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Transformation of Collaborative Project-Based Learning to Improve 21st Century Learning Outcomes in the Society 5.0 Era

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Abstract: The Society 5.0 era demands educational innovation that integrates technology, collaboration, and complex problem solving into the learning process. This study aims to analyze the effectiveness of implementing a project-based collaborative learning model on improving student learning outcomes and 21st-century skills in geography. The research used a Classroom Action Research (CAR) approach in two cycles, which included planning, action, observation, and reflection. The research subjects consisted of 67 grade XI phase F students at SMAN 1 Siak, Siak Regency, Riau Province, in the 2023–2024 academic year, who were randomly divided into experimental and control groups. The results showed that the experimental group experienced a significant increase in their understanding of geography concepts with an increase of 41.74%, $p < 0.05$, while the control group only increased by 4.49%, $p > 0.05$. In addition, 88.6% of students in the experimental group achieved the "very good" category in 21st-century skills, particularly in collaboration, critical thinking, communication, and creativity. Thus, the project-based collaborative learning model has been proven effective in transforming geography learning and is recommended as an innovative strategy to address educational challenges in the Society 5.0 era.

Keywords: 21st Century Skills; Collaboration; Geography; Project-Based Learning; Society 5.0

Introduction

In the era of Society 5.0, the rapid integration of technology, information, and human centered innovation has profoundly transformed the educational landscape (Padli et al., 2024; Prasetyo et al., 2024; Selviani et al., 2024). Education is now required not only to transfer knowledge but also to develop students' higher order thinking, creativity, collaboration, and problem solving skills to meet twenty first century demands (Ardiansyah, 2025; Jasmanedi et al., 2025; Nyoman et al., 2024; Rinaldi et al., 2025). Geography education, as a discipline that explores the dynamic interaction between humans and their environment, plays a crucial role in preparing students to understand and address global and local challenges such as environmental change, spatial inequality, and sustainable development (Hastuti, Aristin, & Fani, 2022; Putra, Deffinika, & Islam, 2021). Therefore, transforming geography learning into an active, collaborative, and technology integrated process has become a pedagogical necessity.

In Indonesia, the implementation of the Merdeka Curriculum emphasizes learner centered and competency based education that encourages students to explore real world problems through interdisciplinary approaches (Hidayat et al., 2025; Ilham et al., 2024; Listiqowati et al., 2025; Sari et al., 2023). However, in practice, geography instruction often remains dominated by traditional teacher centered methods that limit student engagement, creativity, and collaboration (Carella & Colombo, 2024; Purwantara et al., 2023). This condition highlights the urgent need for an innovative instructional model that allows students to construct knowledge actively, engage collaboratively,

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and apply geographical concepts to authentic issues in their environment.

Project Based Learning (PjBL) has emerged as an effective pedagogical framework to meet these educational challenges (Dzakiyyah et al., 2025; Prasetyo, et al., 2024; Sari et al., 2024; Solís et al., 2017). It promotes experiential learning through inquiry, teamwork, and the creation of tangible products that connect classroom learning to real world contexts (AlAli, 2024; Asad & Anwar, 2025; Ilham et al., 2025; Prasetyo et al., 2024; Selviani et al., 2023). When PjBL is combined with collaborative learning principles, it can foster essential twenty-first-century skills critical thinking, creativity, communication, and collaboration that are indispensable in the Society 5.0 era (Lantada, 2022; Partini, 2023).

Previous research has demonstrated that PjBL can improve students engagement, motivation, and academic performance across multiple disciplines (Agarwal et al., 2025; Burke et al., 2025; Hasmita, 2024; Zaki et al., 2024). Nevertheless, most studies have primarily focused on cognitive outcomes without integrating strong collaborative dimensions or aligning them with the human centered innovation principles central to Society 5.0 (Tunji et al., 2023; Yilmaz et al., 2025). Moreover, studies on geography education have seldom examined how collaborative project based learning can enhance twenty first century competencies particularly within Indonesian secondary education contexts (Ilham et al., 2024; Purwanto et al., 2024; Selviani et al., 2024; Yuanti et al., 2025)

To address these gaps, the present study introduces a Collaborative Project Based Learning (CPjBL) model specifically designed for geography education in the Society 5.0 era. This model integrates collaborative strategies, digital engagement, and authentic project outputs that encourage students to apply geographical knowledge to real world environmental and spatial issues. Unlike previous research that implemented PjBL in teacher-directed or isolated learning settings, this study emphasizes student centered collaboration and provides empirical evidence of significant improvements in both conceptual understanding and twenty first century skills critical thinking, creativity, collaboration, and communication among students who participated in CPjBL.

Hence, the novelty of this research lies in its contextual adaptation of collaborative principles within the PjBL framework for geography learning that aligns with the human centered vision of Society 5.0. This integration bridges the gap between theoretical frameworks and classroom practice by presenting a transformative instructional model capable of preparing Indonesian students to become adaptive, innovative, and globally competent citizens in the digital era.

Method

Research Design

This study adopted a Classroom Action Research (CAR) approach designed to systematically enhance instructional quality and student learning outcomes through iterative cycles of planning, implementation, observation, and reflection (Ilham et al., 2024; Indika et al., 2023).The research was structured into two comprehensive cycles, enabling a progressive and evidence-based evaluation of the Collaborative Project Based Learning (CPjBL) model in the context of geography education. Each cycle was characterized by a reflective collaboration between the researcher and the classroom teacher to critically examine pedagogical practices, identify emerging challenges, and formulate adaptive strategies for continuous instructional improvement. The CAR design was deemed most appropriate as it facilitates real-time observation of pedagogical transformation, allowing the researcher to capture both the process and the outcomes of innovation within authentic classroom environments. This study was conducted at SMAN 1 Siak, Siak Regency, Riau Province. Figure 1 shows the location of the study.

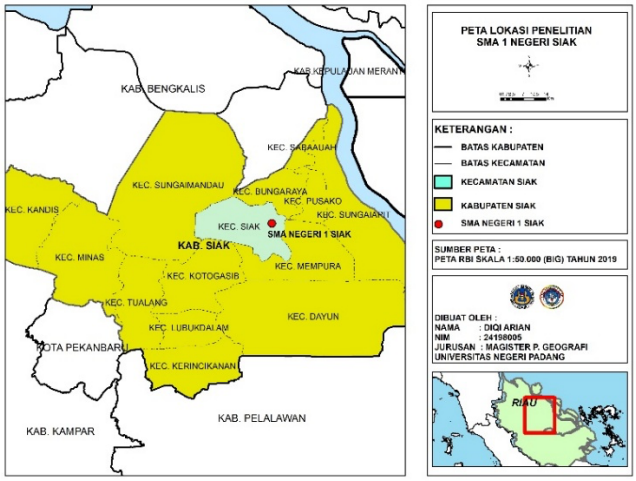

Figure 1. Research Location at SMAN 1 SIAK

Participant Selection

The population of this study consisted of all Grade XI students (Phase F) at SMAN 1 Siak, Siak Regency, Riau Province, during the 2023–2024 academic year, totaling 127 students across four classes. The sample was determined using a random sampling technique to ensure fairness and representativeness. Two classes were randomly selected to participate: one as the experimental group (F4, n = 35) and the other as the control group (F3, n = 32). Both groups were statistically comparable, as verified through a preliminary t-test ($t = -1.047$, $p = 0.300$), indicating no significant difference in baseline performance before the intervention. For further clarification, please refer to Table 1.

Table 1. Research Sample

Class	Number of Students	Intervention
F3	32	Control
F4	35	Experiment

Intervention Protocol

The intervention implemented the Collaborative Project-Based Learning (CPjBL) model in the experimental group, while the control group received conventional teacher-centered instruction. The CPjBL model was designed to promote active learning through inquiry, teamwork, and problem-solving within authentic geographical contexts. The protocol followed two main learning cycles, each consisting of four structured phases: (1) Planning designing the project theme, learning goals, and assessment criteria; (2) Action implementing collaborative project activities in the classroom; (3) Observation monitoring student engagement, interaction, and task completion; and (4) Reflection evaluating learning outcomes and identifying improvements for the next cycle. Projects emphasized spatial analysis, environmental awareness, and digital literacy, encouraging students to produce tangible outputs that connect geography concepts to real-world issues.

Data Collection Instruments

Both qualitative and quantitative data were collected to ensure a comprehensive analysis. Observation sheets were used to document classroom interactions, participation levels, collaboration quality, and teacher facilitation during each learning cycle. Achievement tests (pre-test and post-test) measured students' conceptual understanding of geography before and after the intervention. Rubrics for twenty-first-century skills assessed students competencies in collaboration, critical thinking, creativity, and communication. Data from these instruments were validated through peer review and triangulated between teacher observations and student performance results to ensure reliability.

Statistical Analysis

Quantitative data were analyzed using descriptive and inferential statistics. Descriptive statistics were used to present mean scores and percentage improvements between pre-test and post-test results for both groups. Inferential analysis was conducted using an independent sample t-test to examine the significance of differences between the experimental and control groups. The analysis revealed that the improvement in the experimental group was statistically significant ($p < 0.05$), confirming the effectiveness of the CPjBL model in enhancing geography learning outcomes. Qualitative data from classroom observations were analyzed thematically to support the quantitative findings and provide deeper insights into students engagement and collaboration dynamics

Result and Discussion

Improvements in students understanding of geographical concepts were measured by comparing the average pre-test and post-test scores after implementing the collaborative project-based learning model.

Tabel 2. Comparison of Average Pre-test and Post-test Scores on Understanding Geography Concepts.

Group	Pre-Test	Post-Test	Δ %	P value
Control	67.44	70.47	4,49	0.643
Experiment	60.23	85.37	41.74	0.000

Note. Δ%= difference between pre- and post-tests in percentage

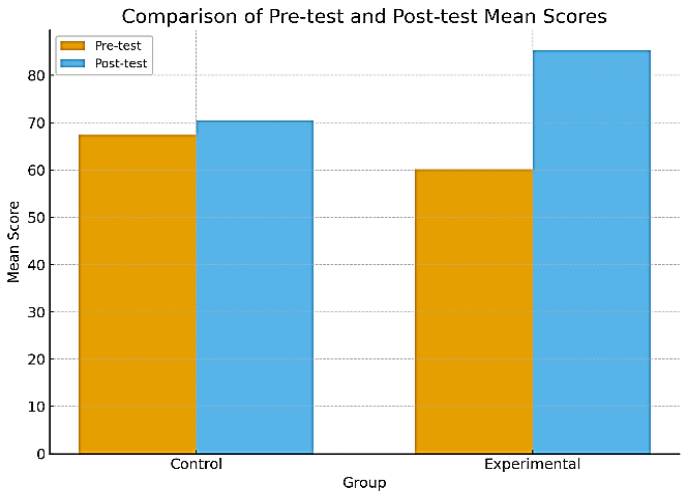

Figure 2. Research Location at SMAN 1 SIAK

Based on Table 2 and Figure 2, which presents a comparison of the average pre-test and post-test scores for understanding geographical concepts, there was a significant difference in improvement between the control group and the experimental group. The control group, consisting of 32 students, showed an average increase in scores from 67.44 on the pre-test to 70.47 on the post-test, or an increase of 4.49% with $p > 0.05$. In contrast, the experimental group, consisting of 35 students, experienced a much greater average increase in scores, from 60.23 on the pre-test to 85.37 on the post-test, or 41.74% with $p < 0.05$. These results show that the intervention or treatment given to the experimental group had a greater impact on improving understanding of geographical concepts than the learning received by the control group. The substantial improvement in the experimental group indicates the effectiveness of the learning methods or models applied in this study.

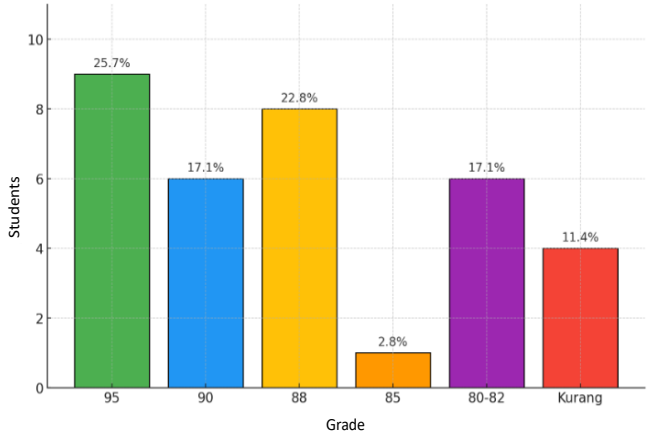

Figure 3. Post-Test Graph for the Experimental Class

Based on Figure 3 above, the results of the analysis of students 21st century skills in project-based learning show that the majority of students demonstrated a skill level of 95 for 9 students (25.7%) and 90 for 6 students (17.1%). there were 8 students (22.8%) with a score of 88 and 1 student (2.8%) with a score of 85, 6 students (17.1%) with scores between 80–82. Meanwhile, 4 students (11.4%) scored 70, 65, and 50, which are classified as "Poor." This shows that a small number of students still have difficulties in developing 21st-century skills, particularly in the aspects of teamwork, effective communication, and complex problem solving.

This study confirms that the implementation of Collaborative Project Based Learning (CPjBL) effectively improves students' conceptual understanding of geography and their twenty-first-century competencies. The findings revealed a significant increase in the mean score of the experimental group (from 60.23 to 85.37; 41.74% improvement, $p < 0.05$) and that 88.6% of the participants achieved a "very good" category in collaborative, critical thinking, creativity, and communication skills. Therefore, the research objectives were successfully achieved, and the evidence demonstrates that CPjBL can serve as an effective framework for pedagogical transformation in geography education within the context of Society 5.0.

Comparison with Previous Studies

The results are consistent with previous works by (Aljohani et al., 2022; Poláková et al., 2023), who found that Project Based Learning enhances engagement and academic achievement through authentic and experiential learning. However, this study extends earlier findings by incorporating a collaborative dimension that reinforces the impact of PjBL beyond cognitive outcomes. Unlike Daher et al., (2025), who demonstrated PjBL's efficacy mainly for improving academic achievement in mathematics, this research provides evidence that integrating structured collaboration within PjBL strengthens both conceptual mastery and essential soft skills. Furthermore, while Broo et al., (2024) examined online PjBL applications, this study shows that face to face CPjBL implementation fosters richer interpersonal interaction and deeper reflective learning, particularly relevant in geography, where contextual and spatial understanding are critical.

The novelty of this research lies in its contextual adaptation of CPjBL for geography education under the Merdeka Curriculum framework and the Society 5.0 paradigm. Its distinctive advantages include: (1) explicit integration of collaborative principles in project design, (2) focus on authentic outcomes addressing local spatial and environmental issues, and (3) simultaneous measurement of cognitive and twenty first century skill improvements with statistically significant evidence ($p < 0.05$). By bridging pedagogical theory with classroom practice, this study offers a more holistic and practical model compared to prior research that focused solely on one dimension of learning outcomes.

Theoretically, these findings reinforce constructivist learning perspectives (Wuttiphan & Kwangmuang, 2025), which emphasize knowledge construction through social interaction and meaningful experience. Practically, CPjBL serves as a promising instructional model for developing conceptual understanding alongside collaborative and critical thinking abilities (Marić et al., 2023). Teachers can implement CPjBL to engage students in authentic inquiry projects related to environmental and spatial challenges, encouraging creativity and communication. Schools and policymakers may also use this model to train teachers in project design, assessment rubrics, and the integration of digital tools that support spatial analysis and project presentation (AlAli, 2024; Ilham et al., 2025). Adopting CPjBL at a broader scale may cultivate adaptive learners prepared to contribute effectively in an innovation-driven society.

Despite the overall success of the intervention, approximately 11.4% of students remained in the "remedial" category for twenty-first-century skills. This result suggests that not all learners adapt equally to collaborative project settings, possibly due to differences in self-efficacy, prior teamwork experience, or motivation. Moreover, the limited sample size (two classes from one school) restricts generalizability, and the absence of standard deviation data prevented effect size calculation. Future research should involve larger samples, longer observation periods, and mixed-method analyses to measure both immediate and sustained impacts of CPjBL implementation.

In summary, the study contributes new insights into how collaborative project-based learning transforms geography education by integrating teamwork, inquiry, and contextual problem-solving. The objectives of the research were achieved, and the evidence indicates that CPjBL significantly enhances learning outcomes while cultivating twenty-first-

century skills aligned with the principles of Society 5.0. Compared with earlier studies, this research introduces a novel pedagogical model that unites collaboration, project design, and human-centered innovation. CPjBL thus emerges not merely as a method of instruction but as a transformative educational framework capable of preparing Indonesian students to become creative, adaptive, and globally competent citizens in the digital era.

Conclusion

This study demonstrates that the application of Collaborative Project Based Learning (CPjBL) significantly improves students' conceptual understanding of geography and their twenty-first-century competencies. The experimental group showed a substantial increase in learning outcomes (41.74%; $p < 0.05$) and achieved high performance in collaboration, creativity, communication, and critical thinking. These results confirm that embedding collaborative principles within project-based learning transforms geography instruction into a more student centered, interactive, and contextually meaningful process aligned with the demands of the Society 5.0 era.

The study contributes to the existing body of knowledge by introducing a contextualized CPjBL model that integrates constructivist theory with the Merdeka Curriculum framework. It provides both theoretical reinforcement and practical direction for educators seeking innovative strategies to enhance engagement and transferable skills. Beyond improving classroom performance, CPjBL offers a sustainable model for developing adaptive, creative, and human-centered learners. Future research is recommended to test this model in broader contexts, explore long-term effects, and investigate the role of digital collaboration in strengthening CPjBL effectiveness in diverse educational environments.

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Conceptualization, methodology, funding acquisition, formal analysis, investigation, resources, data curation, writing original draft preparation, D,A and P,I.; writing review, editing, supervision, project administration, and validation, D.A and D,H. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

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