



Enhancing Students' Interest through Culturally Responsive Problem-Based Biology Learning

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ABSTRACT

This classroom action research aimed to improve students' learning interest, participation, and achievement in biology through the application of Culturally Responsive Problem-Based Learning (CRPBL) supported by flipped classroom strategies. The study was conducted in two cycles with 32 students from class XI at SMA Negeri 7 Palu. Data were collected using questionnaires, observation sheets, and achievement tests, and analyzed through percentages, mastery, and N-Gain. The findings indicate substantial improvements across all dimensions. Students' interest rose from 62.5% (moderate) in Cycle I to 85.3% (high) in Cycle II, while participation increased from 38% (low) to 81% (high). Academic achievement also improved, with mean scores rising from 80.0 to 86.2 and mastery from 76% to 91%. The N-Gain of 0.48 reflected medium improvement. These results provide strong evidence that CRPBL with flipped classroom strategies can effectively enhance students' engagement and performance in biology. Beyond its effectiveness, this study addresses the scarcity of empirical research integrating culturally responsive teaching, problem-based learning, and flipped classroom approaches in Indonesian secondary schools, thereby filling a critical gap in contextualized biology education. The findings imply that teachers can adopt CRPBL to design more meaningful lessons, while schools may

implement it to align with the Merdeka Curriculum. Future studies are recommended to apply CRPBL in varied contexts with longer durations to further validate its effectiveness.

INTRODUCTION

Education in the 21st century emphasizes the mastery of critical thinking, creativity, collaboration, and communication skills, often referred to as the 4Cs. However, biology learning at the secondary school level still faces persistent challenges, particularly students' low interest and limited engagement. Many learners often demonstrate passivity and lack enthusiasm to participate actively in class activities such as group discussions, presentations, or reflections. Research has shown that students' interest in science tends to decline during secondary education, which in turn negatively affects their academic achievement (Steidtmann et al., 2022). This issue reflects broader educational concerns, as effective 21st-century learning requires not only content mastery but also learning environments that foster motivation, equity, and student well-being (Darling-Hammond & Cook-Harvey, 2018).

To address these challenges, innovative teaching models have been proposed. One approach is Flipped Problem-Based Learning (flipped PBL), where students engage with resources such as videos or readings before class, and classroom time is dedicated to collaboration, critical discussions, and problem-solving (Wang et al., 2022; Chen et al., 2017). This design has been found to enhance conceptual understanding, foster motivation, and increase active participation (Alhabeeb, 2020; Bergmann & Sams, 2021).

In addition, Culturally Responsive Teaching (CRT) emphasizes connecting learning with students' cultural backgrounds and lived experiences. Empirical studies confirm that CRT can increase motivation and performance in science learning (Fuller & Torres Rivera, 2021; Hidayati et al., 2024; Ernawati et al., 2024) and strengthen equity and inclusion in diverse classrooms (Gay, 2018; Gay & Howard, 2020; Ladson-Billings, 2021; Ulbricht, 2024). Curriculum changes in Indonesia, such as the Merdeka Curriculum, also stress contextualized learning, yet challenges in classroom implementation remain (Mu'aziyah & Isnawati, 2023).

From a theoretical perspective, student engagement is a multidimensional construct involving affective, behavioral, and cognitive aspects (Ben-Eliyahu et al., 2018). Recent models highlight that these dimensions jointly influence learning outcomes, which aligns with the principles of Culturally Responsive Flipped Problem-Based Learning (CRFPBL): students engage cognitively through preparation, behaviorally through collaboration, and affectively through culturally meaningful content.

Problem-Based Learning (PBL) itself is strongly supported by research as an effective model for developing critical thinking, collaboration, and problem-solving skills (Hmelo-Silver, 2004; Savery, 2006; Setiana et al., 2022). In science education, PBL has been found to improve both conceptual understanding and critical thinking (Verawati, 2025; Wiratama, 2024; Nurhayati et al., 2023). Integrating PBL with CRT and flipped strategies therefore provides a promising foundation for addressing the issues of engagement and achievement in biology classrooms.

Despite this growing body of evidence, empirical studies that combine these approaches in Indonesian secondary school contexts remain limited. This gap highlights the importance of investigating how CRFPBL can be applied to enhance both students' interest and achievement in biology, and aligns with broader efforts to contextualize science learning in culturally diverse settings (Nurhayati et al., 2023; Ernawati et al., 2024). Therefore, this study specifically addresses the research gap by examining the implementation of CRFPBL in Indonesian secondary schools, focusing on its potential to improve students' learning interest and achievement in biology.

METHOD

This study employed Classroom Action Research (CAR) conducted in two cycles, each consisting of planning, implementation, observation, and reflection. The participants were 32 students of class XI at

SMA Negeri 7 Palu, consisting of 18 females and 14 males.

The learning design used the Culturally Responsive Problem-Based Learning (CRPBL) model supported by flipped classroom strategies. Previous research has demonstrated the effectiveness of PBL in fostering problem-solving and analytical skills (Hmelo-Silver, 2004; Savery, 2006; Verawati, 2025), while flipped learning has been widely adopted to maximize active learning during classroom sessions (Bergmann & Sams, 2021; Chen et al., 2017; Ramdhani et al., 2024). CRT principles were incorporated to make biology learning more meaningful by connecting content with students' cultural contexts (Gay, 2018; Gay & Howard, 2020; Ulbricht, 2024).

The research design followed a Classroom Action Research (CAR) framework consisting of two cycles. The research design is illustrated in Figure 1, which shows the cyclical stages of planning, acting, observing, and reflecting in Classroom Action Research (CAR), based on the model of Kemmis & McTaggart (2000).

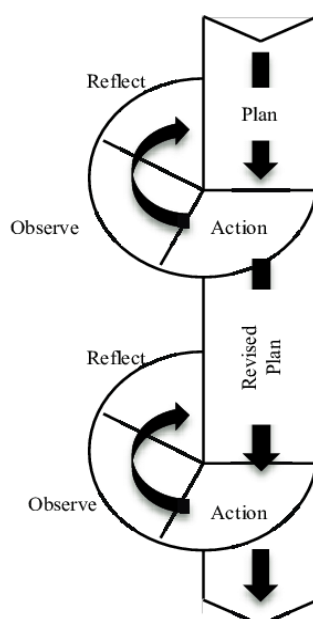


Fig 1. Classroom Action Research (CAR) cycle (Kemmis & McTaggart, 2000, adapted)

Cycle 1

In Cycle 1, the planning stage involved developing a lesson plan using the *Culturally Responsive Problem-Based Learning* (CRPBL) model combined with the *flipped classroom* strategy. Learning materials were uploaded to Google Classroom beforehand, including short instructional videos, infographics, and reading summaries about the nervous system. The classroom problems were designed to connect biological concepts with students' cultural contexts, such as traditional practices or local health issues. Additionally, instruments such as observation sheets, a learning interest questionnaire, and an achievement test were prepared.

During the action stage, the lesson began with a problem trigger related to the nervous system in daily life. Students worked in groups to analyze the problem and propose solutions. Each group presented their findings, followed by a class discussion. The teacher acted as a facilitator, guiding the discussions, clarifying concepts, and reinforcing key ideas.

In the observation stage, student engagement was recorded through observation sheets that focused on indicators such as participation in discussions, collaboration, asking questions, and sharing ideas. At the end of the cycle, students completed the learning interest questionnaire and took the achievement test.

The reflection stage revealed that while some students actively participated, others remained passive and hesitant. The reflection suggested the need for more structured guidance during discussions and the inclusion of more culturally relevant problems to better capture students' interest.

Cycle 2

In Cycle 2, the planning stage was carried out based on the reflection from Cycle 1. The lesson plan was revised to include more challenging and culturally grounded problems, such as discussing cases of nervous system disorders caused by lifestyle habits. Additional scaffolding strategies, including guiding questions and structured group roles, were incorporated to help less active students engage more effectively in the learning process.

During the action stage, the lesson began with the new problem scenario. Students worked collaboratively in groups with clearly defined roles such as leader, recorder, presenter, and timekeeper to ensure active participation from all members. The teacher emphasized critical analysis and synthesis of concepts, encouraged deeper questioning, and provided positive feedback at the end of the lesson to reinforce learning outcomes.

In the observation stage, observers noted a higher level of participation, with more students contributing to group discussions and sharing their ideas. At the end of the cycle, students once again completed the learning interest questionnaire and took the achievement test to evaluate progress.

The reflection stage showed a significant improvement in learning interest, participation, and academic achievement compared to Cycle 1. The reflection confirmed that implementing the CRPBL model combined with flipped classroom strategies and culturally relevant problem scenarios effectively enhanced the quality of biology learning in the classroom.

The instruments consisted of a learning interest questionnaire with 20 Likert-scale items (1–5) covering indicators such as attention, involvement, and enthusiasm; observation sheets rating participation on a 1–4 scale; and a biology achievement test with 20 items (15 multiple-choice and 5 short-answer questions) targeting C2–C4 levels of Bloom’s revised taxonomy. Instrument validity was ensured through expert judgment, and reliability was tested using internal consistency analysis. Quantitative data from the questionnaire and achievement test were analyzed descriptively using means, percentages, and normalized gain (N-Gain) to measure improvement between cycles. Qualitative data from observations and reflections were used to provide contextual explanations and to triangulate the quantitative results.

RESULTS AND DISCUSSIONS

RESULTS

The findings from Cycle I and Cycle II showed significant improvements in students’ learning interest, participation, and achievement. Table 1 presents the comparison of students’ learning interest and participation across the two cycles

Table 1. Students’ Interest in Biology Learning per Cycle

Variable	Cycle I	Cycle II	Category
Learning Interest (%)	62,5	85,3	Moderate → High
Discussion Participation (%)	38	81	Low → High

As shown in Table 1, students’ learning interest increased from 62.5% (moderate category) in Cycle I to 85.3% (high category) in Cycle II. Similarly, student participation during group discussions rose from 38% (low category) in Cycle I to 81% (high category) in Cycle II.

Table 2. Students’ Learning Achievement per Cycle

Variable	Cycle I	Cycle II	Category
Mean (%)	80	86,2	Increased
Mastery (%)	76	91	Increased
N-Gain	–	0,48	Moderate

Table 2 shows that the average test score increased from 80.0 in Cycle I to 86.2 in Cycle II, while mastery level rose from 76% to 91%. The N-Gain value of 0.48 indicates a medium level of improvement. These results demonstrate that the CRPBL model with flipped classroom strategies was effective in improving both student engagement and achievement in biology.

DISCUSSIONS

The findings demonstrate that CRPBL effectively enhanced students' interest and achievement in biology. Student motivation increased from 72% in the first cycle to 87% in the second, shifting from the "moderate" to the "high" category. This growth reflects that combining culturally relevant practices with problem-based inquiry encourages learners to actively participate and connect lessons with their lived experiences (Hidayati et al., 2024; Gay, 2018). Similar improvements in student engagement through PBL and CRT have also been reported in other contexts (Fuller & Torres Rivera, 2021; Ernawati et al., 2024).

Achievement gains further confirmed the effectiveness of CRPBL. Mean scores increased from 80.0 to 86.2, mastery from 76% to 91%, and the N-Gain of 0.48 was in the medium category. These results align with previous findings that combining PBL with flipped strategies enhances students' performance in science learning (Wang et al., 2022; Chen & Li, 2017; Darmastuti, Isfaeni, & Komala, 2025). They also reinforce the constructivist perspective that knowledge is built through collaboration and contextualized problem-solving (Hmelo-Silver, 2004; Savery, 2006). Furthermore, Wiratama (2024) confirmed through meta-analysis that PBL significantly enhances students' critical thinking in science education, strengthening the evidence that CRPBL is a promising approach for improving achievement in biology classrooms. Similarly, a flipped classroom e-module study reported by Ayunda, Hasanah, and Ariyanti (2024) demonstrated increased problem-solving and student independence, reinforcing the pedagogical value of CRFPBL.

This study also supports the broader relevance of culturally responsive practices in science education. By valuing students' cultural backgrounds, CRPBL not only increased cognitive outcomes but also fostered affective engagement. These findings are consistent with literature that emphasizes the link between cultural inclusion and science learning success (Gay & Howard, 2020; Hidayati et al., 2024; Safira & Agustina, 2024). Additionally, recent bibliometric evidence shows that the Nature of Science (NOS) in science education increasingly acknowledges cultural diversity and contextualized approaches (Sulaiman & Dewi, 2023). This further validates the argument that culturally grounded PBL can address both content mastery and the development of scientific literacy.

Overall, the improvement in both motivation and achievement highlights the transformative potential of CRPBL. These findings contribute to ongoing debates on effective strategies for implementing the Merdeka Curriculum, offering practical insights for teachers seeking to bridge curriculum policy with classroom practice (Mu'aziyah & Isnawati, 2023).

CONCLUSION AND SUGGESTION

This study concludes that the implementation of Culturally Responsive Problem-Based Learning (CRPBL) supported by flipped classroom strategies was effective in improving students' learning interest, participation, and achievement in biology. Students' interest increased from a moderate to a high category, participation rose from low to high, and achievement scores showed medium improvement based on the N-Gain. These findings indicate that CRPBL can serve as an alternative instructional model for developing meaningful and engaging biology learning. Nevertheless, this study was limited to one class and two cycles, so the results cannot be generalized broadly. Further research is recommended to apply CRPBL in different contexts with longer durations to strengthen its validity. In terms of educational practice, teachers may implement CRPBL by preparing culturally relevant problem scenarios, integrating digital platforms for pre-class learning resources, and guiding collaborative inquiry, while schools are expected to provide continuous professional development, adequate technological facilities, and institutional policies that support culturally responsive pedagogy.

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