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The Effect of Problem Based Learning Based on Multiple Representations on Ecosystem Material in Class X on Problem Solving Ability by Students

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Abstract

The skills that can be developed through education are 21st century skills, including the ability to solve problems related to issues faced in everyday life. Therefore, students need to be taught problem solving by using PBL model based on multiple representations on ecosystem material. The purpose of this study was to analyze the effect of PBL based on multiple representations in class X ecosystem material on students' problem solving skills. The research design used is an experiment with the quasi experiment method. The population in this study were all grade X students at SMAN 14 Semarang in the 2023/2024 school year. Sampling in this study using purposive random sampling technique based on the teacher's consideration that the selected class has a balanced ability. Two classes were sampled, namely class X5 as the experimental class which was given treatment using PBL model based on multiple representations and X9 as the control class which was given treatment using PBL model without multiple representations. Based on the results of the research, students' problem solving skills have increased in both experimental and control classes. The N-Gain test results of the experimental class are 0.3661 which means an increase in problem solving ability is moderate, while the N-Gain results of the control class are 0.1544 which means an increase in problem solving ability is low. The T-test results show that there is a significant difference between the average pretest-posttest scores in the experimental class and a significant average difference between the posttest scores in the experimental and control classes. The results of the Spearman Rank correlation test show that the Sig. (2-tailed) 0.880>0.05 which means that the application of PBL based on multiple representations has no effect on students' problem solving skills on ecosystem material. This can be influenced by several factors, namely the PBL model used, the formation of discussion groups, and also the number of multiple representations taught to students.

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INTRODUCTION

The Merdeka Curriculum is a curriculum whose learning structure is divided into two main activities, namely intracurricular learning which refers to learning achievements by students in each subject, and the Pancasila Student Profile Strengthening Project (P5) which refers to the graduate competency standards that students must have (Kemendikburistek, 2022). This curriculum is considered necessary to overcome the learning crisis in Indonesia, which based on various study results shows that most students in Indonesia are unable to master basic literacy skills such as understanding simple reading and do not master basic numeracy skills such as applying basic mathematical concepts (Kemendikburistek, 2022).

United Nations Educational, Scientific and Cultural Organization (UNESCO) (2021) reports education as a key driver for a country's sustainable development. This is relevant to the function of education in helping develop individual qualities. The abilities that can be developed through education are abilities in the 21st century, including the ability to solve problems related to issues faced in everyday life (UNICEF, 2015).

Solving problems is one dimension of scientific literacy, namely the context aspect. The context used in the PISA assessment for scientific literacy includes the context of problems related to personal, local, national and global life. Where in this context aspect students are asked to provide solutions at a personal, local/national and global level (Delima et al., 2022). It is very important to teach students' problem solving abilities because they are contained in the Learning Outcomes (CP) of the Merdeka Curriculum. The CP states that at the end of phase E, students have the ability to create solutions to problems based on local, national or global issues. This problem solving skill is a basic skill that a person must have which can be used in various fields in everyday life (Kaya et al, 2014). This problem solving ability can be taught through material in the Merdeka Curriculum, one of which is ecosystem material. Ecosystem material is closely related to everyday life so that it can improve students' problem-solving abilities, foster students' concern for the natural surroundings and realize the importance of protecting and caring for ecosystems. Ecosystem material can be taught through the learning model in the Merdeka Curriculum.

The learning model that can be applied to teach this ecosystem material is the Problem Based Learning (PBL) model. This PBL model is one of the learning models used in the independent curriculum. The PBL model is also called problem-based learning which is oriented towards solving various problems, especially those related to the application of lesson material in real life (Anggiana, 2019). PBL-based learning has many advantages. The advantages of the PBL model include: 1) Students become active when learning in class; 2) Students think more critically about solving existing problems, and; 3) Students can search for information and knowledge widely (Susilowati et al., 2017).

The difficulty in implementing the PBL learning model is when students orient themselves to existing problems. Students do not fully understand the concept of biology because students cannot visualize the concept clearly. Therefore, to optimize the PBL learning model, Multiple Representation-based PBL learning is used. Multiple representation is a method used to show material or concepts in different ways, whether through words, pictures, diagrams, mathematical equations and so on (Ainsworth, 2006). The material is presented with multiple representations using various formats such as images, videos, verbal, tables, flow charts, bar charts, graphs, animation, audio, and so on. Apart from that, multiple representations also help facilitate variations in student learning styles by presenting material concepts in various forms of representation that help students analyze and solve problems correctly (Muyassaroh et al., 2022). PBL based on multiple representations is very suitable for use in learning ecosystems that require special representations because they relate to energy flows, biogeochemical cycles, and interactions between ecosystem components. Students need special delivery with the help of various representations such as tables, flow charts, pictures, videos, verbally so that ecosystem material can be understood, is easy to apply in the surrounding environment, and makes it easier to find solutions to problems because it is related to everyday life. Based on this background, research was conducted regarding the influence of the multiple representation-based PBL model in class X ecosystem material on students' problem solving abilities.

RESEARCH METHOD

This study uses a quantitative approach. The research design used was an experiment using a quasi-experimental method with a non-equivalent control group design. The research location is at SMAN 14 Semarang. The population in this study were all class X students for the 2023/2024 academic year, consisting of 9 classes. The research sample is class X5 as the experimental class and X9 as the control class. Sampling in this study used a purposive random sampling technique based on the teacher's consideration that the selected classes had balanced abilities. The data collected in this research includes the results of problem solving abilities based on pretest-posttest results, student LKPD results, student response questionnaire results, and teacher interview results.

RESULTS AND DISCUSSION

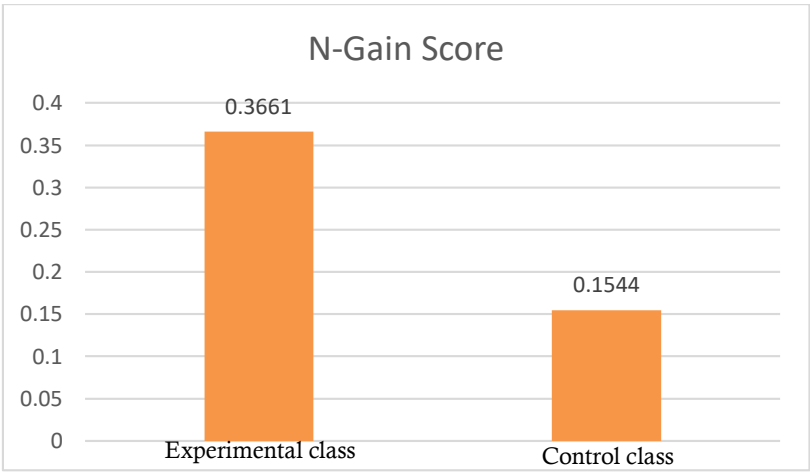
Students' Problem Solving Ability on Ecosystem Material

This research uses written tests to test students' problem solving abilities. Specifically, the pretest and posttest consist of 12 multiple choice questions and descriptions. There are 3 multiple choice questions with indicators for identifying the problem and 9 description questions with 3 indicators each for formulating a solution plan, implementing a solution plan, and reviewing the results of solving the problem. Testing of validity, reliability, level of difficulty, and differentiating power of questions used for the pretest and posttest can be found in. The experimental group and control group took a pretest at the beginning before learning material related to ecosystems and both groups took a posttest at the end of learning. The problem solving abilities of students in the experimental and control classes can be seen in Table 1.

Table 1 Results Pretest and Posttest Problem Solving Ability

Group		N	Lowest Score	Highest Score	Average
Experiment	Pretest	31	42	84	59.87
	Posttest	31	49	96	73.97
Control	Pretest	30	35	89	55.20
	Posttest	30	49	88	65.53

Based on Table 1, it can be seen that the pretest and posttest scores in the experimental group and control group have increased. In order to determine the increase in the results of problem solving abilities in ecosystem materials, it can be clearly seen through the N-Gain calculation of the experimental group and the control group. The results of the N-Gain test for both groups can be seen in Figure 1.



Picture1 Test Results N-Gain Students' Problem Solving Ability

Based on Figure 1, it can be seen that the N-Gain results for the experimental class are 0.3661, which means an increase in problem solving abilities in the experimental group is moderate, while the N-Gain results for the control class are 0.1544, which means an increase in problem solving abilities in the low control group. This means that the increase in students' problem solving abilities in the experimental group's ecosystem

material was higher compared to the control group.

The increasing problem solving abilities of students in both the experimental and control classes shows that students' understanding has also increased in ecosystem material. This combination of PBL with multiple representations helps present problems in a real way because it uses tables, pictures, bar charts, videos, and so on so that it is easier for students to understand the material presented. Moreover, ecosystem material is related to energy flows and biogeochemical cycles which require representations such as pictures, flow diagrams and videos so that the material is presented very clearly which can make it easier for students to understand the material. Apart from that, PBL based on multiple representations can also encourage students to think because students have to solve ecosystem problems with their own thinking. That way, students are trained to think deeply about the right solution and the advantages and disadvantages of the chosen solution to solve the ecosystem problems presented. Apart from that, students' reasoning is also trained by presenting problems and relating them to the ecosystem material that has been studied and the ability to think to solve problems is improved by asking students to formulate appropriate solutions to the ecosystem problems presented. In this way, students not only know, but are also trained to think more deeply to solve problems.

The problems given can help students develop problem-solving techniques that will improve high-level abilities (Fitriani et al., 2022). The skills in question are identifying problems, formulating a resolution plan, implementing a resolution plan, and reviewing the chosen plan to resolve the problem. The problems presented can also train students to solve problems in learning. Students who were previously unfamiliar with problem-based questions began to learn to recognize and get used to it so that students would get used to it and their problem-solving abilities would be honed over time. Evidence that problem solving can be trained is the increase in pretest and posttest scores (Widodo, 2021). Rahayu and Ismawati (2019) also stated that in problem solving learning it is very necessary to train students to think and find solutions based on the information or experience they have gained. So that students will indirectly apply the knowledge and understanding they have gained to solve problems.

One of the high-level learning outcomes that needs to be developed in learning is students' problem-solving abilities, which begin with identifying problems and trying to solve them by providing information about the ecosystem material they have. This means that apart from teaching students how to make a plan to solve the challenges given, the presentation of the problem aims to investigate students' opinions about the ecosystem material being taught. Students can relate problems to the ecosystem material they have studied. So that students can use their understanding of ecosystem material well.

Using a PBL model based on multiple representations in ecosystem material can improve students' problem solving abilities higher than using the PBL model alone. The multiple representation-based PBL model used is accompanied by group discussions that require students to actively seek information and be sensitive to various ecosystem problems that exist around students. The problem-solving abilities of students in the experimental group and control group were honed through group discussions. In this group discussion, students are asked to formulate solutions to ecosystem problems.

At each meeting, students discuss in groups through Student Worksheets (LKPD) which are in accordance with PBL syntax regarding ecosystem problems around the school environment. In the experimental class, LKPD uses various representations such as pictures, flow charts, reading texts, tables and bar charts. In the control class, the LKPD uses multiple representations, only in the form of images. This is in accordance with Sunyono (2015) who states that multiple representations can describe learning concepts with various forms of representation such as images, verbal, video, graphics, and so on, because students have different abilities in understanding the material. Ainsworth (2008) also suggests that multiple representation presentations are the key to problem solving and help develop students' multiple representation abilities. This can be seen in the N-Gain results for the experimental class which are higher compared to the N-Gain values for the control class.

Through LKPD students are also trained to understand problems, know the impact of problems that occur, look for solutions, and also analyze the chosen solutions. In this way, learning in class becomes more meaningful because students not only learn about ecosystem material but also train students' sense of concern

for ecosystems. In the LKPD, problems regarding ecosystems are presented which must be discussed in groups. Students are asked to analyze the impact of the problems presented on the ecosystem. After students have analyzed, they are then asked to formulate solutions that must be implemented so that the ecosystem is well maintained. The problems chosen are problems that are close to students, such as river pollution, forest fires, damage to coral reefs, and so on. The discussions held are oriented towards problem solving and students can provide appropriate solutions to ecosystem problems. This can also train students' problem solving, hone cognitive abilities, and generate creative ideas taken from various perspectives.

The data resulting from students' problem solving abilities were then analyzed using the Wilcoxon Signed Ranks test to determine the significance of the average value of problem solving abilities in the pretest-posttest results of the experimental class and control class as well as the Mann-Whitney test to determine whether there was a significant difference between the average solving abilities. student problems in the experimental class and control class. The results of the Wilcoxon Signed Ranks test can be seen in Table 2 and the Mann-Whitney test can be seen in Table 3.

Table 2 Test Results Wilcoxon Signed Ranks

Class	Sig.(2-tailed)	Sig level.	Conclusion
Experiment	0,000	0.05	There are significant
Control	0,000	0.05	differences

Table 3 Test Results Mann-Whitney

Class	Sig.(2-tailed)	Sig level.	Conclusion
Experiment	0.013	0.05	There are significant
Control			differences

Based on Table 2, the results of the Wilcoxon Signed Ranks test show that the Sig. (2-tailed) value for the experimental and control classes is 0.000<0.050, so it can be seen that there is a significant difference between the average pretest value and the average posttest value in the experimental class. and control class. Based on Table 3, the results of the Mann-Whitney test show that 0.013<0.05, it can be seen that there is a significant difference between the posttest average of students' problem solving abilities on ecosystem material between the experimental group and the control group.

The difference in problem solving ability results could be caused by the experimental class implementing multiple representation-based PBL. The multiple representations used in the experimental class are more diverse compared to the control class. PBL learning based on multiple representations involves students solving given problems which require students to actively understand the concept of the topic. PBL also increases student activity in expressing opinions and solving problems together with their group. The multiple representations contained in PBL syntax make learning more diverse because students not only understand the material through writing but also through pictures, flow charts, bar charts, videos, tables. Students in the experimental class are also trained to apply multiple representations in solving problems such as writing biotic and abiotic components in tabular form, creating food chains with flow diagrams, and interpreting bar diagrams and tables. According to the research results of Suardani et al., (2014) it shows that learning that uses problem-based models and direct learning models has different problem-solving abilities. Ngalimun (2016:117) also states that PBL is a learning model that involves students solving a problem through the stages of the scientific method so that students can learn knowledge related to the problem and at the same time have the skills to solve the problem. Based on the opinions of these two experts, it can be concluded that the PBL model can improve students' problem solving abilities through scientific methods so that students can have skills in solving problems. The research results of Nova and Simanjuntak (2021) also show that there are significant differences in students' problem solving skills by implementing multiple representation-based PBL in science learning.

This difference in results was also due to the fact that in the experimental group students were taught how to solve the problems presented in the PPT, whereas in the control group they were not taught only an explanation of the ecosystem material. Students in the experimental class are taught problem solving according to the problem solving indicators used. These indicators include understanding the problem,

formulating a plan to solve the problem, implementing the plan, and reviewing the results. The teacher guides students to understand the problems presented in the form of images displayed in the PPT. The teacher asks students what problem occurred and the relationship between the problem and the ecosystem material. Students are guided to connect the problems that occur with the ecosystem material they have studied. Students have a little difficulty when asked to connect problems with the concepts of the material they have studied so they need to be trained to develop this ability. In formulating a problem solving plan, most students can state the problem solving plan correctly. For students, formulating a plan is easier than understanding the problem and connecting it with the material they have studied.

In the plan implementation indicator, students are guided on how to implement the plan chosen in the previous indicator. For students, this is also relatively easy after formulating a plan. In implementing this plan students show their creative ideas to solve problems. Students really think about how the problem can be solved with the solution plan that has been chosen.

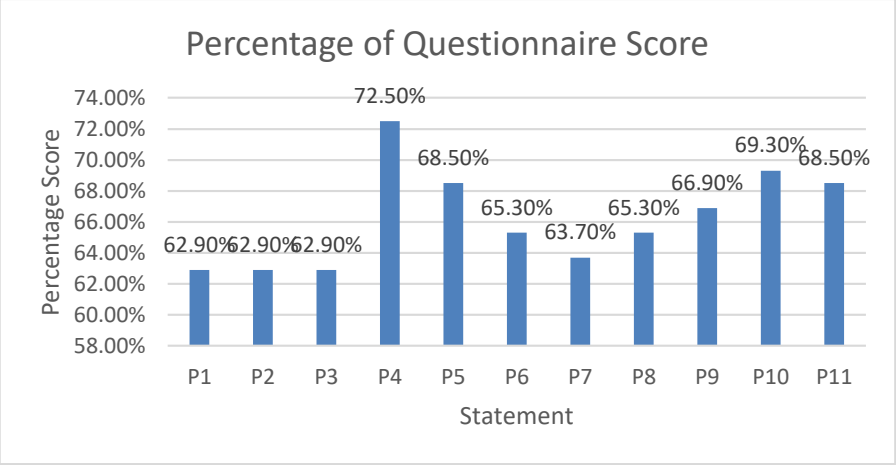
In the indicator of reviewing the results, students are guided to see whether the plans that have been implemented can solve the problems stated by the reasons. Students must relate the reasons stated to the material they have studied. In this case, students find it difficult because they are confused about connecting the reasons they make with the learning material. Some students also felt confused in stating reasons. This is because students are not yet familiar with these problem solving indicators. Therefore, teaching problem solving according to these indicators aims to train and introduce students so that they become accustomed to solving problems according to the indicators used. Thus, the problem-solving abilities of the experimental group have been trained a lot in learning, causing students' problem-solving abilities to increase higher compared to the control class. Apart from that, the experimental group's problem-solving abilities were also trained through more complex LKPD using various multiple representations such as pictures, tables, flow charts, bar charts and reading texts compared to the control group which only used multiple representations in the form of pictures. The multiple representations used can help students solve problems given by the teacher. Multiple representations also make it easier for students to understand the concept of ecosystem material. That way, when students are faced with a problem, students can apply the understanding they have gained to solve the problem. This is in accordance with the opinion of Irwandani (2014) that the use of multiple representations also helps in solving problems, developing concepts, forming affection, and improving psychomotor skills in students. Of course, this is what can influence the results obtained in both the experimental group and the control group

The differences in the results of the problem solving abilities of the experimental and control groups can also be caused by students' different abilities. Students who have good problem solving abilities will solve problems easily so they get high grades, and vice versa if students' problem solving abilities are low then students will have difficulty solving problems so they get low grades too. Students who can understand the concept of the material being taught will find it easier to understand the material and relate it to real life. This is in accordance with Stephani (2017) that the ability to understand a concept is influenced by the individual's thinking ability. The better the students' thinking abilities, the better their ability to understand a concept will be. Therefore, there are differences in the results of solving abilities between the experimental class and the control class.

Implementation of Multiple Representation-Based Problem Based Learning Models

The implementation of a PBL model based on multiple representations on ecosystem material needs to be measured. This aims to find out how much the implemented model is implemented and how much influence it has on students' problem solving abilities in ecosystem material.

The implementation of the multiple representation-based PBL model in this study was measured using a questionnaire filled out by students. The implementation questionnaire consists of 11 statements and 4 answer choices. The percentage of multiple representation-based PBL model implementation questionnaires can be seen in Figure 9.



Picture 2 Percentage of PBL Model Based Implementation Questionnaire Multiple Representation

Based on the analysis of the percentage of student responses in Figure 9, it can be seen that the average percentage of all student response scores is 66.3%, which is included in the good criteria. This shows that learning by applying the PBL model based on multiple representations in ecosystem material gets a good response from students. The application of the multiple representation-based PBL model makes students feel fully involved in learning. This can be seen from the results of the questionnaire percentage in statement number 4 of 72.5%, which is the highest response percentage among the other statements. This is because learning with PBL makes students actively involved in learning through group discussions. The existence of group discussions formed by the teacher makes students actively express opinions and exchange ideas to solve the problems given

By using multiple representation-based PBL, students' problem solving abilities increase and students can solve pretest and posttest questions about ecosystems. This is because the existence of multiple representations can help students to understand ecosystem material presented through various kinds of representations. Students' ability to represent material in many ways will make it easier for students to understand a topic well. Multiple representations can also make it easier for students to identify and solve ecosystem problems given by the teacher. This combination of PBL with multiple representations can be applied to improve students' problem solving abilities, especially in biology subjects. Apart from that, when learning applies PBL based on multiple representations, students feel enthusiastic about participating in the learning process. This is because in the learning process students not only solve problems but also actively discuss in groups to solve problems given by the teacher through LKPD.

This is in accordance with the research results of Kurniawan (2024) that the use of various representation-based learning models can improve student learning outcomes while fostering better social interaction, critical thinking, problem solving and collaborative abilities. The results of research conducted by Bahri et al., (2018) also show that the results of biological problem solving skills for students taught using the problem-based learning (PBL) model are higher compared to students taught using the direct learning model. It can be concluded that learning using the PBL model based on multiple representations can be applied to improve students' problem solving abilities.

The Effect of Multiple Representation-Based Problem Based Learning Models on Students' Problem Solving Ability

The correlation test is used to analyze how much influence PBL based on multiple representations has on students' problem solving abilities in ecosystem material. The results of the Spearman Rank correlation test can be seen in Table 4.

Table 4 Test Results Rank Spearman

Class	Sign. (2-Tailed)	Conclusion
Experiment	0.880	There is no influence

Based on Table 4.4, it can be seen that the value of Sign. (2-Tailed), namely 0.880>0.05, which means that the application of the multiple representation-based PBL model has no effect on students' problem solving abilities. This correlation test result which has no effect is caused by several factors. The first factor is the PBL learning model used. The choice of model used in learning is one of the influencing factors. In this research, PBL was applied to all ecosystem materials, even though not every material is suitable for PBL. PBL, which should only focus on selected material that is suitable for problem solving, is not optimal because the teacher also has to convey the material as a whole. Thus, a lot of time is wasted in conveying all ecosystem materials. Therefore, teachers must choose only part of the material that is appropriate to PBL. That way, the teacher only focuses on the selected material and students are given facilities such as teaching materials or similar to study material that cannot be conveyed during learning so that learning with PBL will be more optimal in developing students' problem solving abilities. Various student characteristics can also influence the PBL model used. The PBL model cannot facilitate diverse student characteristics to develop students' problem solving abilities. Students who have good understanding abilities will be able to participate in learning using the PBL model, whereas students who have poor understanding abilities will have difficulty participating in learning using PBL, especially in a short time. Therefore, in choosing the right learning model, you must pay attention to the condition of the students, the material, the media, and the condition of the teacher himself. This is in accordance with the statement by Magdalena et al., (2024) that the PBL model has weaknesses, namely: a) Not all learning materials can apply the PBL model; b) PBL has the time required to complete the learning material, which is quite long and not short; c) Students who are not or are not used to analyzing a problem will find it difficult because not everyone has the desire to do it; d) Teachers will find it difficult to condition assignments, this occurs if there are too many students in the class.

In addition, because the LKPD is done in groups with group members consisting of 5-6 people, there is a possibility that not all students actively participate in discussions and work in groups to solve problems. So only a few have their problem solving skills honed. This can also affect students' problem solving abilities between those whose abilities are honed and those whose abilities are not at all.Students who are not motivated to learn cannot participate in learning well. So the ability to understand learning material and concepts is low. Students who have motivation to learn will be enthusiastic about participating in learning, thus triggering the development of students' abilities. In this way, the ability to understand the material and concepts being taught will be higher compared to students who do not have the motivation to learn. This is in accordance with Alfarisi (2017) who states that grouping students is very necessary, because each student has different abilities and characteristics. Many factors influence group learning, including the number of members in a study group. Too many group members is also ineffective. Students will only depend on each other so that active group work does not occur in solving problems.

Another factor that influences the results of the Rank-Spearman correlation test which has no effect, namely the use of insufficient multiple representations, can also be an influencing factor. In this research, students were only taught to make three multiple representations during group discussions, namely making tables, flow diagrams and interpreting bar diagrams and tables.Students must be trained how to use multiple representations when solving problems and learn how to perform problem solving using multiple representations. This is in accordance with the statement of Hasbullah et al., (2019), that to support students' cognitive processes, limit interpretations that allow incorrect use in other interpretations, and encourage students to build a deep understanding of concepts related to various problems, teachers must use various different representations in the learning process, including words, graphs, formulas, pictures, and diagrams. Therefore, training students to get used to using multiple representations is very important because it can help students understand material concepts and also solve problems easily.

CONCLUSION

Based on the results of the research and discussion, it was concluded that students' problem solving abilities had increased in both the experimental and control classes. Based on the results of the Spearman correlation test, it shows that there is no variable relationship between the multiple representation-based PBL model and problem solving abilities. In other words, the application of PBL based on multiple representations has no effect on students' problem solving abilities in class X ecosystem material. This can be influenced by several factors, namely the PBL model used, the formation of discussion groups, and also the number of multiple representations taught to students.

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