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Increasing Student's Cognitive through Problem-Based Learning

Riris Sejati Adjiningsih [a,1]*, Ani Sulistyarsi [b,2], Juli Sukimarwati [c,3]

[a] Teacher Professional Education Preservice Program, Faculty of Teacher Training and Education, UPGRI Madiun University
[b] Biology Education, Faculty of Teacher Training and Education, PGRI Madiun University
[c] Biology Teacher at SMA N 6 Madiun

[1] riris.adjiningsih@gmail.com*; [2]anisulistyarsi@unipma.ac.id; [3]Julisukimarwati224@gmail.com
* Corresponding author: riris.adjiningsih@gmail.com

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ABSTRACT

The observation in class X-F SMAN 6 Madiun showed that students were less curious, had a low desire to ask questions and express opinions, and had a low interest in reading sources of information. Through classroom action, this study aims to increase students' cognitive skills in biotechnology with Problem-Based Learning (PBL) model. This research was conducted with three cycles. The cycle consists of four stages such as planning, action implementation, observation, and reflection. The research targets consisted of 35 students from class X-F. The data was collected through pre-test and post-tests, students' questionnaires, observation notes and interviews. The data were analyzed descriptively. The result found that after using problem-based learning, the percentage of students' cognitive outcomes increased, from 51% in 1st cycle to 60% in 2nd cycle and 3rd cycle was 86%. According to the questionnaire results, 49% of students strongly agree that the problem-based learning method can help in learning biotechnology. The increase in the percentage of cognitive results shows an increase in the number of students who have passed in each cycle.

Keywords: Biology; classroom action research; problem based learning; students; learning outcome

Introduction

Education is one of the essential factors in improving a person's quality of life and developing individual potential. This is an attempt to help students, physically and mentally, from nature to become better human beings (Sujana, 2019). A breakthrough in fostering innovation opportunities to obtain good teaching methods is needed. Teaching and learning is the most crucial part of improving the quality of learning and national education (Pristiwanti et al., 2022). In line with "Law number 20 of 2003" the National Education System, article number 3 concerns the objectives of national education. It was encouraged to develop the skills of students to become human beings who are faithful and worshipful to God Almighty, have a noble character, are healthy, knowledgeable, capable, creative, independent, and become democratic and responsible citizens.

In the context of education, learning models and strategies are very important. Choosing a suitable learning model can optimize students' learning process and their understanding (Asyafah, 2019). Learning models are arranged to make the learning activity easier. Problem-based learning is one of the learning models that is based on a problem. This problem encourages students to learn and work cooperatively (Yew & Goh, 2016). This learning strategy is in line with the government's campaign regarding the use of problem-based learning as one of the choices for student-centred learning models (Hotimah, 2020).

Learning by using a problem-based learning model (PBL) has been proven to improve students' mathematics learning outcomes. The learning outcomes increase from 5% to 40%. This is supported by Ariyani's & Kristin's (2021) research which found that the application of PBL has a positive influence, characterized by an increase in learning outcomes before and after applying the problem-based learning model. Based on the analysis results, a significant increase in student learning outcomes was obtained from 8.9% to 83.3%. In addition, research from Assegaff & Sontani (2016) reported that problem-based learning improved student learning outcomes as well as analytical thinking skills through discussion.

Student understanding and achievement are critical indicators for biology subjects, especially in biotechnology topic. Biotechnology is a branch of science that studies the utilization of scientific principles that use living things associated with technology. In application, it is used to manipulate organisms or biological materials to produce products and services for the benefit of humans. Biotechnology materials include genetic engineering technology, the production, and use of recombinant hormones, cloning, and recombinant DNA technology. It is known as a multi-disciplinary and applicable science (Zulpadly et al., 2016).

Based on the observations result of biology learning in class X-F, it showed that the percentage of students who passed the minimum score was only 26%. There are nine students who passed the minimum score on the diagnostic cognitive test. Furthermore, based on the observation, the results show low enthusiasm in participating in discussion, lack of curiosity, low activity in asking questions and expressing opinions, and low enthusiasm for reading sources of information about the subject matter. This situation occurs because all this time the learning is still teacher-centred and does not actively involve students. It is similar to the research from Rahmadani et al.,(2017) in Medan. The result found that students had low motivation to learn biology. It happens due to their lack of concentration in learning biology. Likewise, research by Zulpadly et al., (2016) in one of the high schools in Rokan district stated that student learning outcomes on biotechnology material were still low, this was related to factors from within students.

Based on direct observation this research aims to improve student learning outcomes in biotechnology subjects with a Problem-Based Learning model. Biotechnology is included in

phase E in grade X, senior high school. Students are expected to have the ability to be responsive to global issues and play an active role in providing problem-solving.

Methods

This study is a classroom action research (CAR) where research is conducted by teachers in their classrooms consisting of three cycles. The cycle consists of four stages, consist of 1) planning, 2) action implementation, 3) observation, and 4) reflection. The research will be continued in the next cycle if the given action has yet to achieve the expected indicators. The four stages in classroom action research are carried out sequentially. The first and second steps are the initial part of the improvement plan. The third step is a prerequisite for the fourth step. Assuming the improvement action has not addressed the teacher's concerns, in this case, the reflection action, including data analysis and synthesis, is used to re-plan the improvement activities in the next cycle. The cycle will end if the improvement has been successful.

Place and time of research

Classroom action research was conducted at SMA Negeri 6 Madiun, in the even semester of the 2022/2023 academic year, for one month, from March to April 2023. This classroom action research was implemented for biology subjects on biotechnology topics.

Subjects

The subjects of this study were students of class X-F at SMA Negeri 6 Madiun 2022/2023 academic year, with a number of 35 students.

Data collection and analysis techniques

The observation data obtained in each cycle will be analyzed descriptively. Data collection techniques have met the requirements of triangulation data. There were four data collection techniques were used in this research. First, tests to measure students' cognitive abilities, there are ten HOTS questions consisting of true and false, multiple choice, and complex multiple choice. Second, questionnaire of perceptions on learning with a problem-based learning model. There are twenty questions with five Likert scales such as strongly agree, agree, doubtful, disagree, and strongly disagree. Furthermore the third technique, the interview question was an open-ended question. There are 10 questions were used to find out deeper information from students. Fourth, observation worksheet records during teaching-learning activities.

The students' test was analyzed descriptively by finding out the percentage of students' cognitive results and interpreted in the form of words. Then, the questionnaire and observation data were analyzed descriptively. Lastly, the students' interview answer was analyzed descriptively by finding the keyword of their answer related to the usage of problem-based learning model.

Results and Discussion

Based on classroom observations of cognitive diagnostic test scores on biotechnology material, it is known that the average score of students who passed the minimum score of 75 was low. There were nine students who passed the minimum required score. The preliminary score was obtained based on the previous cognitive diagnostic test score. The test is used to determine students' strengths and weaknesses when learning something so that the results can be used as a basis for further improvement.

Table 1. The completeness of students' cognitive tests on biotechnology material

Cycle	The results of cognitive test assessment			
	Completed		Incomplete	
	Total	%	Total	%
Cycle 1	18 students	51%	17 students	49%
Cycle 2	21 students	60%	14 students	40%
Cycle 3	30 students	86%	5 students	14%

From 35 students who were given treatment by implementing a problem-based learning model, there were 18 people who were able to achieve a complete score in cycle I, 21 people in cycle II, and 30 people in cycle III. The percentage of completeness increased from 51% to 60% then 86%. Based on the data in Table 1, it is known that the number of students who are not complete in learning has decreased significantly. The results of this student knowledge test are supported by a perception questionnaire. The average statement of learners is at the level of strongly agree 49% and agree 51% that there is an increase in understanding the material, collaboration between friends, and communication in learning.

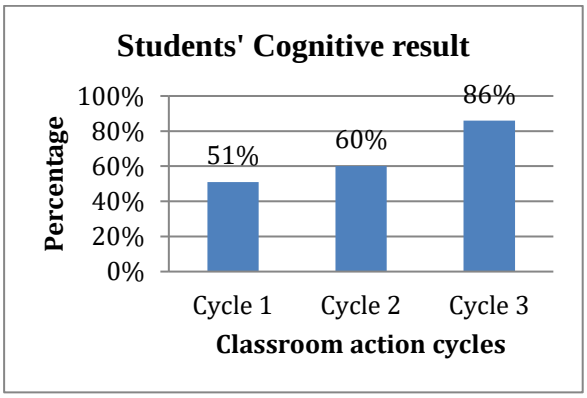

Figure 1. Percentage of students' score

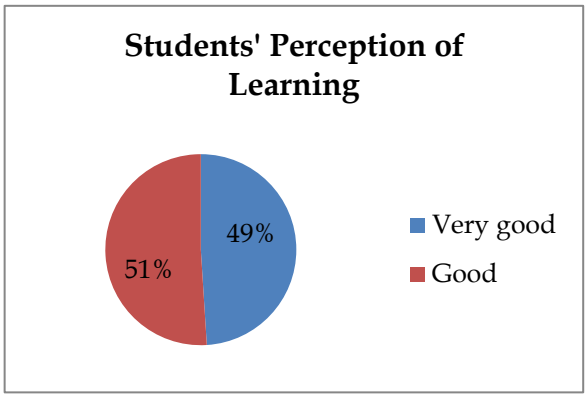

Figure 2. Percentage of students' perception towards problem based learning model

The results show that problem-based learning model on biotechnology material has an impact on the learning process. The average student's cognitive was increased significantly. At the beginning of the cycle, students who completed the score test were 18 students. The teacher evaluated the learning media and worksheet to improve based on the problem related to their activity and culture. In the 2nd cycle, teacher prepares the problem related to students habitual. For instance, a familiar product (yoghurt, bread, and service related to traditional biotechnology. Lastly, in the 3rd cycle teacher provides the problem that leads students to understand the steps of using modern biotechnology. The questionnaire results of students' perceptions towards PBL show 49% are in the category of strongly agree and 51% agree that learning using PBL improve their score and understanding. This is supported by interview data where students said that "learning is exciting, not the same as before". The students state that learning with the discussion and presentation process helped them gain more understanding from different perspectives.

Through the problem-based learning model, students are able to explain the meaning of biotechnology, the role of microorganisms, the principles of developing products or services, types of biotechnology, and positive and negative impacts, and differences. The students state that during learning students were able to develop critical thinking and active collaboration during the group discussion and communication during the presentation. A total of 21 studies using literature review methods related to articles on problem-based learning within five years

2018-2022, proved that problem-based learning model can improve students' critical thinking and cognitive outcomes in biology learning (Agnesa & Rahmadana, 2022). Besides, the study from Assegaff & Sontani (2016) stated that problem-based learning model also improves students' analytical thinking skills.

The problem-based learning model increases students' cognitive aspect. It occurs because of the activities provided by the teacher both individually and in group formats (Manuaba *et.al.*, 2022). During research, the group of students consisted of high and low cognitive scores. Students are encouraged to work together to complete a mission. Learners in the group will share different knowledge and experiences. Through communication and information sharing, there are activities such as doing the task, asking questions, expressing curiosity, expressing their answer and ideas, and exchange of knowledge and information among learners in the group (Sari, 2018). Students were encouraged by the teacher to collaborate and study together to complete the task. This explanation is supported by class action research by Apriana (2023) that found at the end of the cycle the students' understanding had increased from cycle I with 60 % to cycle II 80%.

Implementing PBL in the classroom increases students' activeness and enthusiasm (Yovianda et al., 2019). Students start to ask questions and express their opinions during learning activities. During the learning process, students' cognitive could increase if they are assisted by someone who understands completely the communication and sharing with peers or adults. It is related to Vygotsky's (1978) theory of zone proximal development which is cited from Jones & Araje (2002) which refers to the range of tasks that a student can perform with the help of a more knowledgeable person, such as a teacher or a peer. In this zone, students are able to tackle challenges that are just beyond their current level of understanding, but with appropriate guidance, they can successfully complete them. It is a way to scaffold learning and promote cognitive development. In line with research conducted by Adjiningsih & Sriwattanarothai (2022) states that learning with a cooperative model or discussion will improve students' understanding.

Problem-based learning model creates an active learning atmosphere. The activities not only transfer information from teachers to students but also construct knowledge based on understanding and experience. The teacher was required to design a lesson that would make students actively ask questions within the lesson and collaborate to achieve the agreed decision from all involved (Caesar et al., 2016). According to the research by Liu & Liu (2021), Teachers should act as facilitators and guides rather than leaders in problem-based learning. In the beginning, teacher needs to set the basic rules of the formation. For example, students need to emphasize respect during the lesson, which means even if students do not agree with the group's opinions, they should still listen.

According to the questionnaire analysis, students agree that problem-based learning helps learning to be more easily understood. This is proven by the scores of students who have increased in each cycle. Similar to Meilasari et al., (2020) in science learning research, the problem-based learning model has a significant effect with a percentage of 76%. The advantages of applying problem-based learning are that there are many materials that can be used as discussion topics and develop students' critical thinking. Meanwhile, the weakness is the implementation requires a long time and there are still some students who still rely on their group (Nadeak & Naibaho, 2020).

Conclusion

Problem-based learning model can improve cognitive learning outcomes of students in class X-F SMA Negeri 6 Madiun. The improvement was shown by the number of students who passed the minimum score increased in each cycle. Problem-based learning shifts the

focus from passive content delivery to active engagement and problem-solving. Through collaborating with small group discussions, students help to improve their understanding as well as their cognitive test results. It encourages students' active engagement and participation, promoting a deeper understanding of concepts and fosters teamwork, collaboration, and effective communication skills by asking and expressing their ideas when students are working together. PBL Also promotes self-directed learning, helping students develop research skills, independent thinking, and the ability to acquire knowledge from various sources.

Biology teachers are expected to always innovate in implementing learning systems that are active, creative, effective, efficient and innovative. In addition, further research related to the motivation and attitude of students needs to be done. Based on the data findings, students have improved in the knowledge aspect but there has been no research related to the motivation and attitude of students during learning.

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