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Improving the Cognitive Ability of Senior High School Students on the Subject of Biological Technology Innovation through Problem Solving LKPD based on Lesson Study

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ABSTRACT

Learning problems in class X-I SMAN 6 Madiun lead to cognitive aspects. The majority of students have not been able to achieve completeness in biological technology innovation material, students have not been actively involved, and teachers rarely use student worksheets (LKPD). This study aims to improve the cognitive abilities of students after participating in the biology learning process on biological technology innovation material using lesson study-based problem solving worksheets. The research method used was Classroom Action Research which was carried out in 3 cycles. Each cycle consists of four stages, namely planning, action, observation, and reflection which are collaborated with the lesson study stages, namely plan, do, and see. The results showed that there was an increase in the n-gain value from cycle 1 of 30.74%, cycle 2 of 49.17%, and cycle 3 of 64.36%. Strengthened by the achievement of completeness has increased from cycle 1 to cycle 2 and to cycle 3, namely from 3.45%, to 82.76%, and to 89.66%. The conclusion of this study is that the application of lesson study-based problem solving worksheets can improve students' cognitive abilities. The benefits obtained by students are that through problem solving worksheets students can improve cognitive abilities, make the learning atmosphere more enjoyable and make students active in class.

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INTRODUCTION

The quality of education can be improved explicitly in the cognitive domain of students. The biology learning process requires direct experience for students to build their own knowledge (Marsa, 2016). One of the learning tools is through Problem Solving Learner Worksheet (LKPD).

LKPD is defined as a means to assist learning activities in the classroom that are

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arranged systematically, contain descriptions of the content of tasks (theory and practice), and provide directions on how the activity will be carried out by students (Saleh, *et al.*, 2023). Problem solving is an attempt to find explanations and answers to any problems encountered. LKPD problem solving is a student worksheet that contains cases in everyday life that require problem solving associated with learning material and used as a learning resource (Aini, *et al.*, 2019). Based on the research of Novitasari & Puspitawati (2022) problem solving needs to be trained in every material content in accordance with the current independent curriculum. Research from Sihafudin & Trimulyono (2020) states that through problem-based LKPD (problem solving) can make students play an active role in the learning process, and make students have a role in social life. Learning activities can be carried out using a problem-based learning (PBL) learning model.

The problem-based learning (PBL) model is a curriculum and learning process (Ayunda, *et al.*, 2023). The main idea of the PBL learning model is to help students be independent, confident, actively express opinions, and have good skills (Novita, *et al.*, 2022). Model integration needs to be harmonized with learning tools in the form of LKPD. Elfina & Sylvia (2020) states that the role of LKPD is very important in the implementation of the learning process because it can increase student activity and PBL can create student-centered learning through the problem solving process. Research by Parapat, *et al.*, (2023) explained that the existence of problem solving-based LKPD in the learning process can increase student activity and make it easier for students to understand the material. Learners can search based on research or investigation, based on theories, concepts, and principles from various sciences (Mayasari, *et al.*, 2022). Teachers need to prepare lesson plans that meet the learning needs of students well, one of which is through lesson study.

Lesson Study is a collaborative and sustainable educator professional training model between teachers and researchers, teachers and lecturers, and researchers and lecturers so that a learning community is formed. Prayitno & Hidayati (2016) research through lesson study observers can provide information on the shortcomings and strengths of teachers in the classroom so that the quality of learning and learning effectiveness can be known. Strengthened by the research of Sari & Hidayat (2023) that lesson study can increase the collaboration of teachers to exchange ideas and provide feedback in learning, so that it has an impact on students being able to understand the material well. Salasiah, *et al.*, (2023) explained that the design of learning tools prepared by lesson study can equalize teachers' perceptions regarding learning activities and the achievement of learning carried out. Komarudin, *et al*. (2023) explains that lesson study in learning is used as an effort to improve competence and self-reflection after the learning implementation process.

Problems during learning generally lead to 4 aspects, namely infrastructure fulfillment, fulfillment of teaching materials, learning models, and learning media (Yuhanna, 2021). Based on the results of initial observations made by researchers on one of the biological subjects, namely biological technology innovation for 29 students in class X-I SMAN 6 Madiun, it was found that students had not been able to achieve the expected learning outcomes. This is evidenced when the teacher gives a pre-test question at the beginning of learning, there are still many students who have not reached the KKM score and during the discussion some students are not active so they only rely on their groupmates.

Based on the results of interviews with biology teachers at SMAN 6 Madiun who teach class X, information was obtained that biology teachers very rarely make their own LKPD that will be taught to students and more often use the same LKPD from year to year. The commonly used LKPD has a cognitive level between C1-C2 so that students have not been trained to think at a higher level. By looking at the problems that occur, one of the learning activities that are expected to improve the cognitive abilities of students is through problem solving LKPDs that are prepared in a lesson study.

From the above advantages, it can be seen that the use of LKPD problem solving based

on lesson study can improve the cognitive abilities of students in learning biology. Therefore, to prove this, research is needed with the aim of improving the cognitive abilities of class X-I SMAN 6 Madiun on the subject of biological technology innovation through LKPD problem solving based on lesson study. The benefits of this research in the learning process are that it can activate students, especially active in discovering new knowledge as a result of transferring knowledge into real-world problems, developing cooperation skills, and communication skills.

METHODS

The method used in this research is the Classroom Action Research method of the Kemmis & Mc Taggart model (1988). Classroom action research is a systematic research carried out by teachers, education organizers or others who give hope to teaching and learning activities (KBM) with the aim of collecting various information such as how schools work, teachers and how students learn (Hasan, *et al.*, 2023). The implementation of this action research includes four steps, namely: planning, action, observation, and reflection collaborated with the stages of lesson study, namely plan, do, and see for 3 cycles.

Planning Stage (Plan)

The action planning consisted of general planning and specific planning. General planning consists of the time of research implementation starting in March - May 2023, the research site in class X-I SMAN 6 Madiun with a total of 29 students. Special planning consists of discussion-presentation learning methods, problem-based learning models, teaching modules, teaching materials, teaching media, and assessments on biological technology innovation materials.

Action Implementation Stage (Acting/Do)

Implementing the content of the pre-planned design in class X-I SMAN 6 Madiun for 3 learning cycles. The research instruments used in data collection were formative tests consisting of pre-test, LKPD and post-test. The tests were given in the form of multiple choice, true false, and short form where there were 10 questions for each cycle. The tests were arranged based on the cognitive aspects of Bloom's taxonomy which consisted of HOTS questions at the C3 (application) and C4 (analysis) levels. The purpose of this test is to analyze the improvement of students' cognitive abilities on biological technology innovation material for three cycles as an implication of PTK.

To calculate whether there was an increase after the research was carried out, the researchers used the N- gain (Normalized-gain) formula.

$$g = \frac{score\ post\ test - score\ pre\ test}{score\ ideal - score\ pretest}$$

To analyze the data from the gain score data, you can use the gain score category Table according to Hake (1999).

Table 1. N-*gain* Score Categories:

N-gain Score Distribution	
N-gain Value	**Category**
g > 0.7	High
0.3 < g < 0.7	Medium
g < 0.3	Low

To show the percentage level of completeness of students, seen from the pre-test or post-test score, it can be calculated using the formula:

$$Percentage = \frac{number\ of\ students\ completed}{Total\ number\ of\ students} x\ 100$$

Observing

Conducting observations during the action on what happens in the classroom to record learner activities referring to the lesson study format (FLO-ILS).

Reflecting/Seeing stage

Review what has been done during the action research and then develop a follow-up plan.

RESULTS AND DISCUSSION

N-gain Cycles 1, 2, and 3

Based on the calculation of all gains in cycles 1, 2, and 3, the gain categories can be seen in Table 2.

Based on Table 2, the high N-gain category from cycle 1, 2, 3 increased from 0%, 10.34% and 31.03%, the medium category also increased from 48.27%, 72.41% and decreased to 55.17% because it switched to the high category, and the low category decreased from 51.72%, 17.24%, and 13.79%.

Table 2. N-gain categories in cycle 1, 2, and 3

No.	N-gain categories	Cycle1	Percentage	Cycle 2	Percentage	Cycle 3	Percentage
1.	High	0	0%	3	10.34%	9	31.03%
2.	Medium	14	48.27%	21	72.41%	16	55.17%
3.	Low	15	51.72%	5	17.24%	4	13.79%
Total		29	100%	29	100%	29	100%

The overall average N-gain value from cycles 1, 2, and 3 has increased, namely from cycle 1 by 30.74%, cycle 2 by 49.71%, and cycle 3 by 64.36%. The three cycles can be seen in Figure 1.

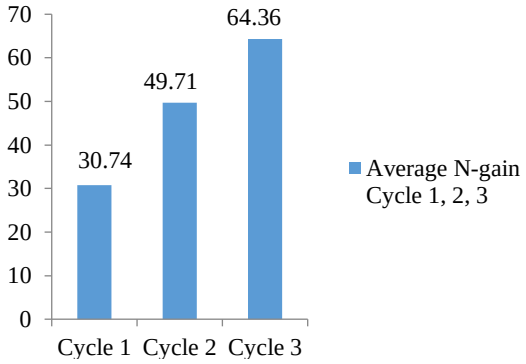

Figure 1. Average N-gain Cycle 1,2,3

Analysis of Achievement of KKM Cycle 1, 2, and 3

Based on the calculation of all learning outcomes in cycles 1, 2, and 3, the categories of complete (T) and incomplete (TT) students are obtained which can be seen in Table 3.

Table 3. Improvement in Achievement of KKM in Cycle 1, 2, dan 3

	Cycle 1		Cycle 2		Cycle 3	
	T	TT	T	TT	T	TT
The number of students	1	28	24	5	26	3
Percentage	3.45%	96.55%	82.76%	17.24%	89.66%	10.34%

Based on Table 3 above, the category of complete learners increased from cycle 1 as many as 1 learner, cycle 2 to 24 learners, and cycle 3 to 26 learners. While incomplete learners decreased from cycle 1 as many as 28 students, cycle 2 to 5 students, and cycle 3 to 3 students.

The average percentage of overall completeness from cycles 1, 2, 3 has increased, namely cycle 1 by 3.45% cycle 2 by 82.76%, and cycle 3 by 89.66%. The three cycles can be seen in Figure 2.

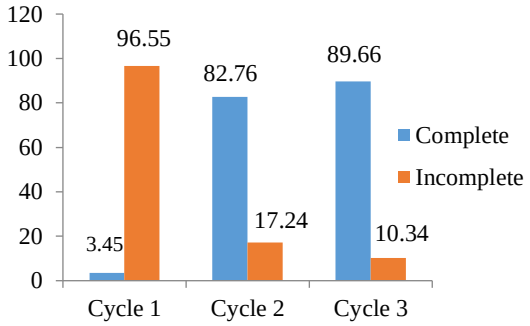

Figure 2. Improvement in Achievement of KKM in Cycle 1, 2, 3

Based on the results of research that has been carried out with 3 meetings with cycle 1 for 1 time, cycle 2 for 1 time, cycle 3 for 1 time, it shows that learning carried out using a problem-based learning model through LKPD problem solving which is arranged in a lesson study can improve the cognitive abilities of students. This is indicated by the increasing cognitive abilities of students with the average n-gain value increasing from cycle 1 to cycle 2 and to cycle 3. The average n-gain value in cycle 1 was 30.74%, in cycle 2 it was 49.71%, and in cycle 3 it was 64.36%. This is in accordance with the research of Istni, et al., 2012 which states that an average of 62% of students have very good critical thinking skills after using problem solving LKPD. Reinforced by the results of research by Adinia, *et al.*, (2022) that problem solving LKPD effectively improves problem solving skills with a gain value of 62% with a moderate category.

In cycle 1, there were 28 students who were not complete, because the students' pre-test scores had not reached the KKM, which was 80. But cycle 2 showed a success that learning with a problem-based learning model using LKPD problem solving was able to improve the cognitive abilities of students, due to an increase in post-test scores from cycle 1 to cycle 2. This is in accordance with the results of research by Danial, *et al.*, (2022) which states that the use of LKPD problem solving obtained an average n-gain of 64% with a moderate category and learning completeness reached 81.82%, this shows that cognitive abilities in solving problems increased.

The success of students to improve their cognitive abilities is influenced by the provision of problem solving LKPD to students. Learners can solve problems well by thinking logically, analytically, and systematically. The problems presented make it easier for students to learn because they are included in contextual problem solving problems. In line with the research of Napsiyah, *et al.*, (2022) that students with different cognitive abilities also have different problem solving abilities. In cycle 1 learners can analyze an article about fields that use biotechnology in making their products. However, many learners experience misconceptions in the part of determining the microorganisms used in making biotechnology products.

Observations of the learning process in cycle 1 obtained other problems, namely in the learning process there are still many students who do not want to discuss with their friends because they only rely on one friend in working on LKPD, while those who tend to play an active role in discussions are students who are classified as smart. In terms of presentation of the results of the discussion, there are still students who are embarrassed and do not even want to present it in front of the class. Learners who are not active in participating in learning cause harm to themselves because when drawing conclusions or being asked questions cannot provide answers. Therefore, teachers need to develop an action plan for the next learning cycle by motivating and guiding students to play a more active role in group discussions and presentations. In line with the research of

Widyasari, *et al*., (2023) that students in doing group activities tend to rely on their friends to do the task, so it is necessary to take action to improve problem solving skills so that students are independent.

In cycle 2 learning gradually improved because students were divided into groups according to the results of the pre-test in cycle 1, combining students with low, medium, and high cognitive abilities proved to increase the activeness of the discussion. This is due to the clear division of tasks by students with high cognitive coordinate their friends in working on LKPD. In accordance with the research of Esminarto, *et al*., (2016) that the existence of heterogeneous teams ensures that all members can learn well, there is a division of tasks for each member, so they do not depend on each other.

LKPD conventional biotechnology material contains video barcodes of making several conventional biotechnology products, students are asked to analyze the principles of conventional biotechnology used in these products. Learners with high cognitive abilities work on questions that tend to be more difficult than other friends, namely the principles of conventional biotechnology and then can explain to their friends, students with moderate cognitive abilities work on questions that are not too difficult and not too easy, namely examples of other conventional biotechnology products and microorganisms used, while students with low cognitive abilities work on the easiest questions, namely the stages of making products based on videos.

Students' understanding increased in cycle 2 because students were able to answer the LKPD by mentioning examples of conventional biotechnology products and the microorganisms used correctly. Learning difficulties experienced by students in cycle 1 can be resolved with the help of their groupmates by discussing. Collaborative activities show that students are active, because they are supported by the use of LKPD which contains material related to everyday life. In line with research by Mafruroh, *et al*., (2020) which explains that phenomena or events that are close to everyday life can be easily remembered by students. Reinforced by research by Siregar, *et al*., (2023) that LKPD which presents various real problems in everyday life (contextual) can stimulate students to learn. However, some students still need a lot of guidance from the teacher to focus and increase motivation in learning. Therefore, teachers need to develop a follow-up plan in the next learning cycle.

In cycle 3, learning gradually improved because students were accustomed to the learning process using problem solving LKPD. Learners are more active in discussions. Learners with low cognitive abilities are decreasing and increasing to medium or high cognitive abilities. This is because students already know the division of tasks in working on LKPD, students are free to ask friends in groups without feeling embarrassed. LKPD in cycle 3 contains questions that require analysis of a picture of the manufacture of several modern biotechnology products. Learners analyze the stages and principles of biotechnology used, the positive and negative impacts of modern biotechnology, and the differences between conventional and modern biotechnology.

The results of this study are in line with the results of research proposed by Sukimarwati (2013) which states that the use of modified free LKPD can have an influence on the cognitive, affective, and psychomotor learning achievements of students. In line with the research of Adinia, *et al*., (2022) who conducted research on the effectiveness of problem solving skills and mastery of biological concepts through problem solving LKPD activities. Another study conducted by Rohmani & Kuntjoro (2023) also suggested that the achievement of critical thinking indicators based on problem solving aspects was also obtained from the pre-test and post-test results. By applying LKPD problem solving, students' critical thinking skills can be improved. Another study was also conducted by Jannah (2021) which suggested that the active learning model supported by LKPD problem solving effectively improved students' problem solving skills.

Learners with different cognitive abilities are able to convey the discussion material to their friends during presentations well, so that

the concepts conveyed can be remembered longer by students. The problem-based learning model using LKPD problem solving was more effective than the conventional learning model applied previously. The problem-based learning model using LKPD problem solving can improve the cognitive abilities of students because it uses the type of problem that is HOTS (higher order thinking skills) so that it requires critical thinking in solving the problem. Through LKPD problem solving, students are required to be more active than the teacher. Students can overcome their learning difficulties by discussing with their groupmates (Shafira & Suratsih, 2023).

The implementation of the lesson study on student teachers and peers can be identified from various things found. Collegial collaboration was built during the plan, do and see activities. During the plan activity, model teachers, student teachers and observers dialogued and exchanged ideas to design teaching modules and their devices so that lesson planning was better organized and optimal for implementation. During the do activity, the observer observes the model teacher and supervises the effectiveness of the discussion that occurs in the group when working on the problem solving LKPD. During the reflection activity, the student teacher and the observer express their opinions to evaluate the do activity, so that the model teacher can continue to improve the quality of learning for the next meeting. Reflection (see) is the most important activity in lesson study because the improvement of the learning process that will be carried out depends on how sharp the observer's analysis is during the learning process (Devi, *et al.*, 2020).

In line with the research of Salasiah*, et al.*, (2023) that at the plan stage the teacher determines the problems faced during learning, then designs lesson plans to deal with these problems collaboratively. In the do stage, teachers use learning tools that have been validated to carry out learning in open lessons/open classes, while other partner teachers are observers. At the see stage, the teacher reflects with the partner teacher to reveal the problems found as well as alternative solutions to problems and document them in the form of an action plan for the next cycle of learning.

Thus, the problem-based learning model using LKPD problem solving prepared by lesson study provides many benefits for students, including being able to create an active and enjoyable learning atmosphere, the learning material presented is more interesting, and is able to improve the cognitive abilities of students.

CONCLUSION

Based on the data from the results of class action research in class X-I SMAN 6 Madiun in the 2022/2023 academic year, it can be concluded that the problem-based learning model through LKPD problem solving which is arranged in a lesson study can improve the cognitive abilities of students with the achievement of n-gain cycle 1 of 30.74%, in cycle 2 of 49.71%, and in cycle 3 of 64.36%. Reinforced by the achievement of completeness of students in cycle 1 by 3.45% in cycle 2 by 82.76%, and in cycle 3 by 89.66%.

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