THE EFFECT OF COLLABORATIVE PROBLEM BASED LEARNING MODEL ON PROBLEM SOLVING SKILLS

O EFEITO DO MODELO DE APRENDIZAGEM COLABORATIVA BASEADA EM PROBLEMAS NAS HABILIDADES DE RESOLUÇÃO DE PROBLEMAS

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Abstract

The development of problem-solving skills is a critical objective of contemporary education systems in response to increasing global complexity and the demands of the twenty-first century. This study aims to examine the effect of the Collaborative Problem-Based Learning (CPBL) model on students' problem-solving skills. A quantitative approach employing a quasi-experimental design with a nonequivalent pretest–posttest control group was used. The participants consisted of 130 students divided into an experimental group (65 students) and a control group (65 students), selected through cluster random sampling. The experimental group was instructed using the CPBL model, while the control group received conventional instruction. Data were collected through standardized problem-solving tests administered before and after the intervention. Descriptive statistics and independent samples t-tests were applied after confirming data normality and homogeneity. The results indicated no significant difference in problem-solving skills between the two groups at the pretest stage. However, posttest

Resumo

O desenvolvimento de habilidades de resolução de problemas é um objetivo crítico dos sistemas educacionais contemporâneos em resposta à crescente complexidade global e às demandas do século XXI. Este estudo tem como objetivo examinar o efeito do modelo de Aprendizagem Colaborativa Baseada em Problemas (CPBL) nas habilidades de resolução de problemas dos alunos. Foi utilizada uma abordagem quantitativa empregando um desenho quase experimental com um grupo controle pré-teste-pós-teste não equivalente. Os participantes consistiram em 130 alunos divididos em um grupo experimental (65 alunos) e um grupo controle (65 alunos), selecionados por meio de amostragem aleatória por conglomerados. O grupo experimental foi instruído usando o modelo CPBL, enquanto o grupo controle recebeu instrução convencional. Os dados foram coletados por meio de testes padronizados de resolução de problemas aplicados antes e depois da intervenção. Estatísticas descritivas e testes t para amostras independentes foram aplicados após a confirmação da normalidade e

findings revealed a statistically significant difference in favor of the experimental group (p < 0.05), demonstrating that students exposed to CPBL achieved higher problem-solving performance than those taught using conventional methods. These findings suggest that CPBL is an effective instructional model for enhancing students' problem-solving skills and supports the adoption of collaborative, problem-centered learning approaches to improve educational quality in alignment with international educational frameworks.

Keywords: Collaborative Problem Based Learning. Problem-Solving Skills. Quasi Experimental Study. Student-Centered Learning. Higher-Order Thinking.

homogeneidade dos dados. Os resultados indicaram que não havia diferença significativa nas habilidades de resolução de problemas entre os dois grupos na fase pré-teste. No entanto, os resultados pós-teste revelaram uma diferença estatisticamente significativa a favor do grupo experimental (p < 0,05), demonstrando que os alunos expostos ao CPBL alcançaram um desempenho superior na resolução de problemas do que aqueles ensinados usando métodos convencionais. Esses resultados sugerem que o CPBL é um modelo instrucional eficaz para aprimorar as habilidades de resolução de problemas dos alunos e apoia a adoção de abordagens de aprendizagem colaborativas e centradas em problemas para melhorar a qualidade educacional, em alinhamento com as estruturas educacionais internacionais.

Palavras-chave: *Aprendizagem Colaborativa Baseada em Problemas. Habilidades de Resolução de Problemas. Estudo Quase Experimental. Aprendizagem Centrada no Aluno. Pensamento de Ordem Superior.*

1 INTRODUCTION

In the context of rapid global transformation driven by technological advancement, economic complexity, and social change, education systems worldwide are increasingly required to equip learners with competencies that extend beyond factual knowledge (Kioupi & Voulvoulis, 2019; Habibulloh *et al*., 2025). International frameworks promoted by the United Nations, UNESCO, and the OECD emphasize the importance of higher-order thinking skills, particularly problem-solving, as essential capacities for sustainable development and lifelong learning (Bouckaert, 2023; Saengchuk *et al*., 2024). Problem-solving skills enable individuals to analyze situations critically, evaluate multiple perspectives, and generate effective solutions to complex challenges (Van Merriënboer, 2013; Briganti, 2025). These competencies are not only central to academic achievement but also fundamental to preparing students to participate productively in society and contribute to global development goals.

Problem-solving skills are widely recognized as a core component of twenty-first century learning. In educational practice, these skills involve the ability to identify

problems, formulate strategies, apply relevant knowledge, and reflect on outcomes (Kim *et al*., 2022; At-tamimy & Eloy, 2025). However, despite their acknowledged importance, many educational systems continue to rely on conventional instructional models that prioritize content transmission and rote learning. Such approaches often limit students' opportunities to engage in meaningful cognitive processes, thereby constraining the development of analytical reasoning and independent thinking (Flores *et al*., 2012; Sholeh, 2025). As a result, there is an increasing demand for pedagogical models that actively involve students in learning and promote the development of problem-solving competencies in authentic contexts.

Problem-based learning (PBL) has emerged as an instructional approach that addresses these challenges by placing problems at the center of the learning process (Sharma & Hannafin, 2007; Rouf, 2025). Through engagement with real or simulated problems, students are encouraged to explore concepts, seek relevant information, and apply their knowledge collaboratively. PBL aligns with constructivist learning theory, which asserts that knowledge is actively constructed through interaction with the learning environment rather than passively received from instructors (Al Abri *et al*., 2024; Abror & Fatinnah, 2025). Empirical studies have shown that PBL can enhance students' critical thinking, motivation, and conceptual understanding (Kantar, 2014; Habibulloh, 2025). Nevertheless, the effectiveness of PBL is strongly influenced by the social dynamics of the learning environment and the extent to which students are supported in collaborative inquiry.

Collaborative learning, as a pedagogical strategy, emphasizes interaction among learners as a means of knowledge construction, collaboration enables students to exchange ideas, challenge assumptions, and develop shared understanding through dialogue and collective problem-solving (Baker, 2015; Mahbubi *et al*., 2025). From a socio-constructivist perspective, learning is inherently social, and cognitive development is facilitated through interaction with peers. When students work collaboratively, they are exposed to diverse viewpoints and alternative problem-solving strategies, which can deepen their understanding and foster reflective thinking (Shengqiang *et al*., 2025; M. Munif *et al*., 2024). Moreover, collaborative learning contributes to the development of communication, teamwork, and social responsibility, competencies that are increasingly emphasized in global education agendas.

The integration of collaboration into problem-based learning has given rise to the Collaborative Problem-Based Learning (CPBL) model, CPBL combines the inquiry-driven nature of PBL with structured collaborative processes, creating a learning environment in which students jointly analyze problems, negotiate meaning, and co-construct solutions (Yusof *et al.*, 2012; Mokgadi, 2025). This model is particularly relevant in contemporary education, as it reflects the interdisciplinary and cooperative nature of real-world problem-solving (Bates *et al.*, 2022; Munif & Wahrudin, 2025). By engaging students in collaborative inquiry, CPBL is expected to enhance not only cognitive outcomes but also social and interpersonal skills, thereby supporting holistic student development.

Despite the theoretical advantages of CPBL, empirical evidence regarding its effectiveness in improving students' problem-solving skills remains uneven, particularly in formal classroom settings where instructional constraints and contextual factors may influence learning outcomes (Sánchez-García & Reyes-de-Cózar, 2025; Santos *et al.*, 2025). Many existing studies focus on either problem-based learning or collaborative learning as separate approaches, with limited attention given to their combined effect (Chang *et al.*, 2022; Fitriani & Rahmadewi, 2025). Furthermore, variations in research design, measurement instruments, and learning contexts have resulted in inconsistent findings. This highlights the need for rigorous empirical studies that examine the impact of CPBL using controlled experimental or quase experimental designs.

Educational research in developing and transitional contexts has identified persistent challenges related to instructional quality and learning outcomes. Large class sizes, limited instructional time, and reliance on traditional teaching methods often hinder the effective implementation of innovative pedagogical models. Within this context, it is essential to examine whether CPBL can be implemented effectively and produce measurable improvements in students' problem-solving skills. Evidence-based findings are necessary to inform educators, policymakers, and curriculum developers about the practical value of adopting collaborative and problem-based instructional strategies.

Therefore, this study aims to investigate the effect of the Collaborative Problem-Based Learning model on students' problem-solving skills through a quasi-experimental research design. By comparing learning outcomes between students taught using CPBL and those taught using conventional instructional methods, this study seeks to provide empirical evidence on the effectiveness of CPBL as an alternative pedagogical approach.

The findings are expected to contribute to the growing body of international literature on student-centered learning and support policy initiatives aimed at improving educational quality in alignment with global development frameworks.

2 METHOD

This design uses a quantitative approach, with the type of experimental research. The experimental research conducted was a quasi-experiment. Quasi experiments test whether there is a causal relationship between the independent and dependent variables (Loewen & Plonsky, 2016). The independent variable is tested as the variable that influences the dependent variable, which is the impacted variable, in this quasi-experimental study. Nonequivalent pretest-posttest control group design is the type of quasi-experimental design that is employed. This design evaluates the differences between two groups empirically (Gribbons & Herman, 2019), Specifically, the experimental group and the control group have been divided up. The experimental group and the control group are groups that come together naturally, like classrooms, and can be tested using a pretest. One group may then receive treatment under the researcher's supervision, and after receiving treatment, another test may be administered using a posttest. The control group in the pretest-posttest nonequivalent control group design is matched to the group that received the intervention rather than being randomly assigned (Miller *et al.*, 2020).

This study examines the effect of the independent variable on the dependent variable. The independent variable is the collaborative problem solving model. While the dependent variable is students' problem solving skills. The participants of this study were 130 students. The research object was divided into two treatment groups; one was used as the experimental group (65 students) and the other was used as the control group (65 students). The technique of determining the object of research using cluster random sampling because it is impossible to do randomly.

This research was conducted on both treatment groups, namely the experimental group and the control group. The experimental group was treated using a collaborative problem-based learning model and the control group using a conventional model. The research gave a pretest with the aim of knowing the initial ability of students in each class, both classes were given a pretest-posttest with the same test tool.

The research data were analysed using descriptive techniques and Independent Sample T-Test techniques. The aim was to determine the significance level of the effect of the collaborative problem-based learning model on problem solving skills by testing the difference in the average value of student project competency learning outcomes. However, before conducting this test, researchers first conducted a prerequisite test of research assumptions using normality and homogeneity tests, so that the assumptions of data parameters were met. The normality test used the Kolmogorov-Smirnov technique and the homogeneity test used the Levene's test technique. The research data were tested at a significance level of 5% or 0.05 using the SPSS statistical application.

3 RESULTS

The results of the research findings in the form of the results of the pretest and posttest of the two groups are described below, following the results of the normality test on the pretest and posttest scores of the experimental group and control group:

Table 1

Normality Test

One-Sample Kolmogorov-Smirnov Test		Pretest_E	Pretest_C	Posttest_E	Posttest_C
N		65	65	65	65
Normal Parameters[a,b]	Mean	33.54	33.00	81.54	75.92
	Std. Deviation	6.106	7.278	6.055	7.649
Most Extreme	Absolute	.164	.162	.162	.144
Differences	Positive	.150	.126	.154	.128
	Negative	-.164	-.162	-.162	-.144
Kolmogorov-Smirnov Z		1.321	1.307	1.309	1.163
Asymp. Sig. (2-tailed)		.061	.066	.065	.134

Based on table 1, the normality test results on the experimental group pretest obtained a significance value of 0.061, on the control group pretest obtained a significance value of 0.066. The value on the posttest of the experimental group obtained a significance value of 0.065, on the posttest of the control group obtained a significance value of 0.134. Thus all the results of the normality test on the pretest and posttest of the experimental and control groups above the significance value> 0.05, so the data results of the two groups were declared statistically normally distributed. The results of the homogeneity test on the pretest and posttest of the experimental and control groups are as follows:

Table 2

Homogenity Test

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
Posttest	2.053	1	128	.154
Pretest	3.521	1	128	.063

Based on table 2, the results of the homogeneity test on the pretest of the experimental group obtained a value and the control group obtained a significance value of 0.063. The value on the posttest of the experimental group and control group obtained a significance value of 0.151. Thus all the results of the homogeneity test on the pretest and posttest of the experimental and control groups above the significance value> 0.05, so the data results of the two groups were declared statistically homogeneous.

The following are the mean results on the pretest and posttest of the experimental and control groups after statistical testing as follows:

Table 3

Mean Pretest Posttest

Group Statistics		N	Mean	Std. Deviation	Std. Error Mean
	Group	N	Mean	Std. Deviation	Std. Error Mean
Pretest	Experiment	65	33.54	6.106	.757
	Control	65	33.00	7.278	.903
Posttest	Experiment	65	81.54	6.055	.751
	Control	65	75.92	7.649	.949

Based on table 3, the mean on the pretest of the experimental group obtained 33.54 and the control group obtained 33.00. The mean on the posttest of the experimental group obtained 81.54, on the posttest of the control group obtained 75.92. Thus, the mean pretest of the two groups is not much different, while the mean on the posttest in the two groups is much different.

The following are the results of hypothesis testing on the pretest and posttest of the experimental and control groups after statistical testing as follows:

Table 4

Hypothesis Test

Independent Samples Test			Pretest Equal variances assumed	Equal variances not assumed	Posttest Equal variances assumed	Equal variances not assumed
Levene's Test for Equality of Variances		F	3.521		2.053	
		Sig.	.063		.154	
t-test for Equality of Means		t	.457	.457	4.641	4.641
		df	128	124.247	128	121.590
		Sig. (2-tailed)	.648	.648	.000	.000
		Mean Difference	.538	.538	5.615	5.615
		Std. Error Difference	1.178	1.178	1.210	1.210
	95% Confidence Interval of the Difference	Lower	-1.793	-1.794	3.221	3.220
		Upper	2.870	2.871	8.010	8.011

Based on table 4, the results of the independent sample t test on the pretest of the experimental group and the control group obtained a significance value of $0.648 > 0.050$, thus there was no difference in the initial ability of students in the sense that the problem

solving skills were not much different. The value on the posttest of the experimental group and the control group obtained a significance value of 0.000 <0.050, thus problem solving skills increased by applying the collaborative problem-based learning model.

4 DISCUSSION

The findings of this study provide empirical evidence that the Collaborative Problem-Based Learning (CPBL) model has a significant positive effect on students' problem-solving skills. The absence of a statistically significant difference in pretest scores between the experimental and control groups confirms that both groups began the intervention with comparable levels of problem-solving ability. This equivalence strengthens the internal validity of the study and indicates that the observed differences in posttest performance can be attributed primarily to the instructional model applied, rather than to pre-existing disparities among students.

The statistically significant improvement in posttest scores among students exposed to the CPBL model demonstrates the effectiveness of this approach in enhancing problem-solving skills. Students in the experimental group achieved substantially higher mean scores than those in the control group, suggesting that learning environments which emphasize collaboration and problem-centered inquiry are more conducive to the development of higher-order cognitive skills than conventional teaching models (Yılmaz, 2025; Pradhana *et al*., 2025). These findings are consistent with constructivist learning theory, which emphasizes that knowledge is actively constructed through engagement with meaningful tasks and social interaction.

One key factor contributing to the effectiveness of CPBL is its emphasis on collaborative learning processes (Mohd-Yusof *et al*., 2011; Chaanpraserta *et al*., 2024). Through structured collaboration, students are encouraged to articulate ideas, negotiate understanding, and evaluate alternative solutions collectively (Amhag & Jakobsson, 2009; Ma *et al*., 2024). This interaction fosters deeper cognitive engagement and supports the development of analytical reasoning (Byrnes & Dunbar, 2014; Abror & Wahrudin, 2025). The collaborative dimension of CPBL aligns with socio-constructivist perspectives, which highlight the role of social interaction in cognitive development (Gannar & Kilani, 2025; Sholeh, 2025). By engaging with peers, students are exposed to

diverse perspectives that challenge individual assumptions and promote reflective thinking.

The problem-based nature of CPBL provides authentic learning contexts that require students to apply conceptual knowledge to practical situations (Baran & Sozbilir, 2018; Syafi'i & El-Yunusi, 2024). Such contexts encourage learners to move beyond surface-level understanding and engage in higher-order processes such as analysis, synthesis, and evaluation (Baker, 2015; Satyawati & Dwikurnaningsih, 2024). The results of this study suggest that when students are actively involved in identifying and resolving problems, they are more likely to develop transferable problem-solving skills. This finding is particularly relevant in light of global education agendas that emphasize competency-based learning and the development of skills applicable to real-world challenges.

The findings also highlight the limitations of conventional instructional models in fostering problem-solving skills, although students in the control group demonstrated improvement from pretest to posttest, the magnitude of their gains was significantly lower than that of the experimental group. Conventional approaches, which often prioritize teacher-centered instruction and individual work, may limit opportunities for students to engage in meaningful problem-solving processes. This reinforces the need for pedagogical reform that shifts the focus from content transmission to active, student-centered learning.

From a broader perspective, the results of this study have important implications for educational practice and policy, particularly in contexts where instructional quality and learning outcomes remain pressing concerns (Mejía-Rodríguez & Kyriakides, 2022; Eli Dwi Nabila, 2025). The successful implementation of CPBL in this study demonstrates that innovative learning models can be applied effectively within existing classroom structures, even in settings where random assignment and ideal experimental conditions are not feasible (Sukackė et al., 2022). This finding supports the relevance of CPBL as a practical instructional strategy for improving educational quality.

The emphasis on collaboration and problem-solving aligns closely with international education frameworks promoted by the United Nations and UNESCO, which advocate for the development of cognitive, social, and collaborative competencies as part of quality education (Giangrande et al., 2019). By fostering these competencies, CPBL contributes not only to academic achievement but also to the preparation of

learners for active participation in society and the workforce. In this sense, the model supports broader goals related to sustainable development and human capital development.

Despite its contributions, this study also has limitations that should be acknowledged. The quasi-experimental design, while appropriate for the research context, does not allow for full control over all extraneous variables. Additionally, the study focused on a specific sample size and educational setting, which may limit the generalizability of the findings. Future research is therefore recommended to examine the long-term effects of CPBL, explore its impact across different disciplines and educational levels, and incorporate qualitative data to gain deeper insight into students' learning experiences. The discussion of findings confirms that Collaborative Problem-Based Learning is an effective instructional model for enhancing students' problem-solving skills. The results reinforce the value of integrating collaborative and problem-centered approaches into classroom instruction and provide evidence-based support for educational practices that align with international standards for quality and inclusive education.

5 CONCLUSION

This study concludes that the Collaborative Problem-Based Learning (CPBL) model has a statistically significant and positive effect on students' problem-solving skills. The absence of meaningful differences in pretest scores between the experimental and control groups confirms that both groups began the learning process with comparable levels of ability. The substantial improvement observed in the posttest scores of students exposed to CPBL demonstrates that instructional approaches integrating collaboration and problem-centered inquiry are more effective than conventional teaching methods in fostering higher-order cognitive skills. These findings affirm that CPBL provides a learning environment that actively engages students in analyzing problems, constructing knowledge through social interaction, and applying concepts in meaningful contexts. As a result, students are better equipped to develop analytical reasoning, reflective thinking, and solution-oriented competencies that are essential for academic success and real-world problem-solving.

From a broader educational perspective, the results of this study underscore the relevance of CPBL in supporting international education agendas that emphasize quality, equity, and competency-based learning. The alignment of CPBL with global frameworks promoted by the United Nations and UNESCO highlights its potential contribution to the development of essential twenty-first century skills, including collaboration, critical thinking, and social responsibility. By fostering both cognitive and interpersonal competencies, CPBL supports holistic student development and prepares learners to participate constructively in complex social and professional environments. Despite the limitations associated with the quasi-experimental design and contextual scope of the study, the findings provide strong empirical support for the integration of collaborative and problem-based instructional models in formal education settings. Future research is recommended to explore the long-term impact of CPBL, its application across diverse disciplines and educational levels, and its influence on broader learning outcomes. Overall, this study confirms that Collaborative Problem-Based Learning represents an effective and sustainable pedagogical approach for enhancing problem-solving skills and improving educational quality in alignment with international standards and global development goals.

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Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

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