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The effect of the problem-oriented project-based learning (POPBL) model on high school students' collaboration skills on metabolic and cell division materials

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Abstract

The Problem-Oriented Project-Based Learning (POPBL) model is believed to be a learning approach that can effectively facilitate students in developing 21st-century skills. Adopting a student-centered approach is essential to engage students actively in learning activities. This study investigates the impact of the POPBL model on collaboration skills related to metabolic material and cell division. The research employs a quasi-experiment design, and the instrument used for data collection is a collaborative questionnaire that includes peer assessment and self-assessment. Analysis of students' collaboration skills, based on the average collaboration skills calculation, indicates that the experimental class using the POPBL learning model outperformed the control class. Prerequisite tests confirmed that the data are normally distributed and homogeneous. The ANCOVA data analysis results show a significant impact of the learning model treatment, with a significance value of $p = 0.000 < \alpha = 0.05$. This indicates that the hypothesis is accepted, and H0 is rejected. Consequently, there are significant differences in collaboration skills between the experimental class (XII MIPA 3) and the control class (XII MIPA 2). These research findings are expected to serve as a valuable reference for educators seeking effective learning models to enhance the quality of biology education, particularly in improving students' collaboration skills.

Abstrak. *Model pembelajaran Problem Oriented Project Based Learning (POPBL) diyakini dapat pembelajaran yang dapat memfasilitasi siswa agar dapat memberdayakan keterampilan abad-21. Pembelajaran dengan student center perlu dilakukan agar siswa terlibat aktif dalam kegiatan pembelajaran. Penelitian ini bertujuan untuk mengetahui pengaruh antara model POPBL terhadap keterampilan kolaborasi pada materi metabolisme dan pembelahan sel. Metode penelitian yang digunakan dalam penelitian ini adalah quasy experiment, dan instrument yang digunakan dalam penelitian ini adalah angket kolaborasi (Peer assessment dan self-assessment). Analisis data keterampilan kolaborasi siswa dengan dengan hasil perhitungan rerata keterampilan kolaborasi menunjukkan kelas eksperimen yang menggunakan model pembelajaran Problem Oriented Project Based Learning (POPBL) lebih tinggi daripada kelas kontrol. Uji prasyarat terbukti data berdistribusi normal dan homogen. Hasil nilai analisis data ANCOVA memiliki nilai signifikansi perlakuan model pembelajaran yaitu p =0,000<α =0,05 artinya hipotesis diterima dan H0 ditolak. Ini menunjukkan bahwa terdapat perbedaan yang signifikan keterampilan kolaborasi anatara kelas eksperimen (XII MIPA 3) dan kelas kontrol (XII MIPA 2). Hasil penelitian ini diharapkan dapat dijadikan sebagai rujukan model pembelajaran yang memberikan solusi dalam upaya meningkatkan kualitas pembelajaran biologi khususnya untuk meningkatkan keterampilan kolaborasi pada siswa.*

A. Introduction

Education in the era of the Fourth Industrial Revolution (4.0) in the 21st century faces various demands. There is a necessity for skills that can support and are essential in the world of work, such as problem-solving skills, critical thinking, communication, and collaboration with others (Yokhebed, 2019). Through education, we can nurture a superior generation equipped with skills tailored to the needs of the 21st century. Several ways have been done to achieve the development of a particular generation, including learning must be carried out in a student-centered manner, enabling students to acquire critical thinking skills, problem-solving abilities, collaboration and communication skills, informativeness, innovation, creativity, and information literacy (Elitasari, 2022). The 21st-century competencies incorporated into the curriculum consist of six terms, abbreviated as the 6Cs of 21st-century education. These 6Cs encompass critical thinking, creativity, collaboration, communication, culture or citizenship, and character education or connectivity (Shabrina & Astuti, 2022).

Learning in the 21st century demands innovative support systems to engage learners through applied skills and knowledge, appropriate technology, and real-world connections, rendering understanding a reality that must be relevant, personalized, and engaging. The 6Cs must be seamlessly integrated into learning activities to attain the goal of intelligent growth and sustainability. Therefore, teachers must creatively design learning practices in line with the needs of the times to optimize students' skills. The lack of student engagement in biology learning activities can make biological concepts meaningless and challenging to comprehend, posing a problem for schools (Noviar & Hastuti, 2015).

An organization called The Partnership for 21st Century Skills (P21) was founded to ensure students' success in learning within a world of dynamic change. P21 is a national organization that has developed a framework for 21st-century skills. The Partnership for 21st Century Skills (P21) created the P21 Framework for 21st Century Learning, designed to define and describe the skills, knowledge, expertise, and support systems students need to succeed in work, life, and citizenship (One Massachusetts Avenue NW, 2007).

These 6Cs encompass critical thinking, creativity, collaboration, communication, culture or citizenship, and character education or connectivity (Shabrina & Astuti, 2022). The Partnership for 21st Century Skills (P21) identifies three subjects taught to students: life and career skills, learning and innovation skills, and information, media, and technology skills. Learning in the 21st century necessitates innovative support systems to engage learners through applied skills and knowledge, appropriate technology, and real-world connections, making learning a reality that must be relevant, personalized, and engaging.

The 6Cs must be integrated into learning activities for intelligent growth and sustainability. In incorporating the 6Cs, teachers play a crucial role in aiding students to achieve their educational goals optimally. Consequently, teachers must creatively design learning practices to the needs of the times to enhance students' skills optimally. Teachers formulate lesson plans for the learning process, integrating the 6Cs into these integrated skills (Shabrina & Astuti, 2022). One of the 21st-century skills that remains relatively low in Indonesia is collaboration skills (Reni et al., 2021). Collaboration skills are considered transferable skills that will be beneficial in life (Kundariati et al., 2019).

Collaboration is a process of learning to work together to balance differences in opinion and knowledge and actively participate in discussion activities by providing input, listening, and supporting each other (Greenstein, 2012). Collaboration skills can encourage students to actively contribute to achieving joint learning goals. Through collaboration, students depend on each other to solve problems, teaching them to interact with their peers (Ilma et al., 2021). The low level of student collaboration skills is attributed to the fact that learning is still teacher-centered, and teachers are not accustomed to implementing innovative learning models to develop students' collaborative skills in group learning activities. Weak collaboration skills result from two factors, namely external and internal factors. One external factor is that the learning method places more emphasis on individual work (Sidi, 2020). The low level of collaboration skills in Indonesia is supported by the results of previous research conducted by Sidi (2020), showing that the average collaboration skills of students is 63.44%. In addition, it is supported by research from Ulhusna et al. (2020) that group learning results show that there are still many students who have not achieved scores above the KKM (only 40%). The results of research from Sarifah & Nurita (2023) show that the level of student collaboration skills is 39% and is included in the criteria for less collaboration.

To enhance 21st-century skills in students, teachers must implement learning models that can empower these skills, focusing on collaboration skills (Munthe et al., 2023). One alternative learning model that centers around students and involves creating projects to address issues in their surroundings is the POPBL model (Lehmann et al., 2008; McLoone et al., 2014; Wan Husin et al., 2016). According to Rongbutsri (2017), the POPBL model is a collaborative learning approach that combines project-based learning activities within a problem-based learning process. The POPBL model is

characterized by its focus on problems, project engagement, cross-disciplinary nature, student-centered approach, and collaborative elements. It offers advantages such as the ability to motivate students, opportunities to support sustainable education, and students participating in problem-oriented project activities (Yasin & Rahman, 2011).

The described learning process also occurs in a Malang City, East Java school. The findings from the researchers indicate that the collaboration ability in one of the high schools in Malang City is still relatively low. Some students lack awareness of collaboration, tend to be passive in group work, and are indifferent to their group responsibilities. One of the causes of this issue is the inappropriate learning model used, leading to students feeling bored during lessons. Nuzalifa (2021) states that implementing a suitable learning model can enhance learning activities' productivity, effectiveness, and enjoyment.

Based on observations conducted at a school in Malang City, a learning model is necessary to enhance students' collaboration skills, particularly in biology subjects. Using this learning model, the expectation is for students to transition from passive learning to an active learning process with a student-centered approach, thereby improving their collaboration skills. Cooperative learning effectively enhances students' collaboration abilities (Zulfia et al., 2019).

Previous researchers have conducted various studies on the POPBL model. However, in several recent research findings, researchers have used different variables. For instance, Supratman & Ramdhayani (2022) focused on science process skills, Eliyawati et al. (2020) examined the mastery of science concepts, and Sari et al. (2022) utilized learning outcome variables. These studies show that relatively few researchers have specifically investigated the POPBL model about collaboration skills. Moreover, this research employs distinct collaborative instruments, namely self-assessment and peer assessment, which distinguish it from other studies.

Based on this description, this research aims to assess the impact of the POPBL model on students' collaboration skills. The hope is that this research will yield valuable insights as a reference learning model, offering solutions to enhance the quality of biology education and improve students' collaboration skills, ultimately ensuring the achievement of learning objectives.

B. Material and method

The research method employed in this study is a quasi-experiment. The research design is a pretest-posttest control group design, and the sample was selected through random sampling. The study comprises two groups: the experimental class and the control class. Both groups underwent a pretest and a posttest. The experimental class received the POPBL learning model treatment, while the control class was exposed to the PBL learning model.

This research was conducted at one of the high schools in Malang City from September 2023 to October 2023. The population for this research comprised students in class XII MIPA, which consisted of two classes with 70 students. The study utilized samples from classes XII MIPA 2 and XII MIPA 3. The biology material covered in this research focused on metabolism and cell division.

The instruments employed in this research to assess students' collaboration skills were the pretest and posttest, utilizing self-assessment and peer assessment questionnaires. The pretest was administered at the beginning of the learning process to gauge students' collaboration skills. At the same time, the posttest was conducted after the treatment to evaluate their collaboration skills at the end of the learning period. Each self-assessment and peer assessment questionnaire comprised 15 statement items, and respondents were required to indicate their responses on a scale ranging from "always," "sometimes," "ever," to "never." The data analysis techniques applied in this research involved a normality test using Kolmogorov-Smirnov, a homogeneity test using Levene's Test for Equality of Error Variances, and hypothesis testing using the One-Way Analysis of Covariance (ANACOVA) test.

C. Results and discussion

The data discussed here includes the results of the normality and homogeneity tests. The normality test is conducted prior to the homogeneity test and prerequisite tests. The One Sample Kolmogorov-Smirnov test is employed for the data normality test. This test is applied separately for the experimental class using the POPBL model and the control class using the PBL model. The normality test assesses students' collaboration skills, pretest experiments, posttest experiments, pretest control, and posttest control. The decision-making criterion for this normality test is that if the significance value is > 0.05, then the data is considered normally distributed. If the significance value is < 0.05, then the data is deemed not normally distributed.

The homogeneity test is conducted after the data normality test meets the requirements. Once the data meets the normality test requirements, Levene's Test of Equality of Error Variances uses the homogeneity test. The analyzed data is derived from the pretest and posttest results on the dependent variable, namely collaboration skills. The homogeneity test aims to determine the uniformity of the data. If the significance value is > 0.05, then the data is considered homogeneously distributed; if the significance value obtained is < 0.05, then the data is considered not homogeneously distributed.

Table 1 Normality test results

Variable	Pretest		Posttest	
	Significance	Description	Significance	Description
Collaboration Skills	0,082	Normal	0,200	Normal

Table 2 Homogeneity test results

Variable	Pretest		Posttest	
	Significance	Description	Significance	Description
Collaboration Skills	0,140	Homogeneous	0,075	Homogeneous

Table 3 ANCOVA results for collaboration skills

Source	Type III Sum of Squares	df	Mean Suare	F	Sig.
Cor. Model	1086.280	2	543.140	7.409	.001
Intercept	1267.616	1	1267.616	186.730	.000
PRETEST	743.424	1	743.424	5.255	.000
CLASS	536.374	1	536.374	7.395	.000
Error	30.999	65	.477		
Total	571768.795	68			
Corrected Total	1117.279	67			
a. R Squared = ,972 (Adjusted R Squared=,971)					

Based on the summary of normality test results in Table 1, it can be observed that the significance value for the pretest on the three dependent variables, namely collaboration skills, is 0.082 (> 0.05). This indicates that the collaboration skills data follows a normal distribution. Similarly, the significance value for the posttest is 0.200 (> 0.05), concluding that the collaboration skills data also conforms to a normal distribution.

Based on the summary of homogeneity test results from Table 2, it is evident that the significance value in the pretest on the dependent variable, namely collaboration skills, is 0.140 (> 0.05). Therefore, it can be concluded that the data is homogeneously distributed. Similarly, the significance value in the posttest on collaboration skills is 0.075 (> 0.05), leading to the conclusion that the data on collaboration skills between one class and another is homogeneous.

After the data fulfills the homogeneity test requirements, the analysis continues with hypothesis testing using ANACOVA. The decision-making criterion is that if the p-value > 0.05, Ho is accepted, and the research hypothesis is rejected; if the p-value < 0.05, then Ho is rejected, and the research hypothesis is accepted. The results of the data analysis presented in Table 3 indicate a significance value for the learning model treatment, specifically $p = 0.000 < \alpha = 0.05$. This signifies that the hypothesis is accepted, and H0 is rejected, demonstrating a significant difference in collaboration skills between the experimental class (XII MIPA 3) and the control class (XII MIPA 2).

Collaboration can be interpreted as a process of participation and coordination within a group to achieve common goals (Lelasari et al., 2017). Vygotsky's sociocultural learning theory suggests that collaboration skills can be acquired through social interaction in a learning environment. Vygotsky posited that learning is a process of social cognition in which sociocultural and environmental factors become elements that shape an individual's knowledge and cognitive skills.

The importance of collaboration skills in biology learning cannot be ignored, as students are expected to work together to achieve common goals and prepare themselves to participate in society. As stated by Redhana (2019), collaboration skills foster cooperation and instill an attitude of responsibility and a spirit of mutual cooperation in society. According to Firmayanti & Fardhani (2023), collaboration skills are essential for students because they can enhance learning outcomes and social feelings. Thus, collaboration in learning encompasses cognitive aspects and shapes character and social values crucial for social life.

The results of the ANCOVA test reveal significant differences in collaboration skills between the experimental class (XII MIPA 3), which applies the POPBL model, and the control class (XII MIPA 2), which uses the PBL model. Based on the conducted data analysis, this is evident from the average scores in the two classes. The POPBL model has been proven to encourage students to collaborate in solving problems and enhance their cognitive abilities, as stated by Ting et al. (2021). In this context, POPBL has a positive impact on students' scientific skills within work teams and contributes to the development of collaboration skills (Latada & Kassim, 2017).

The application of the POPBL model is known to bring about significant improvements in students' collaboration skills. This model emphasizes explicitly collaborative learning based on project work and is oriented toward real problems, aligning with project-

based collaborative learning (McLoone et al., 2014; Wan Husin et al., 2016). The POPBL model involves several stages, including orientation and problem formulation, organizing students for learning, designing and implementing projects, and presenting results and evaluation (Rongbutsri, 2017; Yasin & Rahman, 2011). The first stage, problem orientation, can enhance collaboration skills by identifying real problems through reading news articles in groups. Problem identification activities, conducted individually and in groups, positively impact the learning experience (Prasutri et al., 2019).

The second stage, organizing students to study, also improves collaboration skills. This process involves building knowledge construction by summarizing basic concepts and information from handouts and other relevant sources. Collaboration in learning activities to achieve common goals is considered capable of forming a sense of responsibility in students (Webster et al., 2022).

The third stage, designing and implementing projects, can also improve collaboration skills. The project's design was collaboratively carried out through discussion activities by student worksheets directions. According to Greenstein (2012), collaboration skills are related to working effectively and efficiently, respecting other people's opinions, and making decisions collaboratively. Collaborative activities can benefit the development of good plans (Putra et al., 2020). The fourth stage, presenting results and project evaluation, involves reporting results during learning and reflecting through presentations or exhibitions. The assessment of learning outcomes through evaluation, conducted by reflection, aims to assess the quality and level of learning achievement, in line with the opinion expressed by Shabrina & Astuti (2022).

Based on the researcher's observations during research activities, it was found that in the experimental class (XII MIPA 3), the average score of students' collaboration skills was greater than that of the control class because students felt happy while participating in the lesson. This happiness was attributed to the problems presented by the teacher, which were highly relevant to life in the surrounding environment. Consequently, students were enthusiastic about discussing in their groups, as they wanted to share experiences or knowledge related to the presented problems with their group friends. Additionally, the POPBL learning model enhanced students' collaboration skills because participants in the experimental class (XII MIPA 3) were more inclined to enjoy learning that resulted in products or works. This aligns with the notion that project-based learning increases students' enthusiasm and interest in learning, as they are motivated to create something innovative. This heightened curiosity in each student contributes to creating unique works (Saputro & Rayahub, 2020).

D. Conclusion

The use of the POPBL model influences the collaboration skills of high school students, as evidenced by the relatively high average score. Therefore, teachers can employ the POPBL learning model in classroom teaching and learning activities to enhance students' collaboration skills.

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