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Literature study: Application of the Problem-Based Learning (PBL) learning model to improve problem-solving abilities and cognitive learning outcomes in biological sciences

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ARTICLE INFO	ABSTRACT
<p>Article history</p> <p>Submission 20 March 2024</p> <p>Revision 14 May 2023</p> <p>Accepted 28 October 2023</p> <p>Keyword:</p> <p>Problem-Based Learning</p> <p>Problem solving</p> <p>Cognitive learning outcome</p> <p>Biological science</p>	<p>Students are required to be able to master 21st-century skills in learning biology. One of the demands of 21st-century skills is the ability to solve problems and biology learning outcomes. This study aims to analyze the effect of Problem-Based Learning model on problem solving ability and cognitive learning outcomes of biological science with literature study analysis. This research is a literature study with a narrative review type. The scientific articles used in this study amounted to 31 articles, consisting of 2 international journals, 18 accredited national journals, 3 unaccredited national journals, 3 proceedings, and 5 theses. The search for scientific articles was carried out through www.scholar.google.co.id and http://www.doaj.org. The data analysis technique was descriptive. The results showed that the Problem-Based Learning model had an effect on the ability to solve problems and cognitive learning outcomes of biological science.</p> <p>This is an open-access article under the CC-BY-SA license</p>  

Introduction

The ability to solve problems is one of the benchmarks of one's quality in this modern era. Problem solving in the context of science learning has become a major theme in research. In addition, problem solving activities help students to construct new knowledge and facilitate science learning (Mukhopadhyay, 2013). To better face the challenges of the 21st century, teachers prepare students to become a person who has the ability to be a

researcher, think critically, creatively and solve problems (Barell, 2010).

Based on Lestari et al. (2017) the learning process that is not varied can make students less develop their thinking skills so that students still have difficulty in solving problems given by teachers related to real problems in everyday life. Students' ability to solve problems is still low because the teacher still applies the lecture method and is still teacher-centered so that students are less active in classroom learning. Bahri's research (2018) said that one of the factors

affecting the low achievement of students' problem-solving skills comes from within. Students find it difficult to digest biology lessons because the material is considered difficult and must memorize a lot and use scientific language that is rarely used in everyday life.

According to Rusman (2015) learning outcomes are a number of experiences obtained by students covering the cognitive, affective and psychomotor domains. Learning is not only mastery of the concept of subject theory, but also mastery of habits, perceptions, calmness, interests-talents, social adjustment, skills, ideals, desires and expectations. Asih (2018) argues that the low cognitive learning outcomes of students are caused by, among others, the use of inappropriate learning methods or models, and the low ability to think and understand the concepts of students. According to Bustami, et al (2019) the low cognitive learning outcomes of students are due to the learning process carried out mostly still centered on the teacher, so that the teacher is more and dominates teaching and learning activities. On the other hand, the learning process more often uses conventional methods such as lectures. This is in line with research conducted by Kesuma (2013) that conventional learning methods can cause low student learning outcomes.

One alternative solution to overcome the above problems is to choose an effective learning model that can affect the ability to solve problems in learning biology. The selection of the right learning model will make students more active and enthusiastic when following the learning process in class. One of the learning models that can develop students' thinking skills. The learning model applied is Problem Based Learning (PBL). PBL is a learning model that uses real-world problems as a context for students to learn about how to think and problem-solving skills, as well as to gain essential knowledge and concepts from learning materials (Utami, 2013).

This research is a literature review research whose preparation is almost the same as other studies, but the sources and research methods to be used are scientific article sources within 10 years (2011-2021) by taking library data, reading, recording, and processing data used as research data. The data used by researchers is secondary data with research variables, namely problem solving ability and cognitive domain student learning outcomes. Researchers use relevant articles and journals in accordance with the title of the research carried out. The results of these data were analyzed to become a result of the discussion of research on the application of Problem-based learning (PBL) to problem solving skills and cognitive learning outcomes of Biological Science. Method

Method

This research is a literature study in the form of a narrative review. The criteria for scientific articles used as data are scientific articles sourced from journals, proceedings, theses, theses, and dissertations with 10 years of recency, namely from 2011-2021. The steps taken in order to search for articles as literature research data are as follows:

1. Determination of the search database

The data collected are data from accredited national journals, non-accredited national journals, international journals, theses, and proceedings or theses that are relevant to the research. The literature search was conducted through the Google Scholar website and the Directory of Access Journals (DOAJ)

2. Search keywords

The keywords used to search the literature in this study are as follows Problem Based Learning model and Problem solving skills, cognitive learning outcomes, Problem Based Learning and Problem solving skills. Indonesian keywords are used to search for journal articles on Indonesian-based journal search engines, while English keywords are used to search for articles with English-based journal search engines. Based on the

<https://www.doaj.org> was 12 articles,
<https://scholar.google.com> was 36 articles

3. Article Selection

The next step was to select scientific articles by eliminating scientific articles with the same topic ideas if found in each source. The goal is to minimize the possibility of duplicate research topic ideas. Scientific articles were also selected by year, namely from 2011-2021, including quasi-experimental research or classroom action research. The data obtained at this stage were 48 scientific articles.

4. Validation/Review of Literature Quality

The process of validation or review of the quality of scientific articles is carried out by adjusting the scientific articles found according to the research topic, namely the problem-based learning (PBL) learning model to improve problem-solving skills and cognitive learning outcomes in biological science. Validation / Review of the quality of literature is carried out by students together with the supervisor by reading and identifying scientific articles that have been found in accordance with the criteria of the research topic to be carried out or not. The validation process of literature quality is carried out with the following considerations:

K1: The journal can be accessed for free (Open access);

K2: The quality of the research methodology used in scientific articles is included in the types of classroom action research and quasi-experiments.

K3: Quality of data presentation and discussion. This process is done by looking at how the data is presented so that it becomes a discussion related to the research topic.

K4: Sufficiency of data to be analyzed; related to the research topic, biology or science material.

K5: The references are up to date and relevant to the 10-year time span (2011-2021).

The validated data was entered in the validation table and then validated by reading it thoroughly and identifying its

suitability with the 5 predetermined criteria. The validation table consists of table heads including number, title of the journal, criteria 1-5 and conclusion. Scientific articles that meet the criteria are given a check mark (✓), while scientific articles that do not meet the criteria are given a cross (×). Articles that meet all 5 criteria in the conclusion column are given a blue check mark, which means that the article passes validation and can be used as data reviewed in this study, while those that do not meet all 5 criteria are given a red cross, which means that the article does not pass validation and is not used as data in this study.

Results and Discussion

Article searches use the keywords Problem based learning model and problem solving ability and cognitive learning outcomes. Based on the search results with the specified keywords, 48 were obtained from two databases. The keywords used in the search were problem based learning, problem solving abilities, and cognitive learning outcomes. Based on search results with the specified keywords, 48 were obtained from two databases (can be seen in Table 1).

Table 1. Article search results based on keywords

No	Key words	Data base	Amount
1	“model pbl” or “kemampuan memecahkan masalah” dan “hasil belajar”	Google Scholar	36
2	“model pbl” or	DOAJ	12

	“kemampuan memecahkan masalah” dan “hasil belajar	(Directory of Access Journals)	
	Total		48

There were 48 articles obtained at the start of the search. Data was obtained through a search process, namely the process of collecting articles obtained online by accessing directly to the article website used. The process of collecting articles as research data for literature studies begins by visiting the following websites: <http://www.scholar.google.co.id>. got data for 36 articles, <http://www.doaj.org> got data for 12 articles. There were 48 scientific articles obtained with the keywords "pbl model" or "problem solving ability" and "learning outcomes" and then the articles underwent a selection process to determine relevant research results.

Extraction of articles was carried out to group two sub-topics, namely students' cognitive learning outcomes using the PBL model and cognitive learning outcomes and ability to solve problems using the PBL model. The grouping of scientific articles is done to make it easier to choose the type of article that suits the sub-topic. The data from grouping articles based on research sources is presented in Table 2.

Table 2. Results of extraction of research data articles

No	Sub Topics	Number of articles used
1	Student cognitive learning outcomes using the PBL	9
2	Cognitive learning outcomes and	11

	ability to solve problems and with the PBL	
	Amount	20

Based on data from the analysis of scientific publication articles that have been carried out, it can be seen the influence of the Problem-Based Learning learning model on problem-solving abilities and cognitive learning outcomes in biological sciences.

The influence of the PBL model on students' cognitive learning outcomes

Learning outcomes are the most important part of learning. Student learning outcomes are essentially changes in behavior that occur through the learning process. These changes in behavior are in the form of students' abilities after learning activities, which are the result of learning gains. According to Sudjana (2016), the cognitive domain concerns intellectual learning outcomes which consist of six aspects, namely: knowledge/memory, understanding, application, analysis, synthesis and evaluation. This research focuses on students' cognitive learning outcomes. According to research conducted (Magdalena, 2016), students who are used to being taught using the PBL learning model show a significant effect on improving students' cognitive learning outcomes.

Based on research data, it shows that 9 scientific articles are relevant to the topic of the influence of the PBL model on students' cognitive learning outcomes. The results of the descriptive analysis show that there are several studies that use the PBL learning model combined with learning strategies or other variables, or with the help of learning media so that it influences students' cognitive learning outcomes in biology science subjects. The results of the analysis show that the PBL learning model has an effect on student learning outcomes, namely an increase in learning outcomes. This is thought to be because the syntax of the PBL model can facilitate students'

learning to solve biological problems. The increase in students' cognitive learning.

outcomes occurred perhaps because of the influence of the PBL model which uses real world (contextual) problems, providing opportunities for students to be able to practice more in improving and developing their problem solving abilities so they can be applied in everyday life. These problem-solving abilities include the ability to formulate problems, formulate hypotheses, collect data, recommend problem solutions and draw conclusions.

The PBL learning model is a learning model that invites students to work in groups and develop knowledge, reasoning, critical thinking, and gain experience in group discussions. Research (Anggraini et al., 2020) shows that cycle II learning activities using the PBL model have increased. Things that were weaknesses in cycle I could be resolved in cycle II. The teacher can now control the class, so that all students are active and focused on learning, even though there are still 1 or 2 students who are busy. Because cycle II had reached the indicators of success of the action, the research was stopped in cycle II. Research by Harnitayasri & Suryani (2015) shows that the Problem Based Learning (PBL) learning model with environmental pollution material is effectively used in terms of several assessment aspects as follows. Student activities were carried out with an average of 75.70% in the active category, the results of students' biology learning after being taught using the PBL model the posttest score is in the very good category. Increased student learning outcomes after being taught using the PBL learning model in class

Research by Fauzan et al. (2017) found that improving cognitive learning outcomes, social attitudes and students' skills by applying the PBL model was better than conventional learning, especially on solar system material. Research (Ilmi, 2019) This shows that there are differences in cognitive learning outcomes between students who are facilitated by the PBL

model and the control class. The average cognitive score also shows that the PBL-facilitated class is higher than the conventional class, namely the average cognitive score is 81.48. Thus, it shows that there is a significant influence of the use of the PBL model on students' cognitive learning outcomes.

Research by Hardiyanti, Nurhidayati, and Efendi (2017) states that there are differences between the cognitive learning outcomes of experimental class students taught using the Problem Based Learning learning model and control classes taught using conventional learning models. Research (Sari et al., 2019) shows that there is no significant influence on the PBL model with the help of video media on student learning outcomes in excretory material in class XI-1 SMA Pencawan School Medan in the 2016/2017 academic year. This increase is not yet optimal because the teaching time is too short. The researcher believes that if the teaching time is long enough, the improvement in learning outcomes using the PBL model will definitely be much greater than before using the model, especially since the learning process that uses video assistance increases understanding in seeing the content of the teaching material, so that students are better able to understand the content of the learning material that will be conveyed in the lesson.

Hasan & Syatriadi's (2018) research shows that the implementation of the PBL model using concept maps has an effect on improving students' critical thinking skills and cognitive learning outcomes. This is because it makes students learn more actively in uncovering the problems that arise, thereby encouraging students to seek information from various sources relating to these problems. Research by Norrazifiti & Dian (2019) states that there is an influence on student learning outcomes on environmental pollution material for the Experiment class, which obtained a Mean posttest score of 80.28 compared to the control class, which obtained a Mean

posttest score of 74.08. These results prove that the learning outcomes scores of students taught using the PBL model are higher than students taught using the conventional learning model.

The influence of the PBL model on the ability to solve problems

The ability to solve problems (Problem Solving Skills) is the ability to identify problems, formulate problems, formulate hypotheses, draw conclusions and make choices to solve a problem in accordance with the expected goals. Students in the problem solving process must use a scientific and structured approach. Students must often be trained to solve problems with various types of learning approaches that make students active. Learning with a scientific approach is designed to improve students' abilities in solving problems (Yuliati, Riantoni, and Mufti, 2018).

Based on the results of the analysis that has been carried out on 20 scientific publication articles, there are 11 relevant scientific articles related to the influence of the Problem Based Learning learning model on the ability to solve problems in biology learning. Supiandi and Julung's (2016) research shows that students' cognitive learning outcomes can be seen from students' academic results in biology subjects which show that students' academic abilities at Panca Setya Sintang High School are in the sufficient range with an average of 76.45 and the minimum completeness criteria (KKM) for biology subjects is 75. From There are still students who have not been able to reach the KKM with an average score of 23.55.

Factors that cause low student cognitive learning outcomes are: 1) the learning process in schools still uses learning methods that use varied lectures so that they are less able to develop students' potential, namely thinking abilities, including the ability to solve problems, which results in low cognitive learning outcomes, 2) students who tend to be passive and teachers who only provide information and learning methods that are

still inappropriate in the learning process, 3) other problems exist in the biology learning process, namely in conveying material that is still theoretical. Biology learning should use real facts or problems in students' daily lives.

21st century skills require students to have the ability to solve problems so that students are accustomed to dealing with real problems in everyday life. Students must be able to find solutions to complex problems. Based on the problems found in scientific articles that have been analyzed and reviewed, a learning model is needed that can foster students' problem solving abilities, one of which is the PBL model.

Research by Hariatik, Suciati, and Sugiyarto (2017) shows that the PBL model combined with Socratic dialogue can foster students' problem-solving abilities because students are more courageous in expressing opinions regarding learning material in class. The interactions that occur between students and teachers will make students more active so that the PBL model with score dialogue has an effect on students' problem-solving abilities in biology learning.

Apriyanti's research (2014) proves that the Problem Based Learning (PBL) model can improve students' problem-solving abilities and mastery of concepts. This is in accordance with the opinion of Turgut (2009) who states that the PBL learning model is more effective than traditional learning in training students' abilities and skills and can strengthen students' memory of knowledge and skills during the learning process. This is because knowledge is formed by students themselves from group discussion activities to solve problems faced during the teaching and learning process.

The Problem Based learning model has advantages, including the problem solving process so that the material being studied can be understood by students. The problems presented are related to real life so that students are interested in finding out more deeply. Develop critical thinking

skills to adapt to new knowledge. The PBL model can improve students' intellectual abilities in solving problems. The reasons underlying the superiority of the Problem Based Learning model in achieving influence in improving students' Problem Solving Skills abilities can be viewed in terms of Problem Based Learning syntax. According to Arends (2008) there are five stages that must be passed in implementing the Problem Based Learning model, including: 1) providing problem orientation, 2) organizing students to research, 3) assisting with independent and group investigations, 4) developing and presenting the results of work, 5) analyzing and evaluating the process of solving problems.

Based on these stages, it will make students more active during the learning process. The aspects of problem solving ability will be interconnected with the syntax in the Problem Based Learning learning model. This can be seen from the syntax of the PBL learning model which can accommodate existing aspects of problem solving abilities so that students will use their thinking abilities to find solutions to solving a problem. The syntax of the PBL model can facilitate students in developing problem solving abilities. These results are in accordance with research conducted by Jairina, et al. (2020) showing that the Problem Based Learning model has an influence on students' problem solving abilities because the Problem Based Learning syntax can train them to carry out the problem solving process so that it can grow students' ability to solve problems.

Conclusion

Based on the results of the literature review analysis research, it can be concluded that the application of the Problem Based Learning learning model can improve problem-solving abilities and cognitive learning outcomes in biological material.

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