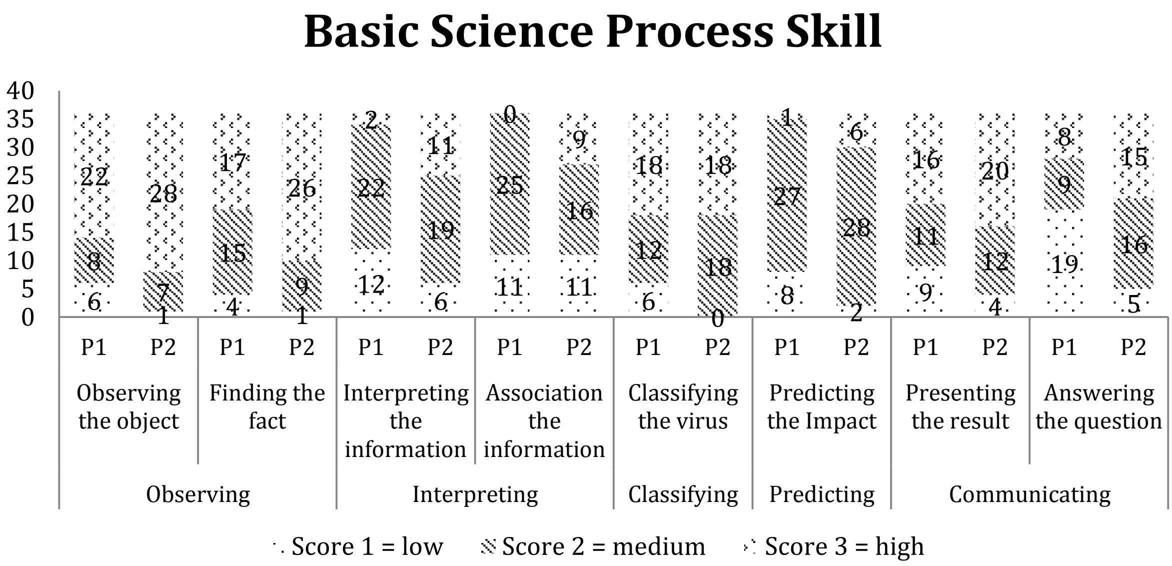

Figure 1 Basic Science Process Skill Graph for Experimental Class Student

Based on the graph, almost all aspects experienced an increase in the number of students in each score. But there are indicators whose graphs do not increase, such as graphs on aspects of classification skills. The number of students who get a score of 3 does not increase, this is because students' initial knowledge of the virus material is still lacking, so students have difficulty analyzing the similarities and differences in viruses with the criteria specified in the student discussion sheet. However, on the aspect of observation and communication aspects experienced a fairly good improvement. 50% of the number of students have achieved score 3 on the observation aspect and the aspect of communicating the indicator conveys the results of the discussion, then on the aspect of communicating the indicator answering the question the number of students who score 1 at the first meeting decreases at the second meeting. This is because at the first meeting students tend to be passive in learning activities, but at the second meeting, students become more active in answering questions. The increase in basic science process skills in each aspect can be seen in Figure 2.

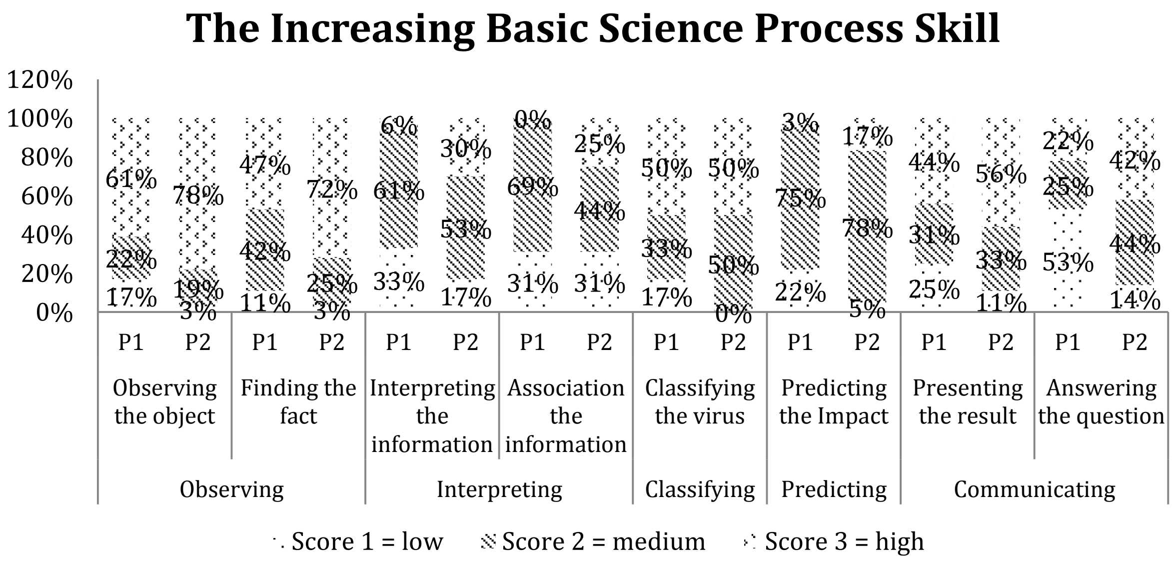

Figure 2 Basic Science Process Skills Graph Experiment Class Students

In the graph, there is a large increase in the score of basic science process skills in each aspect. The highest increase is in the aspect of communicating, then the aspect of observing, aspects of interpreting, aspects of predicting and the lowest increase is the classification aspect. The communication aspect has the highest increase, this is because the teacher gives the opportunity to students to express their opinions in the discussion process so that at the second meeting students are more confident in communicating the results of the discussions that have been conducted and answering the questions asked. Students become more active in the second meeting so there is an increase in the score on communication skills. In line with the research of Handayani et al. (2016) that the syntax of problem-based learning applied in the LKS, namely developing and presenting results also encourages students to be confident and skilled in communicating both verbally and in writing.

Improvement in observing aspects are supported by the presence of virus material through visualization of images and videos so students are directly involved in observing objects and finding relevant facts. In line with the research of Wesson (2011) that there are several ways to improve students' observation skills by presenting photos or illustrations in the surrounding environment. Improvement in the interpreting aspect is caused by problem-based learning students are trained to interpret the concepts of viruses that are learned with the knowledge they already had. This is consistent with the study of Zaim (2017) that interpreting is the ability to analyze and associate information obtained and find a relationship between one information and other information so that conclusions can be drawn. But some students still have difficulty interpreting.

The ability to predict students also increases, students are able to predict the effects caused by viruses based on the learning experience they get. They can also see clearly from the impacts that are caused, for example, some diseases such as flu and chickenpox caused by viruses. In accordance with the research of Handayani et al. (2016), the direct learning experience will be more memorable for students in building their knowledge.

Increasing classification skills is the lowest, this is because students find it difficult to find differences and similarities based on the criteria specified in the student discussion sheet. Students should often be trained to classify learning activities. This is in accordance with the opinion of Lutfa et al. (2014) that the ability to classify the better at each meeting shows that science process skills can grow well if students are accustomed to the practice. From the graph, it can be concluded that problem-based learning in virus material has a positive influence on students' basic science process skills.

In basic science process skills, there is one indicator in the aspect of communicating, which is only carried out only once, namely an indicator of carrying out a poster-assisted campaign on HIV / AIDS. On this indicator, only one assessment is carried out at the end of the lesson because it is not possible to do an assessment at each meeting. The aim is to determine the ability of students to carry out campaigns on the dangers of the HIV virus that can cause AIDS. From the results of the assessment can be seen students who get a score of 1 amounted to 9 people, who get a score of 2 totaling 11 people and a score of 3 amounting to 16 people. The results of this assessment indicate that on indicators of campaigning students already have good science process skills. The results of observations of indicators to carry out campaigns can be seen in full in figure 3.

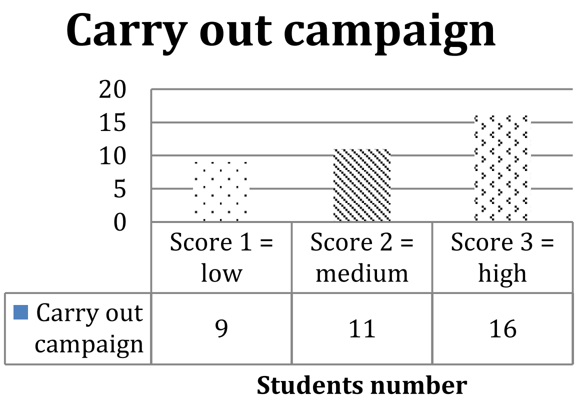

Figure 3 Graphic of Basic Science Process Skill communicating aspect of indicators carry out campaign

The assessment of integrated science process skills is carried out only one meeting, which is at the second meeting. The integrated aspects of science process skills include skills in determining variables, designing experiments, formulating hypotheses and interpreting data. The results of the observation of the assessment of integrated science process skills are presented in Figure 4.

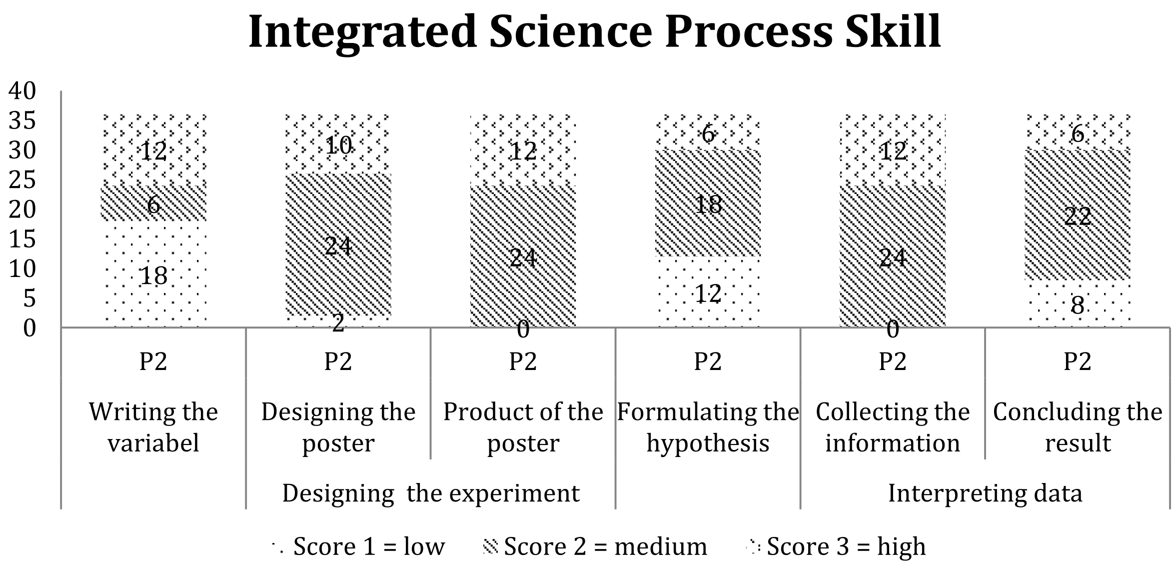

Figure 4 Graphic of integrated science process skills of experimental class students

Figure 4 shows that scores of integrated science process skills of students vary in each aspect. In the aspect of writing variables, as many as 18 students get a score of 1, these results are not good enough. This also occurs in the aspect of formulating a hypothesis. Twelve students received a score of 1. The score obtained from both aspects is caused by many students who do not understand the variables and hypotheses that should have been taught in the biological scope material, so students were still wrong in writing variables and formulating hypotheses in the cases presented. In the aspect of designing the experiment, there are two indicators; they are designing posters and poster products. The observation results in designing aspects of the experiment showed quite good results. Students are able to design posters and succeed in making poster products in accordance with the designs previously made. The poster is used for campaigns related to the dangers of AIDS. The score on the aspect of interpreting the data is also quite good, for indicators seeking information students have begun to independently active look for information needed to solve cases, while the indicators conclude that student outcomes are also quite good, but still need to be improved. According to Capay (2013) that steps are integrated scientific methods which include designing experiments, testing hypotheses and making conclusions able to improve science process skills. From the four aspects of integrated science process skills students aspects of designing experiments on poster product indicators and aspects of interpreting indicator data to collect the best information.

Science process skills have relevance to learning outcomes obtained by students. This is because during the learning process the problem-based learning model that applies scientific skills in solving problems presented will have an influence on student learning outcomes. If the score of science process skills is high, the learning outcomes obtained are also high, and vice versa. The correlation of science process skills with student learning outcomes can be seen in the following figure 5.

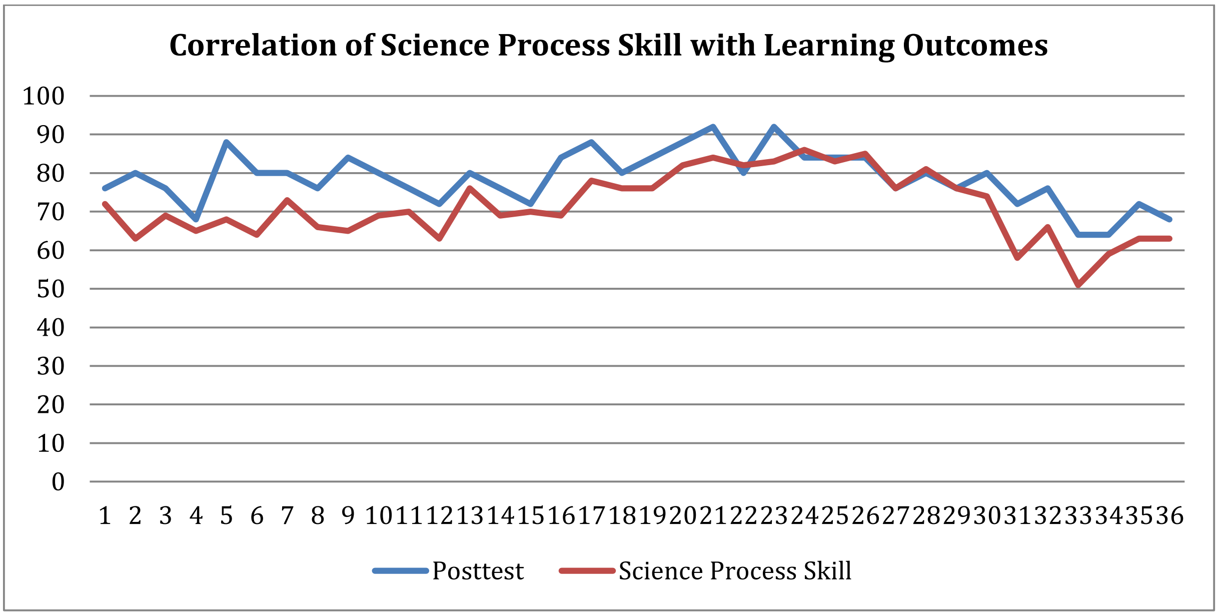

Figure 5 Graphic of correlation of science process skills student learning outcomes

From the results of the drawing 4 students who scored high science process skills also had high learning outcomes, while if the score of the process skills was low the learning outcomes were also low. This is in accordance with Rustaman (2003) that science process skills of students also involve cognitive, manual and social skills, so that the higher the score of students 'science process skills, the higher the students' understanding of the material can be proven by increasing student learning outcomes. Although there are some students who score higher science process skills the difference is very little with the learning outcomes. This can be seen in the graph with the student code B-22, B-24, B-26, and B-28, then students with code B-27 and B-29 get the same learning outcomes and science process skills. Factors that cause these things are students who lack focus in participating in learning activities, activities and learning comprehension of different students and psychological factors of students.

The Effectiveness of Problem-Based Learning on Science Process Skills and Learning Outcomes

The effectiveness of problem-based learning on science process skills and student learning outcomes can be analyzed through the analysis of the results of the pretest and posttest of the control class and experimental class using the N-Gain test. The experimental and control N-Gain test results are presented in table 7

Table 7 Number of students in the control and experimental classes based on the obtained N-gain category

Classes	N	N-Gain Category			N-Gain average	N-Gain increase
		High	Medium	Low		
X MIPA 2 (Control)	36	4	29	3	0,52	16%
X MIPA 6 (Experimental)	36	7	31	0	0,62	

Based on table 7, N-gain experimental class is better than the control class. The N-gain test results show that the increase in students' understanding of virus material in the experimental class was better than the control class. This means that the application of problem-based learning to virus material has an influence on increasing student understanding. The increase understanding of students with problem-based learning is because this learning makes it easier for students to find the concept of a virus. It is also the clear procedures to understand the concept of viruses and their application in solving problems. Muslim et al (2015) also gave the same opinion, that the application of problem-based learning can improve the mastery of students' concepts in each subject taught.

Students and Teacher Response

Supporting data contained in this study include the form of student responses to problem-based learning that has been implemented. Based on the results of the questionnaire students' responses showed that students had felt the positive aspects that existed in the problem-based learning model on virus material. This is shown in problem-based learning to get the percentage results of the average student response which was 74.64 in the good category. Learning that has been carried out makes the learning environment more lively and enjoyable. In accordance with the opinion of Hamalik (2008) which states that teachers need to create a pleasant and supportive classroom atmosphere to generate motivation for students to achieve learning goals.

From the results of student responses, problem-based learning in virus material is more influential to train students to work together in groups. Learning activities emphasize the activities of students in group discussions to solve problems. Students exchange opinions to find solutions to problem-solving that has been given. Students feel trained to work together in solving problems because so far the learning provided still tends to be teacher-centered so students become passive. The lowest score obtained from student responses is formulating variables during learning. There are still many students who do not understand what the research variable is. Students have difficulty in distinguishing between independent variables and dependent variables in a case so that many students are still mistaken in writing down the variables in the case presented. Science process skills students aspects of writing variables also get poor results. Students have actually been taught about research variables in the chapter on the scope of biology, but only a few students understand the research variables. It is expected that students do not forget what they learned in the previous chapter in order to facilitate understanding the virus material.

The teacher also argues that problem-based learning influences science process skills and student learning outcomes. This is in accordance with the study of Hardiyanti et al. (2017) that the problem-based learning model is effective for improving science process skills and student learning outcomes. Although there are many advantages of problem-based learning, there are also shortcomings in learning activities. Problem-based learning in virus material requires careful planning and in this learning need to condition students to stay focused because in learning activities many use scientific terms and teachers must provide more lots of narration before starting learning so students understand the context of the material to be learned. Providing concrete case examples helps students better understand the material being taught.

CONCLUSION

Based on the results of the study, it is concluded that the application of problem-based learning has a positive influence on student SPS and problem-based learning is effective in student learning outcomes.

1. There is a significant difference between student learning outcomes in virus material taught using problem-based learning models with those using lectures. It is indicated by the value of the experimental class learning outcomes higher than the control class, that is the average control class 73.67 and the average grade of experimental class 78.67
2. The application of problem-solving learning in virus material gives a positive influence on students 'science process skills as indicated by the increase in students science process skills graph
3. Problem-based learning is effective to increase student learning outcomes. It is proven by the students learning outcome reach 88% of classical completeness.

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