



Problem-based Learning: Improving 10th-Grade Students' Cognitive Learning Achievements and Collaboration Skills on Protist Material

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Abstract

Good cognitive learning achievements and collaboration skills as one of the 21st-century skills are important for students to have. However, high school students have yet to achieve these abilities, therefore the right learning model is required to improve these two abilities. This classroom action research aims to improve students' cognitive learning achievements and collaboration skills by implementing the PBL model on protist material. The study consists of two cycles, each contains of planning, action, observation, and reflection stages with 10th-grade students as participants. Cognitive learning data was obtained through pre-test and post-test, while collaboration skills data was collected through observation. The test refers to the six cognitive domains, and indicators of collaboration skills was adapted from Greenstein. There is a significant increase in cognitive learning achievements and collaboration skills. Overall, the PBL model is effective to improve collaboration skills and cognitive learning achievements. The results propose ideas for educators to implement PBL for teaching and learning activities.

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INTRODUCTION

The 21st-century challenges require students to be able to collaborate (Hartina et al., 2022). It's because the current contextual problems are increasingly varied and more complex (Hairida et al., 2021). Students also tend to prefer virtual interaction, with their eyes glued to their phone screen, rather than direct interaction with the person close to them. As a result, face-to-face interactions are less frequent. This kind of social skills will affect their mindset when they enter the world of work, they will encounter difficulties when they have to build good working relationships with their colleagues (Moradian et al., 2020). So, good collaboration skills are needed to create more effective and efficient problem-solving solutions. This is due to the equally assigned responsibility rather than one-party responsibility (Bansal et al., 2019). Collaboration also enables the students to come to better solutions, compared to individually-made decisions (Le et al., 2017). Collaboration is one of the must-have 21st-century skills that encourage direct interactions between individuals to achieve the ultimate goal, which not only combine work, but also involves discussion, negotiation, and accommodation (Kozar, 2010). Therefore, it is important to develop students' collaboration skills so they will be ready to work collaboratively in different situations with diverse peers.

Collaboration in solving contextual problems with diverse peers and different kinds of situations also needs the support of an adequate understanding of the problem itself. This is where in-depth mastery of knowledge is needed regarding the problems, phenomena, and events that occur in real-life contexts, so the students are able contribute in solving real-life problems (Rahayu et al., 2022). However, to achieve this, students must be empowered in basic needs first, namely their cognitive learning. The achievements of cognitive learning are related to memory and thinking skills (Angraini et al., 2022). This ability includes the thinking process related to understanding, applying, analyzing, evaluating, and creating (Anderson & Krathwohl, 2001). Hence, before solving the problems, students' cognitive learning achievements also need to be assessed and improved

The problem is, the COVID-19 pandemic these past few years has caused a change in learning practice from face-to-face to distance learning, and unfortunately, the teachers, schools, students, and parents were not ready for that (Nugraha, 2022). As a result, there has been learning loss and learning gap which its impact is prominently felt during the new normal era (Perusso & Baaken, 2020). During the pandemic, students lost the opportunity to learn collaboratively. The result of previous research revealed that during the pandemic, students only worked on assigned worksheets, causing boredom, students did not know each other, communication happened in one way between the teacher and students, and lastly collaboration skills were not the main focus of learning (Ilma et al., 2022). Even though in facing challenges in the 21st century, collaboration skills are needed to encourage students to be able to solve the problems (Davidsen et al., 2020) by carrying out various roles, interacting positively, depending on each other (Sahin et al., 2014), as well as developing cognition and knowledge (Hidayati, 2019). Therefore, teaching and learning process in school should be the place where the students can practice and improve their collaboration skills.

SMA Negeri 2 Batu is one of the schools in the city of Batu that has yet achieve its optimum effort to empower its students in terms of collaboration skills. The observations during pre research shows that the taught applied group learning arrangements, but students seemed confused and only few of them were actively contributed to the group. Supported by the in-depth interview, sample students stated that their classes were dominated by the traditional method of teaching, and lack of learning models variations. Thus, class X students tend to be passive, too accustomed to individual task, and was unfamiliar with learning and working collaboratively in groups. In line with the observation and in-depth interview, the diagnostic assessment showed that 8% of the students were in very low cognitive learning achievements category, 46% in low, 25% in the medium, 21% in high, and 0% in very high category. Thus, efforts are needed to empower collaboration skills as well as cognitive learning achievements of class X students of SMA Negeri 2 Batu through appropriate learning models.

Problem-based learning (PBL) is a potential model to appropriately empower collaboration skills and improve cognitive learning achievements. It is because PBL provide opportunity for students to gain understanding and learning experience through the process of dealing with real problems or solving challenges (Perusso & Baaken, 2020). In solving problems, students are organized in groups so they will learn to build

communication and collaborate by utilizing available resources to formulate problem-solving solutions (Birgili, 2015). The formed communication between group members will encourage collaboration so the students become more active in learning and solving problems collaboratively with their friends (Garnjost & Brown, 2018). Therefore, PBL model is possible to use in order to improve cognitive learning achievements and collaboration skills.

Research about the application of PBL in learning process has indeed been carried out a lot. Previous research findings revealed that PBL able to teach the students of SMA Negeri 1 Muara Beliti to collaborate in order to solve problems (Ariani, 2020). In line with this research, the research in Semarang City shows that PBL can improve collaboration skills in thematic learning of elementary school students (Hartina et al., 2022), improve collaboration skills in class XI students for diffusion and osmosis material in Dompu Regency (Nurwahidah et al., 2021). Apart from improving collaboration skills, research conducted in Sukoharjo also revealed that this model can enhance students' learning achievements in business economics material (Sidi, 2020).

However, research in the city of Batu which examines the improvement of cognitive learning achievements and collaboration skills of grade 10th students for protist material through PBL model has yet been carried out much. Therefore, this research intended to implement PBL model to improve cognitive learning achievements and collaboration skills of grade 10th students at SMA Negeri 2 Batu for protist material. This research is important because the findings could be the basis of further research on PBL implementation at senior high school. In addition, this research could give some input or recommendation for teachers on how to better equip their students with 21st century skills.

RESEARCH METHOD

The design of this research is classroom action research which consists of two cycles. The first cycle was meant for protozoa materials, while the second cycle was meant for algae materials. Each cycle consists of planning, action, observation, and reflection stages (Kemmis et al., 2014). The research was located at SMA Negeri 2 Batu, precisely in Bumiaji, District of Junrejo, Batu, starting from October until December.

During the planning stage, the lesson plan was created by referring to PBL model, then applied in the learning process by following the syntax of the model during the action stage. The action and observation stage are two stages that happens and works simultaneously at the same time, because the observation is possible to do while the action is being carried out (Castro, 2017). The observation was done by the teacher and three observers, namely fellow Biology teachers. Reflection as the final stage was meant to understand the meaning of all the collected data from the action and observation stages.

The subjects of this research were 35 students of class X-10, which contains of 14 male and 21 female students. The reasons for choosing this class were based on the results of observations and preliminary research interviews which shows that students were not used to collaborating, as well as the result of diagnostic assessment which revealed that 46% of the students were categorized as low cognitive ability. So, to improve the cognitive learning achievements and collaboration skills, action is taken in the form of PBL as the learning model. The syntax of this model contains five stages, namely 1) organizing students into problems, 2) organizing students to learn, 3) assisting individual or group investigations, 4) developing and presenting works, 5) analyzing and evaluating the problem-solving process.

Research data was collected by test method using test instrument in the form of pre-test and post-test. Each test instrument consists of 6 essay questions which refer to indicators of learning objectives achievement as well as six cognitive domains from Anderson's Taxonomy (Table 1). In addition to test instruments, observation sheets and rubrics are also used to observe collaboration skills displayed by the students during the learning process. The assessment aspect of collaboration skills adapted from Greenstein (2012) (Table 2). Quantitative data such as test scores and collaboration skills scores were then being analyzed using descriptive statistical techniques. The average of the test scores will be calculated from search cycle, then inferential statistics analysis techniques (Paired-T Test) was used to see the significance increase of cognitive learning achievements on cycle I and cycle II. Furthermore, descriptive statistical analysis was also used to analyze the data of collaboration skills scores, but this time using a mode to determine whether there is an increase in

each collaboration skills indicators or not from cycle I to cycle II.

Table 1. Indicators of Learning Objectives Achievement

Num.	Indicators of Learning Objectives Achievement	Cognitive Domain
Cycle I		
1.	Identifying the definition of protists	C1
2.	Describing the characteristics of protists and animal-like protists (protozoa)	C2
3.	Associating the characteristics of protozoa with their role in everyday life	C3
4.	Analyzing the role of protozoa with real-life context, both beneficial and detrimental roles	C4
5.	Evaluating the disease and the disease-causing protozoa of certain cases	C5
6.	Creating solutions to overcome or prevent disease caused by protozoa	C6
Cycle II		
1.	Identifying the characteristics of plant-like protists (algae)	C1
2.	Explaining the basic classification of algae	C2
3.	Determining the classification of algae	C3
4.	Associating the role of algae in everyday life, both beneficial and detrimental roles	C4
5.	Giving arguments against the environmental problems caused by algae	C5
6.	Creating solutions to overcome problems caused by algae	C6

Table 2. Collaboration skills indicators

Collaboration skills indicators	Criteria
Works productively	Efficient in utilizing the given time Focus on the group-assigned task Doing the task accordingly to the group agreement Tasks completed on time
Demonstrate respects	Listen to others' opinion Discuss all the expressed-ideas Openly accept appreciation, criticism, and suggestions Able to draw conclusions within the group
Compromises	Flexible in working together Prioritizing common goal over individual goals Helping team mates in times of trouble Trying to mediate in a group debate
Contribution to the group	Delegates tasks clearly Doing the best within their ability Follow up on assigned tasks Actively contribute ideas

Adapted from Greenstein (2012)

RESULTS AND DISCUSSION

Cognitive Learning Achievements

The students' cognitive learning achievements are measured by pre-test and post-test sheets for each cycle. In cycle I and II, there was an improvement in the average cognitive learning achievements from before and after the implementation of PBL (Figure 1). Based on the paired t-test for cycle I, there was a significant

difference in cognitive learning achievements between before ($M = 36.94$, $SD = 12.61$) and after implementing the PBL model ($M = 74.83$, $SD = 10.51$), $t(34) = 18.045$, $p < 0.001$. Likewise, there was an improvement in average cognitive learning achievements from 47.49 to 84.46. Based on the results of the paired t-test for cycle II, there was also significant differences in cognitive learning achievements between before ($M = 47.49$, $SD = 25.57$) and after the implementation of the PBL model ($M = 84.46$, $SD = 10.65$), $t(34) = 9.350$, $p < 0.001$.

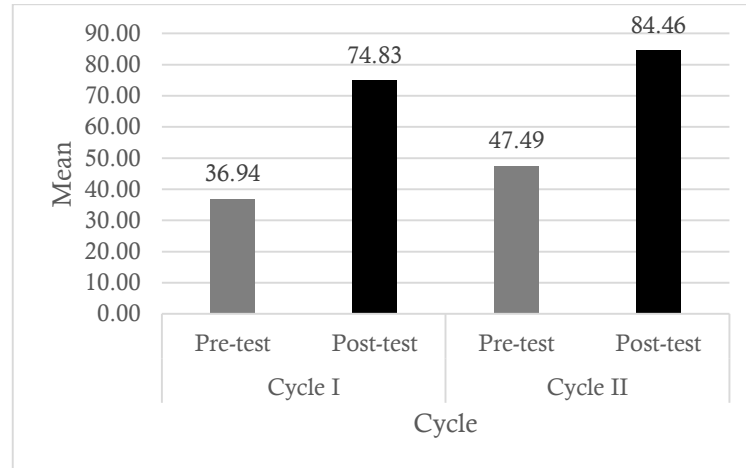


Figure 1. Average score of cognitive learning achievements on cycle I and II

Cognitive learning achievements in cycle I showed an average value of 36.94 with the percentage of students who completed KKM (75) was 0%. However, after implementing PBL model, it was found that there was an improvement to 74.83 with 57% of the students complemented KKM. This improvement was supported by the results of the observations during cycle I, where students were able to follow the syntax of PBL model. Students become more interested when exposed to the real-life problem related to Protozoa. This finding is supported by several previous studies, Lokistawara et al. (2019) in their research showed that PBL can create positive effect on improving students' cognitive learning achievements, because through PBL, students are the active participant in learning. In fact, based on research by Ayuningrum et al. (2015) and Birgili (2015), the PBL model can futher train students not only to conquer learning achievements, but also to train critical thinking skills.

Even so, the number of students who passed the KKM after cycle I was still low. This is because there are still some students who do not pay attention to instructions, sleepy, less active in discussion, and were busy on their phone while the other group members are working (Figure 3). The involvement of the students during the learning process affects the students' learning progress. So, if the students are less involved then it is likely that they will not experience an improvement in learning achievements (Prastya, 2017). Based on the reflection phase, there was a lack of student involvement during the learning process in cycle I because researchers had not reaffirmed the importance of paying attention to instructions and being actively involved in discussions and presentations. Therefore, in cycle II, improvements are made by providing clear and firm references at the beginning so the students could work even more effectively and efficiently.



Figure 2. a) there are students who are always on their phone and chatting outside of group discussion topics; b) there are students who are sleepy during the group discussion

After the actions were perfected in cycle II, the majority of the students became more focused while participating in learning. There are no students who sleep and talk outside of the discussion topic. Students also become more active in asking questions, and presenting their ideas (Figure 3). PBL through its syntax encourages the active participation from the students. Syaveny & Johari (2017), in their research shows that there is a positive correlation between student involvement during learning and cognitive learning achievements, because active participation means that students are responsible for what they learn. In line with this research, Arifin et al. (2020) in their research shows that students who learn with the PBL model have better knowledge retention when compared to students who learn with the direct instruction model. That is, through PBL, students have the ability to capture information, incorporate it into their thinking processes, and recall this information when needed (Zachariah et al., 2022). Thus, there is an increase in cognitive learning achievements.



Figure 3. Students were more active and enthusiastic during cycle II

The obtained results from the entire cycle I and II show that PBL are able to improve students learning achievements. If we look further, this is also rooted from pedagogical frame, where the PBL is a model based on constructivism learning theory. The constructivisme framework as the foundation of PBL model was coined by Savery and Duffy with the premise that, learners should becomes the actively involved party in the learning process to interpret and construct knowledge so that the learning process can take place (Savery & Duffy, 1995). Through PBL, students will define real-life problems, participate in finding information, integrate theory, and develop practical solution (Romanowski & Karkouti, 2021). This way, students able to earn knowledge based on facts as well as learn on how to apply those knowledges and skills in real situations, hence the learning material feels more important and meaningful, and give the sense of urgency for the students to learn (Wulandari et al., 2018). Not only that, PBL instill a systematic way of thinking and learning processes to understand material, which will later have its impact on helping the students think in general, hence improves their cognitive learning achievements (Lapuz & Fulgencio, 2020).

This research's findings showed the advantages of implementing PBL for the learning process to increase students' learning achievements. However, this research contain limitation, namely the measurement of cognitive learning achievements is only based on the results of written test, so it does not pay much attention to the differences of students' learning style. Follow-up plan that worth considering in the future research is to combine written test and oral test or interviews, thus students' ability to elaborate their opinions and ideas possibly honed even more, especially thus with auditory and kinesthetic learning style.

Collaboration Skills

Collaboration skills data were obtained through observaation from cycle I to cycle II. Figure 4 shows that the score for works productively, compromize, and contribution to the group has increased, while the score on demonstrates respect indicator shows no increase from cycle I to cycle II.

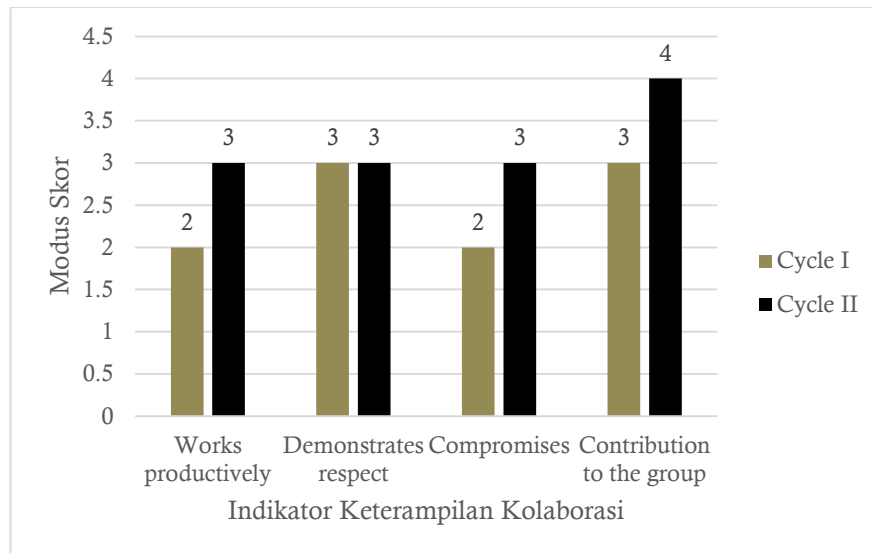


Figure 4. The score mode for each collaboration skills indicators

Collaboration skills in cycle I were dominated by score 2 on the works productively and compromise indicators, while “demonstrates respect” and “contribution to the group” indicators are dominated by score 3. In cycle I, there are several students who are yet to collaborate with their team mates, for example there are several with their eyes glued on their phone screen, creating less positive working environment. By the reflection stage, the group discussion were not conducive enough because there is no clear agreement upon the sanction for those who use their phone outside of the learning purposes. This habit made them paid little attention to their surroundings, basically also because they were so used to individual settings for teaching and learning. This resulted in low collaboration skills in Cycle I.

Therefore, in cycle II, improvements were made by creating and signing class agreement and the observers were asked by the teacher to focus on monitoring how the students use their phone, which only to search for information related to the topic discussion. After completing the action, the mode value on the indicators of works productively, compromise, and group contribution are higher than cycle I. These results were supported by Indriwati et al. (2019) which shows that the improvements of students’ ability to collaborate were made possible by implementing PBL model. Students are encouraged to help each other, care, and share burden to work and finish their assignments well and on time (Davidsen et al., 2020; Indriwati et al., 2019).

The indicators of contribution to the group shows the highest score from both cycles. This is in line with the research conducted by Ibrahim & Rashid (2022), which shows that PBL provides conducive environment to start discussion by taking turns in giving opinions, asking questions, and appreciating one’s ideas. Along with this appreciation, the students especially those with difficulty in expressing themselves will feel valued thereby increasing their self-esteem and made them more enthusiastic in contributing to the group (Lam, 2019). If seen further, PBL generally conducted in small groups, which advantageous because through this arrangement, a learning environment will generate peer pressure to motivate the students to independently study and completing the assigned tasks agreed by the group on time (Schmidt et al., 2011).

The PBL model specifically in “guiding group investigations” and “presenting the works” syntax, provides a good opportunity for the students to present their discussion result and they will receive feedback, both from the teacher and their peers. Research done by Saldo & Walag (2020) shows that the improvement in the ability to compromise was influenced by teacher and peer feedback, which always be given at the end cycle of PBL syntax. From a pedagogical point of view, collaboration skills are also related to constructivism learning theory in which during the feedback phase, namely giving suggestions and questions, students tend to discuss and compromise the problem at hand with their teammates as well as construct knowledge to provide constructive arguments, thereby increasing their collaboration skills, particularly in the compromise indicator (Alvarez et al., 2011; Lapek, 2018).

Students work collaboratively in small group settings to achieve common goals, namely solving real-life problems and finding solutions. The form of collaboration could be contributing ideas, completing assignments on time, preparing good-quality results, and showing cooperative as well as supportive attitudes. Real-life problems, are the distinguish characteristic of PBL, as the learning stimulus encourages the students to develop individual and group accountability skills, so their awareness to actively and productively participate in group discussion is formed (Lapek, 2018). Thus, explains the enhancement from cycle I to cycle II on “works productively” indicators.

For the demonstrate respect indicator, it is known that there was neither improvement nor downturn from cycle I to II. However, based on the observations, it was known that in cycle II, students are no longer constantly glued their eyes to their phone screens, but students have formed a closer collaborative environment. This is supported by previous studies that PBL, which emphasizes activities in small groups, has brought advantages in terms of forming a closer friendships among the students (Schmidt et al., 2011). With good collaboration skills, the student will get accustomed to working effectively and appreciating different perspectives from the group members each one of them bringing different backgrounds and points of view (Hairida et al., 2021), therefore when the students enter the work scheme later on their life, they will be accustomed to building a positive working relationship with their colleagues (Moradian et al., 2020)

CONCLUSION

This study concludes that the PBL model can improve collaboration skills and cognitive learning achievements of the tenth-grade students of SMA Negeri 2 Batu. The results of the research show that students can collaborate even better after the implementation of PBL, indicated by improvements in the collaboration skills indicators. The student’s cognitive learning achievements also significantly increased both in cycle I and II. The result of this study contributes further to encourage further study to examine the correlation between collaboration skills improvement and cognitive learning achievements, as well as providing recommendations for educators and practitioners to consider PBL as the model in their teaching and learning activity to improve the students cognitive learning achievement and collaboration skills.

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