


# The Influence of an Encyclopedia-Based Case Study Model on Students' Critical Thinking and Collaboration Skills in Geography Learning in the Society 5.0 Era

Erman Syarif<sup>1</sup>, Badrizal Al Hazar<sup>1</sup>, Dermawan<sup>1</sup>

<sup>1</sup> Study program of Geography Education, Universitas Negeri Makassar, Makassar, Indonesia

ARTICLE INFO	ABSTRACT
<p><b>Article History:</b> Received: 2025-09-20 Accepted: 2026-01-20 Published: 2026-03-30</p> <p><b>Keywords:</b> collaborative learning; geography education; higher-order thinking skills; instructional effectiveness; senior high school;</p> <p><b>Corresponding author:</b> Erman Syarif Email: <a href="mailto:ermansyarif@unm.ac.id">ermansyarif@unm.ac.id</a> DOI: 10.37905/jgej.v7i1.34517</p> <p>Copyright © 2026 The Authors</p>  <p>This open access article is distributed under a Creative Commons Attribution-NonCommercial (CC-BY-NC) 4.0 International License</p>	<p>This study aims to analyze the effect of implementing an encyclopedia-based case study learning model on students' critical thinking and collaboration skills in geography learning within the Society 5.0 era. Although contemporary educational demands require geography learning models that strengthen these competencies, classroom practices remain largely dominated by conventional approaches that do not optimally support their development. Geography education plays a strategic role in responding to environmental and social challenges, highlighting the need for innovative and contextual learning models. This study employed a quasi-experimental method using a pretest–posttest control group design. The participants consisted of 76 senior high school students, divided into an experimental class (n = 38) and a control class (n = 38). The experimental group implemented the encyclopedia-based case study model, while the control group received conventional instruction. Data were collected using a critical thinking skills test and a 45-item Likert-scale collaboration questionnaire. Data analysis was conducted using ANCOVA, with pretest scores treated as covariates, after meeting assumptions of normality, homogeneity of variance, and homogeneity of regression slopes. The results indicate that, after controlling for students' initial abilities, there were significant differences between the experimental and control groups in critical thinking skills (<math>p &lt; 0.05</math>; <math>\eta^2 = 0.302</math>) and collaboration skills (<math>p &lt; 0.05</math>). These findings demonstrate that the encyclopedia-based case study learning model is effective in enhancing students' higher-order thinking and collaboration skills and is highly relevant for implementation in geography education in the Society 5.0 era.</p>

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## 1. Introduction

The development of education in the Society 5.0 era demands a transformation of learning models that can address the complex challenges of the 21st century. Society 5.0 is not merely about the integration of technology into daily life, but also about how technology can be utilized to solve social, economic, and environmental problems (Amini et al., 2024). In this context, geography education plays a strategic role because it directly relates to global issues, such as climate change, environmental degradation, urbanization, and disaster resilience (Wibowo et al., 2023). Therefore, there is a need for learning models that not only provide factual knowledge but also foster students' critical thinking and collaboration skills.

Geography learning has long tended to be descriptive and focused on mastering basic concepts (Syarif et al., 2024). This often limits students' active engagement in analyzing real-world problems in their environment. Consequently, their ability to think critically and connect concepts with geographical phenomena in daily life remains relatively low (Aliman et al., 2024; Salsabila, N et al., 2025). Geography should train students to understand spatial relations, environmental dynamics, and interactions between humans and nature. Hence, an innovative learning model is required to connect conceptual knowledge with problem-solving (Halek et al., 2021)

In the context of geography education, the development of students' critical thinking and collaboration skills has been increasingly emphasized as an essential learning outcome. Geography, as an integrative discipline, requires learners to analyze spatial patterns, evaluate environmental issues, and understand the complex interactions between humans and natural systems (MÖrike et al., 2021). However, many instructional practices still rely heavily on textbook-centered and teacher-dominated

approaches, which limit students' opportunities to engage in analytical reasoning and collective problem-solving. Consequently, students often struggle to connect geographic concepts with real-world phenomena and collaboratively construct meaningful interpretations of spatial issues (Dos Santos et al., 202; Ardiansyah, A. I et.al, 2024).

The encyclopedia-based case study model offers a pedagogical alternative that addresses these limitations by combining structured reference materials with a contextual problem analysis. Encyclopedias provide comprehensive, verified, and systematically organized information that supports students in exploring geographic cases from multiple perspectives. When integrated into case-based learning, encyclopedic resources enable students to examine empirical data, compare regional and global contexts, and substantiate their arguments using credible evidence. This approach reduces superficial reasoning and encourages students to engage in deeper analytical processes grounded in factual and conceptual understandings (Adinolfi & Giancotti, 2021).

Moreover, case studies encourage active learning through inquiry, discussion, and collaborative exploration of authentic geographic problems. Students are required to identify key issues, analyze causal relationships, evaluate alternative solutions, and communicate their findings within group settings. Such activities naturally promote collaboration as learners must negotiate roles, share responsibilities, and synthesize diverse viewpoints. In this learning environment, collaboration is an integral cognitive process rather than merely a social activity that, foster collective reasoning and shared knowledge construction (Wang et al., 2025).

Within the framework of Society 5.0, this instructional model has become increasingly relevant. Society 5.0 emphasizes the human-centered use of technology to solve complex societal problems, demanding learners who are not only knowledgeable but also critical, collaborative, and adaptive. The encyclopedia-based case study model aligns with these demands by integrating digital information literacy with problem-based collaborations. Through this model, students are trained to critically evaluate information sources, apply geographic knowledge to real-world challenges, and collaborate effectively, competencies that are essential for preparing future citizens capable of addressing global environmental and social issues (Merrett, 2022).

One promising approach is an encyclopedia-based case study model (Sugiharto et al., 2024). This model comprehensively emphasizes the analysis of real cases presented through encyclopedic sources. As reference materials, encyclopedias not only provide broad factual information but also ensure that students access valid and structured data (Fauziah et al., 2024). By utilizing encyclopedias, students can obtain richer information, compare perspectives, and integrate knowledge from various geographical subthemes.

The application of case studies in geography learning helps students to think critically through the analysis, interpretation, and evaluation of problems (Silviariza et al., 2021). For example, when studying urban flood cases, students can explore causal factors, socioeconomic impacts, and mitigation strategies applied in different regions. Using encyclopedic sources, they can also examine similar cases in other countries and compare them with the local context (Asep, 2023). This process encouraged students to ask critical questions, evaluate solutions, and develop new alternatives.

In addition to fostering critical thinking, this model has the potential to strengthen students' collaboration skills. Analyzing encyclopedic cases requires group work, discussion, and role-sharing to comprehensively understand the problem (Ismadi, M. A. bin, & Mohd Najib, S. A, 2025). Collaboration is not merely a task distribution but also the integration of diverse perspectives to form collective understanding. Collaboration is essential in geography learning because environmental and spatial issues cannot be solved individually but rather through multidisciplinary cooperation (Dixit & Dixit, 2024).

Furthermore, collaboration in encyclopedia-based case studies aligns with 21st-century competencies, particularly the 4Cs (critical thinking, creativity, collaboration, and communication). Students are trained not only to solve problems but also to communicate their ideas effectively (As'ari et al., 2024). Through group discussions, case presentations, and report-writing, they learn to express opinions through logical arguments. These skills are highly relevant to the needs of Society 5.0, where human-technology collaboration is key to solving global problems (Hazar et al., 2025).

In the Indonesian context, the challenges in geography education are becoming increasingly complex. Environmental issues, such as deforestation, flooding, air pollution, and coastal ecosystem degradation, require in-depth analysis and creative solutions (Bentil & Ababio, 2020). Unfortunately, classroom learning often remains textual and provides few opportunities for students to explore real-world

problems (Yamwongsri & Chen, 2025). The encyclopedia-based case study model has emerged as an alternative that bridges theory and practice, enabling students not only to learn about geography but also to think geographically (Rokhman et al., 2025).

Another strength of this model is its integration with digital technologies. Today, encyclopedias are not only available in print but also in online formats, which are widely accessible. This aligns with the spirit of Society 5.0, in which information is processed to improve the human quality of life. Accordingly, students are trained to use digital resources wisely, critique information, and integrate it into case analysis.

Previous studies have shown that case-study applications in learning can improve students' critical thinking, analytical ability, and teamwork (Dos Santos et al., 2023; Huang et al., 2025; Lavi & Marti, 2023; Rokhman et al., 2025). However, research integrating encyclopedic sources remains limited, particularly in the context of geography education. Nevertheless, encyclopedic resources provide distinct advantages in terms of informational depth, credibility, and comprehensive coverage, which are crucial for analyzing complex geographic cases. Accordingly, this study addresses an important research gap by proposing an innovative encyclopedia-based case study learning model that responds to the educational demands of Society 5.0 era. This approach is also aligned with the initiatives of the Ministry of Higher Education, Science and Technology and the Ministry of Primary and Secondary Education, which emphasize deep and impactful learning that can be directly experienced by students.

Research on the encyclopedia-based case study model and its effect on students' critical thinking and collaboration skills in geography learning within the Society 5.0 era is highly significant. It contributes not only to the development of innovative learning theory but also provides practical implications for teachers in designing effective strategies. Ultimately, students are expected to develop critical thinking skills, collaborate productively, and be better prepared to face environmental and social challenges in the Society 5.0. The research problem addressed in this study is as follows: How does the implementation of an encyclopedia-based case study learning model affect students' critical thinking and collaboration skills in geography learning?

## 2. Method

### 2.1 Population and sample

The study population comprised 76 eleventh-grade students at SMA Negeri 1 Gowa, who were distributed across two parallel classes. SMA Negeri 1 Gowa was selected as the research site because it applies a curriculum that emphasizes higher-order thinking skills and has parallel classes that support experimental and control group implementations (Nirmalasari et al., 2024). The sample consisted of two intact classes, which were assigned to the experimental and control groups. Grade XI Social Studies served as the control class, while Grade XI Science served as the experimental class. Because group assignment was based on intact classes, baseline differences were statistically controlled using pre-test scores as covariates in the ANCOVA model. The details of the grade level, class assignment, and number of students in each group are presented in Table 1.

**Table 1.** Research Sample Distribution

Grade	Class	Number of Students
XI Social Studies	Control Class	38
XI Science	Experimentaltal Class	38

### 2.2 Data Collection Techniques

This study began with a literature review of prior work on the encyclopedia-based case study model and on students' critical thinking and collaboration skills to establish a conceptual foundation and inform instrument design. A needs-assessment survey was administered to students, teachers, and education practitioners to collect preliminary data on needs, challenges, and readiness for implementation. In-depth interviews with geography teachers and education experts familiar with the model were conducted to identify suitable learning designs, analyze implementation constraints, and elicit strategies to enhance critical thinking and collaboration skills using questionnaire-based instruments. The research instruments comprised: (a) a multiple-choice critical thinking test adapted by *California Critical Thinking Skills Test (CCTST)* framework, which includes five dimensions-analysis, inference, evaluation, interpretation, and explanation-developed through competency mapping, blueprint construction, item writing, content validation, pilot testing, and item analysis; and (b) a

collaborative questionnaire consisting of 45 items using a four-point Likert scale with positive and negative statements to reduce response bias with indicators, namely: strongly agree, agree, disagree, and strongly disagree (Grimmond et al., 2025).

### 2.3 Data Analysis Techniques

The data analysis consisted of descriptive and inferential statistics. Descriptive statistics (mean, standard deviation, minimum, maximum, median, and interquartile range) were used to summarize the students' critical thinking and collaboration scores in the experimental and control groups at the pre-test and post-test stages. Inferential analysis employed Analysis of Covariance (ANCOVA) at a significance level of  $\alpha = 0.05$ , with post-test scores as the dependent variable, group as the independent variable, and pretest scores as covariates to control for initial differences between groups. Prior to ANCOVA, statistical assumptions were examined, including residual diagnostics (standardized residuals and Cook's distance for outlier/influence screening), homogeneity of regression slopes, normality of residuals using the Shapiro-Wilk test, and homogeneity of variances using Levene's test. Given the balanced group sizes ( $n = 38$  each), ANCOVA was generally robust to minor variance heterogeneity. When significant ANCOVA effects were found, the adjusted means were compared using Bonferroni-adjusted pairwise comparisons. All analyses were conducted using SPSS version 30.0.

### 2.4 Hypothesis

Based on the theoretical review and empirical studies discussed in the preceding sections, geographical learning that integrates authentic case studies and credible learning resources is considered effective in fostering higher-order thinking and collaborative skills. The encyclopedia-based case-study learning model combines structured factual information with contextual geographic problems, enabling students to analyze, evaluate, and collaboratively interpret real-world phenomena. Such learning conditions are expected to promote deeper conceptual understanding and more meaningful interactions than conventional instructional approaches. Therefore, the hypotheses of this study are as follows:

$H_0$  states that there is no significant difference in students' critical thinking and collaboration skills between those taught using the encyclopedia-based case study model and those taught using conventional learning methods, whereas

$H_1$  states that there is a significant difference in students' critical thinking and collaboration skills between students taught using the encyclopedia-based case study model and those taught using conventional learning methods.

## 3. Results and Discussion

A descriptive analysis was conducted for both experimental and control classes to provide an initial overview of the characteristics of the data obtained in this study, a descriptive analysis was conducted for both the experimental and control classes, as shown in Table 2.

**Table 2.** Descriptive Data Analysis of the Experimental and Control Classes

Group	Test	n	Min	Max	Median	IQR	Mean	SD
Experimentaltal	Pretest	38	26	72	48	11	48.7	9.78
Experimentaltal	Posttest	38	72	100	88	8	87.6	5.79
Control	Pretest	38	20	60	40	8	40.2	8.32
Control	Posttest	38	60	92	78	11	77.2	7.93

**Source:** Processed research data, 2025

The descriptive statistics in Table 2 indicate that, prior to the implementation of the encyclopedia-based case study learning model, the experimental class had a mean pre-test score of 48.7, with a standard deviation of 9.78, whereas the control class had a mean score of 40.2 with a standard deviation of 8.32. The median pre-test score in the experimental group was 48, while that of the control group was 40. These findings suggest that the initial critical thinking ability of students in the experimental class was relatively higher than that in the control class.

The experimental class demonstrated higher initial ability than the control class. Therefore, the use of ANCOVA with pre-test scores as a covariate was appropriate to control for these initial differences, allowing the effect of the treatment to be analyzed more objectively.

After the implementation of the encyclopedia-based case study learning model aimed at enhancing students' critical thinking and collaboration skills, a significant improvement in learning outcomes was observed in the experimental class. The mean post-test score in the experimental class increased to 87.6 with a standard deviation of 5.79, whereas the control class achieved a mean post-test score of 77.2 with a standard deviation of 7.93. The median post-test score of the experimental class was 88, which was higher than that of the control class (78), indicating a more consistent and superior learning achievement in the experimental group.

The post-test score range in the experimental class ranged from 72 to 100, whereas in the control class, it ranged from 60 to 92. The interquartile range (IQR) values indicate a smaller score dispersion in the experimental class (8) than in the control class (11), suggesting that students' learning outcomes in the experimental class were more consistent and homogeneous.

This condition reflects the effectiveness of integrating structured encyclopedic information with contextual geographic case studies, which helps students analyze, evaluate, and understand geographic phenomena more deeply.

Overall, these descriptive statistical results are consistent with the objectives of the study and provide empirical support for the effectiveness of the encyclopedia-based case study learning model in enhancing students' critical thinking skills in geography learning within the Society 5.0. Based on the findings of this study, residual diagnostic tests were conducted to ensure that the statistical model employed (ANCOVA) met the fundamental analytical assumptions, thereby ensuring that the results of testing the effects of the encyclopedia-based case-study learning model on students' critical thinking and collaboration skills are reliable and valid. The results of the residual diagnostic analysis are shown in Table 3.

**Table 3.** Model diagnostics (two most extreme standardized residual cases for screening)

Group	Pretest	Posttest	Residual	Cook's D	Std. Residual
Control	52	60	-17.80	0.118	-2.618
Control	44	60	-17.40	0.063	-2.532

**Source:** Processed research data, 2025

Residual diagnostic examination indicated no extreme outliers, as no standardized residual values exceeded  $\pm 3$ . Two observations in the control class showed standardized residual values slightly below  $-2.5$ ; however, their Cook's distance values ( $< 1$ ) suggest that these cases were not influential and did not materially affect the model stability. This screening supported the absence of extreme and influential cases, whereas residual normality was evaluated separately using the Shapiro-Wilk test. After diagnostic screening was completed, the homogeneity of the regression slopes test was conducted to confirm the appropriateness of the ANCOVA. The results of the homogeneity test of the regression slope are presented in Table 4.

**Table 4.** Results of the Homogeneity of Regression Slopes Test

Effect	df <sub>1</sub>	df <sub>2</sub>	F	p-value	Description
Groups	1	72	31.893	3.04E-07	Significant
Pretest	1	72	0.318	0.575	Not Significant
Groups $\times$ Pretest	1	72	1.751	0.19	Not Significant

**Source:** Processed research data, 2025

The results of the homogeneity of the regression slope test indicated that the interaction between Group and Pretest was not significant ( $F = 1.751$ ;  $p = 0.190$ ). This finding confirms that the assumption of homogeneity of regression slopes is satisfied; therefore, the use of ANCOVA is appropriate. The relationship between the students' initial ability (pre-test) and final outcomes (post-test) was consistent across both groups. This implies that the observed differences in learning outcomes are not influenced by variations in students' initial abilities, but rather by the effectiveness of the instructional model. These results are in line with the objectives of geography education in the era of Society 5.0, which

emphasizes the equitable and inclusive development of critical thinking and collaborative competencies. After the assumption of homogeneity of regression slopes was satisfied, a residual normality test was conducted using the Shapiro-Wilk test, yielding a p-value of  $0.289 > \alpha = 0.05$ . Therefore,  $H_0$  is not rejected, indicating that the residuals are normally distributed.

In contrast, Levene's test produced a p-value of  $0.046 < \alpha = 0.05$ , indicating a small violation of the homogeneity of the variance assumption across groups. Because the group sizes were equal ( $n = 38$  each), ANCOVA is generally robust to modest variance heterogeneity. Nevertheless, the results should be interpreted with this assumption in mind. The results of the ANCOVA are listed in [Table 5](#).

**Table 5.** ANCOVA test results

Source of Variation	SS (Effect)	SS (Error)	df <sub>1</sub>	df <sub>2</sub>	F	p-value	$\eta^2$	Description
Intercept	19059.9	3550.29	1	73	391.902	< 0.001	0.843	Significant
Pretest	15.285	3550.29	1	73	0.314	0.577	0.004	Not Significant
Groups	1535.27	3550.29	1	73	31.568	< 0.001	0.302	Significant

**Source:** Processed research data, 2025

The output showed  $p = 0.001 < \alpha = 0.05$ ; thus,  $H_0$  was rejected, indicating that after controlling for students' initial ability (pre-test), there was a significant difference in post-test scores between the experimental and control groups. This finding suggests that the observed differences in students' learning outcomes were associated with the instructional model rather than the initial ability differences. Conversely,  $p = 0.577 > \alpha = 0.05$ , indicating a failure to reject  $H_0$ , suggesting that pre-test scores did not have a significant effect on post-test scores after being controlled for in the model. Accordingly, the results indicated that the encyclopedia-based case study learning model was more effective than conventional instruction in improving students' learning outcomes.

The effect size ( $\eta^2 = 0.302$ ) indicated a large practical effect, suggesting that the instructional model contributed substantially to the improvement of students' learning outcomes. Based on the ANCOVA results showing a significant difference between groups after controlling for pre-test scores, subsequent analysis focused on adjusted means to compare post-test learning outcomes ([Table 6](#)).

**Table 6.** Results Adjusted Mean

Group	test (Covariate)	justed Mean	SE	lf	5% (Down)	95% (Up)
Experimental	44.4	87.4	1.19	73	85	89.7
Control	44.4	77.4	1.19	73	75	79.7

**Source:** Processed research data, 2025

After controlling for the pre-test scores at the mean value (44.4), the adjusted post-test mean score of students in the experimental class was 87.4, whereas that of the control class was 77.4. The 95% confidence intervals indicated that the adjusted post-test score of the experimental class (85.0-89.7) remained higher than that of the control class (75.0-79.8). These results confirm that students who learned using the encyclopedia-based case study learning model achieved higher learning outcomes than those who received conventional instruction, even after their initial abilities were statistically controlled. The differences in adjusted mean scores between the groups were further examined through bonferroni-adjusted pairwise comparisons of the adjusted post-test scores ([Table 7](#)).

**Table 7.** Pairwise Comparison of Adjusted Posttest Scores

Comparison	df	t / Statistic	p-value	p-value Bonferroni
Eksperimen vs Kontrol	73	5.62	<0.001	<0.001

**Source:** Processed research data, 2025

The adjusted post-test mean scores based on pretest results indicate that the experimental group achieved higher scores than the control group, suggesting the effectiveness of the treatment after controlling for students' initial abilities. Overall, the findings of this study demonstrate that the encyclopedia-based case study learning model not only enhances cognitive learning outcomes but also

supports the development of students' critical thinking and collaboration skills in geography learning. Therefore, this model is worthy of recommendation as an innovative instructional approach that is relevant to the needs of 21st-century education and Society 5.0, which emphasizes collaborative, knowledge-based solutions to real-world problems.

These findings underscore the effectiveness of the encyclopedia-based case study model in enhancing students' critical thinking skills in geographical learning. The greater mean score improvement in the experimental class suggests that integrating encyclopedic resources within case-based learning fosters a richer, more analytical, and contextually grounded learning environment (Mayrita et al., 2024; Syarif, 2023). This aligns with constructivist theory, in which learners actively process and evaluate knowledge through engagement with authentic problem contexts, rather than passively receiving information. In this sense, the model positions students as knowledge co-constructors, encouraging them to negotiate meaning, justify arguments, and evaluate multiple perspectives to reach informed conclusions.

The model provides scaffolding through encyclopedic factual data, enabling students to link conceptual knowledge with empirical phenomena. By situating learning within authentic geographic issues, students are not only exposed to facts but are also guided to interpret and critically assess those facts in relation to broader social and environmental contexts. Consequently, learners are encouraged to develop higher-order thinking skills (HOTS), such as analysis, evaluation, and synthesis, which are considered essential competencies for 21st-century education (Aryana et al., 2025; Setyarini et al., 2023). This ability to transition from lower-order recall to higher-order reasoning mirrors the goals of Bloom's revised taxonomy, emphasizing transferable skills that extend beyond classroom learning.

Previous research similarly highlights the potential of case-based learning to enhance argumentation, problem-solving, and critical literacy across disciplines (Lavi & Marti, 2023; Robertson et al., 2025). In particular, case-based pedagogies create a dynamic learning environment in which knowledge is contextualized, making it more memorable and applicable to real-world challenges. When coupled with encyclopedic resources, students have access to a breadth of reliable information that prevents shallow or anecdotal reasoning, thus strengthening the credibility and robustness of their critical engagement. This approach also supports the development of epistemic cognition, where students reflect on the nature of knowledge, its sources, and its limitations (Bellocchi et al., 2025; Fowler et al., 2025)

The statistical confirmation of normality and homogeneity further strengthens the validity of the conclusions, ensuring that the observed differences are not merely artifacts of sample variability, but reflect a genuine effect of the instructional design. These quantitative results, in combination with theoretical underpinnings, reinforce the value of adopting innovative, resource-integrated pedagogical models in geography education (Morawski & Georgakaki, 2024; Pandis, 2025)

Nevertheless, this study has some limitations. The relatively small sample size and focus on a single school context restrict the generalizability of the findings. The specific cultural, institutional, and curricular environments in which the study was conducted may also have influenced the way students engaged with the model. For instance, educational contexts that emphasize rote memorization may pose challenges to fostering authentic critical engagement, whereas more dialogic classroom cultures may readily support such pedagogical innovations. To address these limitations, future research should replicate the study across diverse contexts, with larger sample sizes and longitudinal designs, to examine the sustainability of the observed learning gains. In addition, qualitative insights from classroom observations or student interviews could provide a more nuanced understanding of the processes underpinning critical thinking development in case-based, resource-rich environments (Rokhman et al., 2025; Sakata, 2022)

Practically, these results suggest that geography educators should incorporate encyclopedic resources into case-based scenarios. Doing so not only deepens conceptual understanding but also cultivates the critical thinking skills necessary for lifelong learning and responsible citizenship. Geography, as a discipline that bridges the natural and social sciences, provides fertile grounds for applying such integrative approaches. By equipping students with critical literacy and evaluative judgment, educators prepare them to analyze complex global issues, such as climate change, resource conflicts, and urbanization, with informed and critical perspectives. In the long term, embedding encyclopedic, evidence-based reasoning within case study learning may contribute to fostering a generation of learners capable of navigating uncertainty, making sound decisions, and meaningfully contributing to sustainable development goals.

Further findings indicated that students' collaboration skills in both the experimental and control groups were normally distributed, as confirmed by the Kolmogorov-Smirnov and Shapiro-Wilk tests (all Sig. values > 0.05). The homogeneity of variance assumption was also met, as evidenced by Levene's test, which showed equal variances across the groups (Sig. = 0.216–0.262 > 0.05). Therefore, the data satisfied the assumptions required for the parametric analysis. The results of the ANCOVA revealed a statistically significant difference in students' collaboration skills between the experimental and control groups after controlling for initial ability (pre-test) with a significance value of  $p < 0.001$  ( $< 0.05$ ). This finding confirms that the observed difference in collaboration skills was attributable to the instructional treatment rather than pre-existing differences between groups. Specifically, the implementation of the Encyclopedia-based Case Study Model had a significantly more positive effect on students' collaboration skills than conventional instruction.

These results demonstrate that the learning model not only enhances students' critical thinking skills, but also substantially strengthens their collaborative abilities. The significant ANCOVA outcome underscores the model's effectiveness in fostering a participatory, collaborative, and problem-oriented learning environment. Collaboration, as a core 21st-century competency, emphasizes teamwork, idea sharing, and collective problem-solving (Wan & Gu, 2025). Within this framework, encyclopedic resources enrich students' knowledge base, while case-based learning creates structured opportunities for discussion, negotiation, and joint decision-making, representing an integration of information literacy and social competence. Such an approach ensures that students are not merely passive consumers of information but are also active co-constructors of shared knowledge.

Theoretically, these results align with Vygotsky's concept of the zone of proximal development (ZPD), where peer collaboration extends cognitive capacity through social interaction. Learning in this model occurs within a social context that values dialogue, peer scaffolding, and the co-construction of meaning. In practice, case-based discussions enriched with encyclopedic references allow students to test their understanding, critique their peers' arguments, and co-construct more comprehensive solutions. This process strengthens metacognitive awareness, because students must continuously reflect on their reasoning and adapt their perspectives in response to group feedback. Over time, such collaborative exchanges nurture resilience, empathy, and intellectual humility qualities that are increasingly emphasized in global education frameworks, such as UNESCO's Education for Sustainable Development (Achumi, R. M., & Rawat, 2025; Pearl, 2025)

Consistent with prior studies, this model proved effective in advancing soft skills such as collaboration, communication, and academic empathy (Chen & Lee, 2024; Shlenova, 2024). Research on problem-based and case-based learning similarly demonstrates that structured interaction around authentic problems enhances not only disciplinary understanding but also interpersonal competencies (Huang et al., 2025; Pinto, 2023). In this regard, the Encyclopedia-based Case Study Model contributes to a pedagogical shift from teacher-centered instruction toward a more learner-centered paradigm, where students' voices and agency play a central role in shaping knowledge production.

Beyond academic achievement, this model prepares learners to meet the increasingly collaborative and team-based demands of the modern workforce. Employers and international organizations consistently highlight collaboration, adaptability, and problem-solving as critical competencies for the 21st century (Thornhill-Miller et al., 2023; Tushar & Sooraksa 2023). By embedding collaborative practices in educational settings, students gain early exposure to teamwork dynamics, including negotiation, conflict resolution, and collective decision-making. Moreover, when combined with reliable information resources, such as encyclopedias, collaboration is grounded in evidence-based reasoning rather than opinion alone, strengthening the epistemic quality of group outcomes.

Nevertheless, the study was limited by its relatively small sample size and single-school context, with caution against broad generalization. The cultural and institutional contexts in which this study was conducted may also influence how collaboration unfolds in the classroom. In cultures that prioritize individual achievement, fostering deep collaboration may require additional scaffolding and teacher facilitation, compared to contexts where collectivist values are dominant. Future research involving more diverse and larger populations is needed to better capture the impact of the model on collaboration skills across various educational settings. Longitudinal studies would also be beneficial to examine the sustainability of collaboration skills acquired through this model, as well as their transferability to real-world contexts, such as community problem-solving and workplace dynamics (Zamiri & Esmaeili, 2024).

In addition, mixed-method approaches combining quantitative and qualitative data can yield richer insights into how students collaborate within this model. While statistical evidence demonstrates effectiveness, qualitative accounts from students and teachers may reveal subtle dynamics, such as motivation, leadership distribution, and challenges in group coordination. Such insights are valuable for refining the model and ensuring its adaptability across different subject areas and levels of education. Ultimately, the findings of this study reinforce the argument that collaboration is not merely a pedagogical outcome, but also a process that must be intentionally cultivated, scaffolded, and evaluated within the educational system. Thus, the objectives and results of the research show positive results, can be utilized by others, and are widely disseminated.

#### 4. Conclusion

This study confirms that the Encyclopedia-Based Case Study learning model is effective in improving students' critical thinking and collaboration skills in geography learning within the context of Society 5.0 era. After controlling for students' initial abilities through ANCOVA, the findings demonstrated a significant difference in post-test scores between the experimental and control groups, indicating that the observed learning gains were attributable to the instructional model rather than to pre-existing differences. The adjusted mean analysis further confirmed that students who learned through the encyclopedia-based case study approach achieved higher corrected post-test scores than did those who received conventional instruction. These results were reinforced by pairwise comparison analyses, which showed consistent and meaningful differences in favor of the experimental group. The large effect size obtained suggests that the model strongly influences learning outcomes.

In addition, this study provides empirical evidence that the model not only enhances cognitive outcomes, particularly critical thinking, but also significantly strengthens students' collaboration skills. By integrating structured encyclopedic information with authentic and contextual geographic case studies, the learning process encouraged active discussion, joint problem-solving, and shared decision-making among students. Overall, the findings support the relevance and effectiveness of the encyclopedia-based case study model as an innovative pedagogical approach aligned with the demands of 21st-century education and the vision of Society 5.0. Therefore, the model can be recommended as an alternative instructional strategy in geography education to foster higher-order thinking and collaborative competencies in a more meaningful and contextual learning environment.

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**AI Use Declaration.** The AI application used by researchers in interpreting data results to reach conclusions is Chat Gpt. The use of Chat Gpt has been edited, and the author is responsible for any errors that occur.

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