
The Effect of Problem Based Learning Models with Question Cards on Environmental Pollution Materials on Problem Solving Ability, Scientific Attitudes, and Student Learning Outcomes

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Abstract. Problem solving ability (PSA) is one of the skills that is the focus of the 21st century, besides that scientific attitudes and learning outcomes are also important components that must be possessed by students. This research aims to determine the effect of problem based learning (PBL) with question cards on environmental pollution on PSA, scientific attitudes, and student learning outcomes. The type of research used a quasi-experimental study using a nonequivalent pretest-posttest control group design. Sampling used a cluster random sampling technique. Data collection used PSA description questions, scientific attitude questionnaires, and multiple-choice test to measure the learning outcomes. Data analysis techniques used descriptive analysis, multivariate analysis of variance (Manova) test, and N-gain test. The average results of students in the experimental class were higher than those in the control class. The multivariate analysis of variance test results obtained a Sig. 0.000, and the N-gain test result in the experimental class obtained moderate criteria. Based on the results it is concluded that the PBL model with question cards have a significant effect.

Keywords: Problem based learning, question cards, problem-solving ability, scientific attitudes, and learning outcomes

Introduction

The 21st century life skills get attention in the world of education which includes critical thinking and problem solving, (b) communication and collaboration, (c) creativity and innovation (Bishop, 2016). Critical thinking and problem solving, promote students to be able to use various reasons (reasons) such as inductive or deductive for various situations, use systems thinking, make decisions and solve problems. Communication and collaboration, require students to be able to communicate clearly and collaborate with other group members. Creativity and innovation, provide students to be able to think creatively, work creatively and create new innovations (Trilling & Fadel, 2009).

One of the skills that is the focus of the 21st century that needs to be developed is problem solving skills (PSS). According to Chin & Chia (2006) students in the future must be able to learn facts, think creatively, and be able to apply their knowledge in new contexts (solve problems). Facts on the ground that students' problem-solving abilities (PSA) in Indonesia are still low. Research conducted by Haka & Diana (2021) on the PSA of class X

SMA in three classes shows that PSA have a low percentage of the indicator testing the hypothesis with the N-gain class 1 of 59.50%, class 2 of 60, 18%, and class 3 60.18%. Research by Karmana (2015) on high school students in the city of Mataram shows that there are several indicators that have a low percentage, namely the indicator of formulating a problem of 15%, the indicator of collecting data by 20%.

The students' have low PSA because they lack of understanding in determining (alternative) solutions to problem solving and drawing conclusions (Bahri et al., 2018). In developing alternative solutions to problems, a high mental process (thinking) is required and practice. Then, during learning activities students only listen to explanations from the teacher so that students' PSS do not increase significantly (Saputri & Febriani, 2017), there is still a lack of innovation during learning activities (Efriyani & Senjayawati, 2018), and internal factors such as attitude, talents, interests, and self-motivation of students who are still lacking in learning (Sumiantari et al., 2019).

In addition, a scientific attitude is one of the components needed in learning biology, which tends to react consistently, rationally, and objectively in certain ways for certain situations (Olasehinde & Olatoye, 2014). However, the facts on the ground that the scientific attitude in students is still low. Research conducted to Alawiyah et al. (2015) shows that students' scientific attitudes are still low, because teachers still dominate the delivery of material and students are not used to being independent, there is a lack of practical activities. so that students are not familiar with the scientific process, make decisions based on facts, data is not manipulated, and are active in group discussions.

Problem-solving abilities and scientific attitudes of students in the learning process are inseparable from the cognitive abilities of students in understanding the concepts of the material they are learning. Learning outcomes provide a basis for measuring and reporting achievement, providing a clear indication of what students are expected to achieve. However, the facts in the field of students' cognitive learning outcomes are still low. The low average value of learning outcomes can be caused by learning that is less varied and only uses the lecture method, thus making learning monotonous and boring. Teachers do not guide students to acquire knowledge independently, students are also used to receiving knowledge conveyed by teachers and are unable to find concepts through their own experiences, thus affecting student learning outcomes (Natalina et al., 2013). In addition, according to Supiadi & Julung (2016) low cognitive learning outcomes are caused by students who tend to be passive, teachers who only provide information and learning methods that are still inappropriate in the learning process, so strategies are needed in learning.

The selection of learning models is an alternative solution for teachers to carry out an optimal learning process. One model that can be used is the problem based learning (PBL) models. This model can assist students in solving problems with all their knowledge and skills from various sources that can be obtained, besides being able to solve problems students also gain the ability to participate in groups. This model is dominant in discussion activities so that it can stimulate students' ability to solve problems, because this model is in favor of student activity (Huang & Wang, 2012). According to Glazer in Suarsani (2019) states that PBL emphasizes learning as a process that involves problem solving and critical thinking in actual contexts. According to Sonmez & Lee (2003) problem based learning is a learning model that challenges students to find solutions to problems in the real world, independently or in groups. Based on this, PBL activities can improve PSA, scientific attitudes, and learning outcomes.

In this study, the material used is environmental pollution material. Environmental pollution problems that occur around students will be presented in the form of pictures and questions packaged in question card media that support the learning process. The use of the PBL model with question cards is supported by the results of research to (Jumiyatun et al. (2019) which shows that learning using the PBL model with question cards gets better

results. Research conducted to Handayani et al. (2017) showed that the PBL model assisted by question cards and smart cards had a significant effect on students' cognitive learning outcomes. Therefore, as the results of several studies show that question cards in the PBL model help students focus more on solving problems, analyzing, and finding solutions. So, this study aims to determine the effect of the PBL model with question cards on environmental pollution materials on problem solving abilities, scientific attitudes, and learning outcomes of class X students.

Methods

The research design was a pretest-posttest control group design. The sample used is senior high school students' grades X of sciences in Public Senior High School 2 Mukomuko of the 2021/2022 academic year. The sample technique used is random sampling technique which used class that have been formed and have an equal chance to be selected as the sample. Sample in this research is class X MIPA 1 as an experimental class of 32 students, and class X MIPA 3 as a control class of 31 students. This type of research is a quasi-experimental study. The experimental class uses the PBL model with question cards on environmental pollution materials, and the control class uses a scientific approach. Data collection using test techniques is a description test to measure PSA, and multiple-choice tests for learning outcomes in the form of pretest and posttest. Meanwhile, non-test techniques use student scientific attitude questionnaires which are given before and after treatment. The instrument used was a question description on PSA consist of 6 items including identifying problems, formulating problems, analyzing problems, drawing conclusions, finding solutions, and evaluating (Brilliant & Pahlevi, 2015), multiple-choice question for learning outcomes consist of 20 items, and questionnaire instrument used was a scientific attitude questionnaire consist of 20 statement items including curiosity, respect for data, openness and cooperation, an attitude of discovery and creativity, and a sensitive attitude towards the surrounding environment. These questions dan questionnaires have been validated by experts and validated empirically. The data analysis technique used in this study used the microsoft excel SPSS program. Data analysis used descriptive analysis to describe research data includes the mean, median, standard deviation, minimum value, maximum value and number of students, multivariate analysis of variance (Manova) test, and N-gain test to see how much the score increased before and after the treatment.

Results and Discussion

Descriptive analysis is used to provide an overview of the results of PSA, scientific attitudes, and learning outcomes of class X students of SMAN 2 Mukomuko obtained in the experimental class learning using the PBL model with question cards and the control class using a scientific approach to environmental pollution material.

Description PSA, scientific attitude, and student learning outcomes

The results of the description of PSA, scientific attitudes, and learning outcomes in the experimental class and control class. Description PSA can be seen in Table 1.

Table 1. Descriptive analysis of PSA class experiment and class control

Description	PBL+QC		Scientific Approach	
	Pretest	Posttest	Pretest	Posttest
Mean	45.70	86.58	35.75	69.22
Maximum	33.33	75.00	20.83	45.84
Minimum	58.33	100.00	50.00	83.33
Standar Deviation	6.73	6.99	7.19	9.35
N	32	32	31	31

Based on the results of the descriptive analysis in Table 1, it can be seen that the pretest average value of PSA in the experimental class and control class is not the same with a difference of 9.95. The descriptive results of the average posttest of the experimental class and the control class have a difference of 17.36. So it shows that the PSA of the experimental class is greater than the control class. Based on the results of the descriptive analysis, it can be concluded that the average PSA of students has increased after participating in the learning process with the PBL model with QC. When viewed from the minimum criteria of mastery learning (KKM) value (75), the posttest average PSA the PBL class with QC has reached KKM ($86.58 > 75$). The PBL model is a model that can improve students' PSA through activities in analyzing, conducting investigations, and finding solutions to real problems that occur around students. According to Arends (2007) explained that PBL presents a variety of authentic and meaningful problem situations to students, which can serve as a springboard for investigation and inquiry. PBL is designed to help students develop thinking skills and PSA. PBL as a result of a process aimed at creating understanding or finding solutions to existing problems (Thisana, 2013). So, with this PBL model students will be actively involved in constructing their knowledge, especially on real problems that often occur in the student's environment.

The use of the PBL model in learning with real environmental pollution problems can stimulate students to be more active in finding the roots and solving problems that occur. According to Torp & Sage (2002) explained that the PBL model is learning that is focused, organized in investigation and discovery of real problems. Students are challenged as problem finders and root cause seekers. So that this PBL model can improve students' PSA. PSA are carried out by each student, where students can find solutions to problems by expressing their respective opinions in identifying the problem. According to Suharta & Luthan (2013) states that the use of problem based models learning during learning activities make students think more than memorize, understand the lesson more either through discussion. Learning PBL is also more stimulate and challenge deep students learning, encourage students to independent in setting goals their learning (Adiga & Sachidananda, 2015).

Each stage of PBL learning with QC makes students more active in group interactions to solve problems. According to Ngilimun (2014) the steps of PBL begin with a problem presented by the teacher, then students deepen their knowledge of what they already know and what they need to know to solve the problem. Problems that are used as the focus of learning can be solved by students through group work so as to provide diverse learning experiences to students, such as collaboration and interaction in groups, so as to provide rich experiences to students and enable students to determine the best solution what will be chosen in solving the problem. The PBL model directs students to solve problems by searching for information based on existing facts, writing results reports investigations

based on logical and systematic writing rules, explaining the results in front of the class with full responsibility (Sari et al., 2021). In other words, the use of PBL can increase students' understanding of what they are learning and improve PSA so that they are expected to be able to apply it in real conditions in everyday life.

Table 2. Descriptive analysis of scientific attitudes class experiment and class control

Description	PBL+QC		Scientific Approach	
	Pretest	Posttest	Pretest	Posttest
Mean	59.43	88.43	56.12	74.93
Maximum	48.00	78.00	40.00	69.00
Minimum	70.00	94.00	68.00	83.00
Standar Deviation	5.82	3.95	5.48	3.99
N	32	32	31	31

Based on the results of the descriptive analysis in Table 2, it can be seen that the pretest average value of the scientific attitude in the experimental class and control class is not the same with a difference of 3.31. The descriptive results of the average posttest of the experimental class and the control class have a difference of 13.5. So it shows that the scientific attitude of the experimental class is greater than the control class. The results of this study are in accordance with Af'idah et al. (2013) which states that the application of the PBL can develop attitude and cooperation skills in various situations. Each PBL syntax with QC provides an opportunity for students to develop their scientific attitude by trying to solve problems related to real everyday life, with the problems presented in QC students become interested in knowing more about what, why, and how these problems can occur, namely the problem of environmental pollution. According to Hawk & Shah (2007) the PBL model is the most effective method for developing self-ability because there is direct experience with students, in addition to training students in various learning modes, including visual, auditory, and kinesthetic strategies. PBL model can improve students' abilities, motivation, and students' collaboration with others. When learning and problem-based instruction are integrated, it will create active learning, where it is the responsibility of students to engage with PBL according to the needs of students, which can be individual or group needs (Phunaploy et al., 2021). According to Astuti et al. (2019) states that using question card media in the learning process will make learning more fun, students are more active in discussions with their groups in solving existing problems. The PBL model causes students to develop a scientific attitude, is active in the learning process, develops interpersonal relationships and motivation in working groups, creates internal motivation for learning, and can increase the activity of teachers and students in the learning process (Suswati, 2021).

The learning process in the PBL model accompanied by QC can increase students' curiosity. An attitude of curiosity is a component of a scientific attitude which is characterized by a person's desire to understand a situation in more depth (Lacap, 2015). The first and second syntax in the PBL model are observing activities. This observing activity opens wide opportunities for students to make observations related to important things from an object. This is very beneficial for fulfilling students' curiosity (Machin, 2014). The use of the PBL model accompanied by QC also increases the scientific attitude towards data, which is contained in the group investigation syntax. Students in this syntax carry out observational and experimental activities to find the concepts needed in solving-

problems students then write down all the results of data and information obtained in LKPD, therefore with these activities will form honest, objective and open attitudes towards students (Widiadnyana et al., 2014). During the PBL learning process accompanied by question cards, students become respectful of the data they have obtained from the discussions carried out. Respect for facts/evidence also appears when students are confronted with information obtained from data processing activities in the data processing syntax.

Learning with the PBL model can also lead to student learning activities. In the learning process, students are more actively involved in carrying out their learning assignments, are more daring to ask questions, work together in groups to solve problems, dare to respond or give opinions on the work of other students or groups, and present their work in front of the class. The emergence of student learning activities can increase their understanding of the material and become more memorable because they experience the learning process themselves (Agustin, 2013). The results of research by Nugroho and Hanik (2015) state that learning that accommodates student collaboration and interaction can increase learning activities. So that from this, the scientific attitude of students will increase. Someone with a high scientific attitude is able to think logically during learning, with an open mind he is able to accept other people's opinions, tell what is true, conclude something with causal considerations, be objective. This was also seen during the research, students were active in learning doing experiments seriously. Dialogue between group members occurs well, the discussion process takes place with mutual respect for each other's opinions. The experimental results are presented as what was obtained during the experiment. Drawing conclusions also takes place in a good process by considering all data and concepts (Purwanti & Manurung, 2015).

Table 3. Descriptive analysis of learning outcomes class experiment and class control

Description	PBL+QC		Scientific Approach	
	Pretest	Posttest	Pretest	Posttest
Mean	53.28	87.03	48.87	65.32
Maximum	35.00	75.00	25.00	50.00
Minimum	70.00	100.00	65.00	80.00
Standar Deviation	9.28	7.05	10.46	9.12
N	32	32	31	31

Based on the result the average value of the pretest learning outcomes of students in the experimental class and control class has a difference of 4.41. The posttest descriptive results for the experimental class and the control class have a difference of 21.71. Therefore, these results indicate that the experimental class has greater learning outcomes than the control class. When viewed from the KKM value (75), the average posttest learning outcomes of PBL class students with QC have reached KKM ($87.03 > 75$). This is because the syntax of the PBL model makes students active in solving problems, formulating questions, digging up information, answering questions, and providing solutions to these problems. Research conducted Sumardjoko & Musyiam (2018) PBL can improve student learning outcomes with a score of 75%. The use of the PBL model with QC can be seen that it greatly influences student learning outcomes. In QC there are questions that are conceptual, where students are asked about the concept of pollution, the factors that cause pollution, the impact of pollution, and solutions to pollution that occurs. So that students'

understanding of water, soil, air and sound pollution increases and student learning outcomes also increase and activities become student-centered which provide opportunities to acquire knowledge directly by observing and experimenting.

The above results are in line with the opinion of Pimpan (2002) that question-based learning will be able to develop students' cognitive processes, where students can develop ideas using rational, analytical, critical, synthetic, or judgmental thinking in answering questions. In addition, Praimee & Boonserm (2021) suggest that students who use the question-based learning method will have higher achievements after learning than before learning and question-based learning activities are appropriate for producing student learning progress. So, the results of the comparison of the posttest scores of PSA, scientific attitudes, and student learning outcomes show that the PBL model with QC is more effective than the control class with the 5M model.

Description of Manova test results PSA, scientific attitude, and student learning outcomes

The Manova test in this study was carried out after the prerequisite tests had been fulfilled. Testing this hypothesis aims to see whether there is an effect of learning using the PBL model with question cards on PSA, scientific attitudes, and student learning outcomes on environmental pollution material. The Manova test results can be seen in Table 4.

Table 4. The Result of the Manova test of PSA, scientific attitudes, and learning outcomes

Effect		F	Sig.
Class	Pillai's Trace	111.076 ^b	.000
	Wilks' Lambda	111.076 ^b	.000
	Hotelling's Trace	111.076 ^b	.000
	Roy's Largest Root	111.076 ^b	.000

Based on the results of the multivariate test in Table 4 through the Pilla's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root effects it can be seen that the significance value of all these effects is 0.000 which is less than 0.05 so that H_0 is rejected and H_1 is accepted. This shows that there are significant differences between PSA, scientific attitudes, and learning outcomes of students who use the PBL learning model with question cards. Based on these data it can be concluded that the effect of the PBL model with QC has a significant influence on PSA, learning outcomes, and students' scientific attitudes.

The use of the PBL model with QC can make students more active in learning, where the presentation of the problems presented in QC is presented in the form of pictures and questions about the phenomenon of environmental pollution problems that occur both water, soil, air, and noise pollution, so that things this will make students interested and more focused on understanding and finding the root of the problems that occur. This is in line with the opinion according to Lailia (2020) QC presents images and problems related to everyday life that occur and those in the environment around us. In addition, question-based PBL is an important technique for acquiring knowledge in problem solving and this learning strategy contributes to the development of PSA which also lead to the learning process of students (Wattanaphon, 2008).

The PBL model with QC will spur students, make it easier for students to recognize problems, to identify problems, because in the PBL model in the first stage students identify or orient problems, so QC will be given first and students will read QC first then do LKPD.

Card media concretizes an abstract concept and can direct attention so that it is focused on one focus point and increases student interaction so that the message from the teacher can be conveyed properly so that it can help improve students' PSA. Learning with the PBL and QC models that present students' real problems, namely environmental pollution, will improve students' scientific attitudes both individually and in groups. Through discussion activities, observations in LKPD, gathering information, formulating questions, looking for answers and appropriate solutions to problems, as well as presentations in front of the class will encourage students to improve their scientific attitude, namely curiosity, respect for data, thinking, openness and cooperation, as well as a sensitive attitude towards the surrounding environment. According to Janah et al. (2018) PBL with student worksheets makes students curious to solve problems by looking for references to answer the questions available in student worksheets so that the hypotheses prepared can be proven. So that the learning that is obtained is not centered on the teacher, but on students.

The use of the PBL model with QC makes learning in class interesting and can develop students' intellectual abilities. Active learning activities with stages of student orientation to problems, organizing students to learn, guiding individual or group investigations, developing and presenting work, analyzing and evaluating problem-solving processes, where with these stages students will explore information by reading and remembering materials related to environmental pollution issues that occur in the environment around students. So that with this, students can apply the concepts they have learned to solving real problems that occur and improve learning outcomes from students. As according to Marina (2008) that the PBL model is a model with learning that is centered on student constructivism based on analysis, resolution, and discussion of the problems given to train thinking processes so that they enter long-term storage memory, and the knowledge gained is more meaningful.

Through learning using the PBL model with QC, it will make students trained to think at a higher level in finding concepts learned through learning to discuss in groups with activities to analyze, evaluate, and find solutions to problems. The implementation of QC media in PBL provides an opportunity for students to construct their own knowledge based on their prior knowledge. Through QC students analyze the questions given, then formulate questions and answer according to their understanding of these problems. Students learn to solve problems with the material they have learned, so they are able to master the material. In addition, there is also a follow-up test with the test of between-subject effects which can be seen in Table 5.

Table 5. The result of the test of between-subject effects of the PSA, scientific attitudes, and student learning outcomes

Source	Dependent Variable	F	Sig.
Class	Problem Solving Ability	69.867	.000
	Scientific Attitudes	112.050	.000
	Learning Outcomes	182.070	.000

Based on the results in Table 5, it obtained a significance value of 0.000. So that the advanced data shows that the PBL model with QC has a significant influence on PSA, scientific attitudes, and student learning outcomes.

Description of N-gain test results PSA, scientific attitude, and student learning outcomes

The N-gain calculation in this study aims to see an increase in PSA, scientific attitudes, and student learning outcomes after being given treatment. The N-gain test for PSA was taken from the students' essay test scores, the N-gain test for scientific attitudes was taken from the results of the questionnaire scores obtained by students, and the N-gain learning outcomes were taken from the students' multiple choice test scores. The N-gain results of PSA, scientific attitude, and learning outcomes can be seen in Table 6.

Table 6. N-gain test results PSA, scientific attitude, and student learning outcomes

Variable	Class	Pretest	Posttest	N-gain	Criteria
Solving Ability	Experiment	45.70	86.59	0.41	Medium
	Control	37.75	69.22	0.33	Medium
Scientific Attitudes	Experiment	59.52	88.46	0.33	Medium
	Control	56.16	74.04	0.21	Low
Learning Outcomes	Experiment	53.28	87.03	0.34	Medium
	Control	48.87	65.32	0.16	Low

Based on the results of the N-gain test in Table 6 it is known that the average N-gain in the experimental class is greater than the control class. The results of the N-gain PSA obtained show that the N-gain value of the experimental class is higher than that of the control class. This is because the PBL model in its learning encourages students to find real problems that exist in environmental pollution material, identify the best solution to these problems. So that students are really trained in improving their PSA. This shows that the use of PBL with question card media makes students more focused, trains memory and concentration in understanding the problems that occur. This is in line with research conducted to Munir et al. (2017) question cards can be used in PSA, especially in supporting the improvement of students' PSA. This happens because the question cards make each student work together actively and responsibly in learning using the PBL model, so that group members can exchange opinions causing students' memory to be stronger. Jumiyatun et al (2019) also explained that the use of question cards can improve students' solving abilities better than classes that use conventional models. Question cards can encourage students to solve problems regarding questions about a topic of subject matter and learning feels more fun during discussions between group members.

The results of N-gain scientific attitudes showed medium results and were higher than the control class. This is because the PBL model pad is with a question card, students have a high sense of curiosity, respect for the data obtained, an attitude of discovery and creativity by developing and presenting their work, thinking openly and collaborating in completing assigned tasks, and being sensitive to the environment by maintaining cleanliness during group investigation activities. The N-gain value of students in the experimental class learning outcomes showed medium criteria and was higher than the control class. PSS helped them face the challenges in their education and in their social life. Moreover, engaging in PSS also reflected on the skills needed in their life, particularly higher-order skills (Özreçberoğlu & Çağanağa, 2018). The experimental class that uses the PBL model with QC makes students more active with group presentation activities in front

of the class after conducting discussions and observations using LKPD and QC. This presentation is also a way to increase students' understanding of learning material, especially in solving environmental pollution problems, this is because students are trying to better understand existing problems and solutions to solving these problems, students can also listen to the results obtained by the group others, ask questions, and provide responses to the results that have been submitted. In the PBL model, students work collaboratively in order to help in identifying the problem and choose a suitable solution. They go through negotiation of meaning and discussing possible solutions. Thus, PBL also helps in improving student's decision-making skills (Alfares, 2021).

Conclusion

The use of the PBL learning model with question cards has a significant effect on increasing PSA, scientific attitudes, and learning outcomes of class X students of SMAN 2 Mukomuko on environmental pollution material. The average results of students in the experimental class were higher than those in the control class. The multivariate analysis of variance test results obtained a Sig. 0.000, and the N-gain test result in the experimental class obtained moderate criteria. Therefore, it can be concluded that PBL with question cards is effective in biology learning.

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