

The implementation of collaborative flipped learning model integrated with ethnoscience to enhance students' critical thinking skills

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Abstract

Keywords:

Collaborative flipped Learning;
Ethnoscience;
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This research aims to implement an integrated Collaborative Flipped Learning (CFL) model with ethno science to improve students' critical thinking skills. The background of this research is the low critical thinking skills of Indonesian students, particularly in science learning, necessitating more contextual and meaningful learning innovations. The CFL model combines flipped learning, which promotes independent learning, with collaborative learning, which emphasizes group interaction, while ethno science connects scientific concepts with local wisdom. The research method uses a quasi-experimental design. The research subjects are 45 students from three universities, each of university consisted 15 students. Purposive sampling technique was used to determine the research subjects. The data was collected thru Ennis indicator-based critical thinking test, response questionnaires, learning implementation observations, and documentation. The analysis was conducted descriptively, supplemented by N-Gain calculations, normality tests, homogeneity tests, and ANOVA. The research results indicate that learning with the ethno science-based CFL model significantly improved critical thinking skills. This model has proven effective as an innovative 21st-century learning strategy relevant to the local cultural context.

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Introduction

The development of science and technology demands that the world of education produce generations who are not only academically proficient but also possess high-level thinking skills, one of which is critical thinking ability. This ability is crucial in addressing the complexities of real-life problems, as it allows learners to identify issues, analyze information, evaluate arguments, and make logical and reflective decisions (Paul & Elder, 2005). However, various results from international studies such as the Program for International Student Assessment (PISA) show that the critical thinking skills of Indonesian students, particularly in science, are still below the OECD average (Kementerian Pendidikan dan Kebudayaan, 2019). This aligns with the research by (Hartini et al., 2018) because classroom learning tends to focus on memorization and lacks analytical processes.

The progress of science and technology necessitates the education system to develop a generation that is not only academically skilled but also able to exhibit advanced thinking skills, such as critical thinking ability. This skill is crucial for tackling intricate real-world challenges as it allows people to recognize problems, assess data, critique reasoning, and arrive at rational

conclusions. Nonetheless, global evaluations like the Programme for International Student Assessment (PISA) still show that Indonesian students' scientific literacy and critical thinking abilities fall short of international benchmarks. The recent PISA 2022 report noted Indonesia's science score at 383, notably below the OECD average, indicating ongoing difficulties in enhancing students' higher-order thinking (OECD, 2022).

The poor performance of Indonesian students in scientific literacy indicates underlying problems in the educational system, such as the prevalence of teacher-centered teaching, the restricted use of inquiry-based methods, and a lack of chances for students to participate in advanced cognitive tasks. Empirical evidence indicates that students' critical thinking abilities play a significant role in their scientific literacy results, as demonstrated in a study carried out in East Jakarta, which found that critical thinking contributes 19.9% to the variation in students' scientific literacy (Azrai et al., 2020). Moreover, recent systematic reviews indicate that Indonesia's teaching methods remain largely focused on memorization instead of facilitating meaningful analytical interaction, limiting students' ability to form arguments and address non-routine challenges (Wirama et al., 2023).

This condition indicates the need for innovation in teaching approaches that not only focus on knowledge transfer but also encourage students' active involvement in the thinking and problem-solving process. One learning model relevant to these needs is Collaborative Flipped Learning (CFL). This model combines two main approaches: flipped learning and collaborative learning. In the flipped learning approach, students are given access to study the material independently through online media before face-to-face activities take place. Meanwhile, collaborative learning emphasizes the importance of social interaction and cooperation among students in completing tasks or solving problems as a group (Bishop & Verleger, 2013).

Collaborative Flipped Learning (CFL), a learning model that integrates the concepts of collaborative learning and the flipped classroom, provides an approach that can increase student participation in the learning process (Nugroho et al., 2024). The success of using flipped learning depends on the relevance of the material to students' daily lives, requiring a cultural context that aligns with their experiences (Zainuddin & Halili, 2016). The collaborative nature of the CFL learning model can enhance critical thinking skills because it encourages students to collaborate in problem-solving and evaluate information more deeply (Fauzi & Wisanti, 2025). Traditional, unidirectional learning models still fail to encourage active student participation in higher-order thinking processes (Sagala, 2017).

To address these challenges, researchers have investigated culturally relevant learning methods—like ethnoscience-focused teaching—as a way to enhance students' conceptual comprehension and advanced thinking skills. Systematic evidence shows that incorporating ethnoscience into science education can improve students' cognitive results, such as critical and creative thinking (Haryanto & Kencanawati, 2023; Wardana et al., 2025). Nonetheless, studies integrating Contextualized Functional Learning (CFL) with ethnoscience are scarce, as the majority of research explores the two methods in isolation. This disparity highlights the necessity for creative models that integrate CFL concepts with ethnoscience themes to foster contextually pertinent, inquiry-based, and culturally sensitive science education (Fitria et al., 2025; Oviana et al., 2025).

Thus, creating and applying a combined CFL–ethnoscience model is vital for tackling the well-recognized shortcomings in Indonesian students’ critical thinking abilities and is also crucial for bridging a significant gap in educational research. Recent educational research supports that culturally aware and inquiry-based teaching methods are crucial for providing learners with the critical and reflective skills needed to address the complexities of 21st-century scientific issues (Alamsyah et al., 2025; Safira & Agustina, 2024).

Integrating ethno science into learning provides students with the opportunity to learn scientific concepts thru the values, practices, and local wisdom of the community, making the learning process more relevant and meaningful (Juhariyani & Atmojo, 2025; Mukti et al., 2022; Sudarmin, 2014). The ethno science approach has been proven to increase learning motivation because students feel more connected to the material being studied(Djarwo et al., 2025; Rahayu et al., 2024). When ethno science is integrated with the CFL learning model, students not only learn independently thru initial materials but also critically explore the relationship between local culture and science concepts during face-to-face activities(Kasi et al., 2024; Mulyani & Julianto, 2018).

By combining CFL and ethno science, learning becomes not only more interactive and collaborative, but also more reflective and contextual. Students are encouraged to think critically about local phenomena studied scientifically, discuss with peers, and develop solutions based on scientific and cultural understanding. Therefore, this study aims to implement an ethno science-integrated CFL learning model in a local wisdom-based science course for science education students, and to evaluate its effectiveness in improving students' critical thinking skills. The results of this research are expected to contribute to the development of innovative learning models that are relevant to the local context and the needs of the 21st century.

Method

This study employs a quasi-experimental design to examine the effectiveness of the Collaborative Flipped Learning (CFL) model integrated with ethnoscience in improving critical thinking skills (Creswell & Creswell, 2018; Sugiyono, 2019). The study was conducted through a large-scale trial at STKIP Modern Ngawi, PGRI Madiun University, and Lamongan Islamic University. Data were collected using a pretest–posttest procedure. A total of 10 test items were used in this assessment. The sample consisted of 15 students from each university. Purposive sampling technique was used to determine the research subjects. This research activity was carried out from August to November 2025.

Data collection was carried out through a critical thinking skills test developed based on specific indicators(Ennis, 2011), a learning response questionnaire, observation of the learning implementation, and documentation of learning activities. The pretest and posttest data were analyzed descriptively to illustrate the trend of improvement in students’ abilities, complemented by the calculation of the N-Gain (Richard R Hake, 1999) to determine the magnitude of learning outcome improvement. Next, normality tests (Ghasemi & Zahediasl, 2012), homogeneity tests (Field, 2013), and ANOVA (Santoso, 2010) were conducted to test for significant differences between the three universities.

Results and Discussion

The trials were conducted at 3 universities, including STKIP Modern Ngawi, PGRI Madiun University, and Islamic Lamongan University, with a sample size of 15 students at each university. The results of the pretest and posttest on problem-solving skills were analyzed using the N-Gain score.

Table 1. Results of Normality Test for Field Trial Area

Trial	Class	Test of Shapiro-Wilk			
		Statistic	df	Sig.	Summary
Large-scale	STKIP Modern Ngawi	0,818	15	0,062	Sig>0,05 (Normal)
	PGRi Madiun University	0,866	15	0,212	Sig>0,05 (Normal)
	Lamongan Islamic University	0,902	15	0,421	Sig>0,05 (Normal)

Normality testing was conducted using the Shapiro-Wilk method to assess whether the data distribution across each class originated from a normally distributed population. Based on the results presented, the three classes STKIP Modern Ngawi, Universitas PGRI Madiun, and Universitas Islam Lamongan have significance values (Sig.) of 0.062 for STKIP Modern Ngawi, 0.212 for PGRI Madiun University, and 0.421 for Lamongan Islamic University, respectively. Since all Sig. values are greater than 0.05, it can be concluded that the data in the three classes are normally distributed. The data are normally distributed when the Sig. values is greater than 0.05 (Ghasemi & Zahediasl, 2012).

Normal distribution is an important prerequisite in parametric statistical analysis, such as ANOVA or t-tests, as it ensures the validity of statistical inferences. In this context, the results of the normality test indicate that the area data from all three educational institutions can be further analyzed using a parametric approach without the need for data transformation or the use of non-parametric methods (Razali & Wah, 2011). The Shapiro-Wilk statistical value obtained also indicates the trend of data distribution. STKIP Modern Ngawi has a statistical value of 0.818, which is lower than the other two universities. This indicates that although the data is still considered normal, its distribution is slightly more skewed compared to PGRI University Madiun (0.866) and Lamongan Islamic University (0.902). However, because the Sig. value remained above the threshold, the deviation was not statistically significant.

The sample size ($df = 15$) in each class also affects the sensitivity of the Shapiro-Wilk test. With a relatively small sample size, this test is still able to effectively detect normality, making it a suitable choice for educational research with a limited number of participants (Royston, 1995). Therefore, the decision to use Shapiro-Wilk in this study is very appropriate. The conclusion of this normality test strengthens the validity of the data used in the study. With a normal data distribution, researchers can proceed to the inferential analysis stage with confidence that the basic statistical assumptions have been met. This also indicates that the data collection process was carried out consistently and representatively across the population studied.

Overall, the results of the normality test support the suitability of the data for further analysis. The validity of this normal distribution is an important foundation for evaluating the

effectiveness of learning models or educational interventions implemented in each institution. Thus, these results make a significant contribution to the overall quality and credibility of the research.

Table 2. N-Gain Test Results for Large-Scale Trial

Trial	Class	Levene Test		
		Statistic	Sig	Summary
Large-scale	STKIP Modern Ngawi	0,086	0,775	Sig>0,05 (Homogen)
	PGRI Madiun University	0,194	0,667	Sig>0,05 (Homogen)
	Lamongan Islamic University	0,736	0,010	Sig>0,05 (Homogen)

Homogeneity testing was conducted using Levene's method to assess the equality of variances between groups. The results show that the significance values for STKIP Modern Ngawi and PGRI Madiun University are 0.775 and 0.667, respectively, which means the data from both institutions have homogeneous variances.

However, the Lamongan Islamic University showed a Levene's statistic value of 0.736 with a Sig. of 0.010, which is technically below the threshold of 0.05. Although the Sig. value for the Lamongan Islamic University is below 0.05, the table still concludes that the data is homogeneous. This raises methodological questions that need further examination. Statistically, a Sig. value < 0.05 should indicate that the variance between groups is not homogeneous (Field, 2013). Therefore, the interpretation of these results needs to be clarified or retested to ensure consistency.

Table 3. N Gain Score for Each Indicator

Indicator	Class	N-Gain	Category
Elementary Clarification	STKIP Modern Ngawi	0,56	Medium
	PGRI Madiun University	0,56	High
	Lamongan Islamic University	0,68	Medium
Basic Support	STKIP Modern Ngawi	0,65	Medium
	PGRI Madiun University	0,84	High
	Lamongan Islamic University	0,64	Medium
Inference	STKIP Modern Ngawi	0,76	High
	PGRI Madiun University	0,65	Medium
	Lamongan Islamic University	0,88	High
Advanced Clarification	STKIP Modern Ngawi	0,52	Medium
	PGRI Madiun University	0,48	High
	Lamongan Islamic University	0,76	Medium
Strategies and Tactics	STKIP Modern Ngawi	0,68	High
	PGRI Madiun University	0,65	Medium
	Lamongan Islamic University	0,84	High

Based on the results of the N-Gain calculation, it can be seen that the increase in students' critical thinking skills in each indicator shows variation between institutions. Lamongan Islamic University consistently obtained the highest scores in almost all indicators, especially in Inference (0.88), Advanced Clarification (0.76), and Strategies & Tactics (0.84), all of which

are in the high category. This indicates that the learning intervention implemented at Lamongan Islamic University is very effective in improving students' abilities to draw conclusions, analyze advanced arguments, and determine problem-solving strategies. Meanwhile, PGRI Madiun University excelled in the Basic Support indicator with a value of 0.84 (high category), indicating a significant increase in students' ability to provide reasons and strong evidence in the critical thinking process. However, in other indicators, the increase was still in the moderate category. In contrast to these two institutions, STKIP Modern Ngawi showed a stable but not yet prominent increase, as all indicators were in the moderate category, ranging from 0.52 to 0.76. This indicates that despite improvements in students' critical thinking skills, the effectiveness of the learning interventions at STKIP was not as strong as that seen at Lamongan Islamic University or on certain indicators at PGRI Madiun University. Overall, it can be concluded that Lamongan Islamic University showed the most even and significant improvement, PGRI Madiun University had particular strengths in certain indicators, while STKIP Modern Ngawi showed moderate progress across all measured indicators.

Levene's test is a method that is quite robust to violations of the normality assumption, making it suitable for use in educational contexts where data is often not perfectly ideal. However, interpreting the results must be done carefully, especially when statistical values indicate significant differences between groups (Brown & Forsythe, 1974). The heterogeneity of variance at Lamongan Islamic University can be caused by factors such as differences in teaching methods, student characteristics, or learning environment conditions. The same point was also made by (Gillies, 2016), who stated that differences in collaborative teaching methods can lead to non-homogeneous variance among student groups, especially when individual student characteristics—such as cultural background or intrinsic motivation—interact with the learning environment. (Zainuddin et al., 2020) stated that the flipped classroom teaching method can lead to different variances between classes due to differences in student characteristics, such as access to technology or learning preferences, as well as environmental conditions such as the availability of online resources.

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A similar view was also put forward by (Y. Chen et al., 2014), who stated that integrating modern teaching methods with local cultural elements can increase variance due to variations in student characteristics and learning environments, such as in areas with high ethnic diversity.

This indicates that although the data from the other two institutions is homogeneous, the presence of non-homogeneity in one institution can affect the validity of the combined analysis between groups.

In educational research, homogeneity of variance is important to ensure that comparisons between groups are made fairly and without bias. (Ojeda, 2024) revealed that homogeneity of variance is considered an important part of "methodological rigor." If the variances are not homogeneous, then analyzes like ANOVA can lead to misleading conclusions. Therefore, researchers need to consider using alternative tests such as Welch's ANOVA if non-homogeneity persists (Tomarken & Waller, 2005).

Overall, the results of the homogeneity test indicate that two out of three institutions have uniform variances, while one institution shows signs of non-homogeneity. Researchers need to follow up on these findings with additional analysis or methodological clarification to ensure the overall validity of the research results.

Table 4. The Result of Anova Test

	ANOVA				
	Sum of Aquare	df	Mean Square	F	Sig.
Between Groups	57.619	3	19.206	.253	.858
Within Groups	835.714	11	75.974		
Total	893.333	14			

Based on the results of the ANOVA test, an F value of 0.253 was obtained with a significance level of 0.858. Since the significance value is greater than 0.05, it can be concluded that there is no significant difference between the groups at the pretest stage. This finding indicates that the students' initial abilities were relatively similar before the integrated ethno science-CFL learning model was implemented. Thus, learning treatments focused on integrating local cultural contexts with science concepts can be objectively tested to see their impact on improving students' critical thinking skills (Santoso, 2010).

This equivalent initial condition is important in educational research because the effectiveness of the ethno science learning model can be more accurately evaluated. The pretest equivalence indicates that any differences in learning outcomes that may appear in the posttest are more influenced by the learning intervention, rather than by initial differences in students. Thus, the application of the CFL learning model integrated with ethno science is expected to make a real contribution to fostering students' critical thinking skills, which are important 21st-century competencies (Sugiyono, 2019).

The integration of the collaborative flipped learning model and ethno science to improve students' critical thinking in science learning is highly relevant to be applied in the current era. (Etemadfar et al., 2020) stated that the flipped classroom learning model has the ability to improve students' critical thinking skills and is highly recommended for implementation in the contemporary era. On the other hand, the ethno science approach has the potential to enhance cognitive abilities and critical thinking because it connects classroom learning with students' daily lives and encourages them to actively participate in the learning process (Verawati et al.,

2022). This is because the combination of flipped classroom and ethno science allows students to improve their critical thinking skills more effectively as they actively engage in group discussions and analyze ideas with a cultural background (Afdarina et al., 2024).

Claims about the effectiveness of learning models that can improve students' critical thinking skills were also put forward by (Afdarina et al., 2024), who argued that the flipped classroom-based blended learning paradigm has the potential to improve students' critical thinking skills in the classroom. This statement certainly does not contradict the studies the author has previously presented. Additionally, the results of this study also indicate that flipped classroom learning combined with ethno science-based collaborative learning is proven effective in improving students' critical thinking skills.

This is because the integration of two learning models (collaborative learning and flipped learning) provides students with the opportunity to study at home first and then engage in collaborative learning in the classroom. This aligns with (T. Chen et al., 2023) statement that student engagement before class has a significant relationship with the quality of interaction and collaboration within the classroom, supporting the idea that self-preparation at home can foster better cooperation during face-to-face sessions. Rahayu, R., Ismawati, R., and (Rahayu et al., 2024) also emphasize that optimizing pre-class activities contributes to improving students' learning readiness, which in turn reflects an increase in the quality of collaborative interaction in classroom learning. Furthermore, the CFL learning model is linked to the surrounding culture, making learning more contextual. By integrating the appropriate learning model, students can solve a problem and improve their critical thinking skills.

Conclusion

This research shows that the implementation of the Collaborative Flipped Learning (CFL) model integrated with ethno science is effective in improving critical thinking skills. The ANOVA test results showed no significant difference between the groups, indicating that the students' initial conditions were equivalent before the treatment was administered. This confirms that the improvement in critical thinking skills obtained in the posttest stage is a result of applying the CFL learning model based on ethno science, not due to differences in initial abilities. Integrating ethno science into CFL makes learning more contextual, relevant, and meaningful because it connects scientific concepts with local wisdom. Thus, this model not only encourages collaborative interaction and student learning independence but also contributes to strengthening critical thinking skills as an essential 21st-century competency.

Additionally, the results of this study contribute both theoretically and practically to the development of innovative learning models based on local cultural context. This finding recommends that science lecturers integrate ethno science into modern learning strategies such as CFL, as it has been proven to enhance students' motivation, cognitive engagement, and higher-order thinking skills. For future research, it is recommended that the ethno science-based CFL model be applied across various educational levels and other subjects, so that a more comprehensive picture can be obtained regarding the effectiveness and sustainability of the model in education.

Credit Authorship Contribution Statement

Anis Zahrotin: Conceptualization, Methodology, Supervision, Writing – review & editing. **Lucky Amatur Rohmani:** Data collection, Formal analysis, Visualization, Writing – original draft. **Army Al Islami Ali Putra:** Validation, Resources, Project administration, Writing – editing & finalization.

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