

Flipped Classroom Model Combined with Problem-Based Learning: Increase Critical Thinking Ability

Mitra Nata Rahayu*,
Andi Mariono, and Syaiputra W. D.
Universitas Negeri Surabaya, East Java, Indonesia

P-ISSN: 2089-4341 | E-ISSN: 2655-9633

Url Jurnal: <https://jurnal.uia.ac.id/akademika/article/4300>

DOI: <https://doi.org/10.34005/akademika.v13i02.4300>

Received: **06-12-2024**

Accepted: **23-12-2024**

Published: **20-01-2025**

*Correspondence: **Mitra Nata Rahayu**
Natarhy551@gmail.com

Abstract: *The growing complexity of real-world problems has heightened the need for critical thinking ability in education, particularly in fields like statistical education. This study examines the integration of the Flipped Classroom (FC) model with Problem-Based Learning (PBL) to increase critical thinking ability among university students. Conducted at Bhineka University, the research involved 60 students divided into experimental (FC+PBL) and control (PBL-only) groups. A mixed-methods approach was employed, combining pre-tests, post-tests, classroom observations, and reflective journals to collect quantitative and qualitative data. The experimental group participated in pre-class activities such as video lectures and quizzes, with in-class sessions focusing on collaborative problem-solving guided by PBL principles. Analysis of Variance (ANOVA) demonstrated a significant increase in critical thinking ability in the FC+PBL group compared to the PBL-only group ($p < 0.001$). Qualitative findings highlighted increased engagement, collaboration, and deeper inquiry among the experimental group. These results underscore the potential of integrating FC and PBL to create dynamic, student-centered learning environments that increase critical thinking ability and prepare students to tackle complex challenges effectively.*

Keywords: *flipped classroom, problem-based learning, critical thinking*

INTRODUCTION

Critical thinking ability is undeniably one of the foundational pillars of effective education, particularly in a world increasingly shaped by complex problems requiring well-reasoned solutions. Astuti Anggraeni et al. (2023) and Domu et al. (2023) highlight that increasing critical thinking ability supports logical reasoning and informed decision-making abilities crucial for navigating both academic and professional environments. Nugraheni et al. (2022) further defines critical thinking ability as a disciplined process of reflective judgment, relying on evidence to reach sound conclusions. This is especially evident in higher education, where increasing critical thinking ability equips



Akademika: Jurnal Teknologi Pendidikan is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/).

students with the capacity to analyze, interpret, and synthesize data abilities that are indispensable in fields such as statistical education.

Despite its acknowledged importance, increasing critical thinking ability among university students remains a significant challenge. Conventional lecture-based learning methods, as observed by Houghton (2023) and Sointu et al. (2023), often dominate classrooms, prioritizing rote memorization over meaningful engagement. This traditional approach limits opportunities for students to increase critical thinking abilities, such as synthesis and evaluation. Jumhur et al. (2024) demonstrated that implementing problem-based learning (PBL) led to significant improvements in students' critical thinking abilities and learning outcomes, further emphasizing the need for active learning strategies to bridge the gap between theoretical knowledge and practical application.

The issue is particularly evident in statistical education, where students often struggle to demonstrate their abilities in analyzing and interpreting statistical results, as well as synthesizing processed data. These limitations include difficulties in identifying data processing steps, describing analysis outcomes, understanding available data, and proposing improvements. Furthermore, students face challenges in interpreting data, solving statistical problems, and drawing relevant conclusions from the materials studied. These are aligned with the indicators of critical thinking ability outlined by Reynders et al. (2020), emphasizing the importance of this ability in the learning process. Critical thinking ability is therefore crucial for tasks such as analyzing datasets, applying statistical methods, and drawing logical conclusions. Preliminary studies in Indonesian universities echo these concerns, indicating that teacher-centered lectures often result in passive learning environments, leaving students disengaged and unable to fully understand statistical concepts or effectively utilize technology (Houghton, 2023).

To address these limitations, pedagogical innovations such as Problem-Based Learning (PBL) and the Flipped Classroom (FC) have proven to be effective strategies. PBL promotes student-centered learning by involving students in real-world problem-solving tasks, thereby enhancing analytical reasoning and systematic thinking. For example, a study by Ivan et al. (2023) highlighted how the flipped classroom model positively influences students' problem-solving abilities, showcasing the advantages of active learning approaches. Similarly, the FC model shifts the delivery of foundational content to pre-class activities, allowing classroom sessions to concentrate on interactive, higher-order cognitive tasks like critical analysis (Simanjuntak et al., 2021).

The integration of PBL and FC presents a promising solution, blending the strengths of both models to create a dynamic and engaging learning environment. Domu et al. (2023) argue that this combination encourages active participation and increases critical thinking ability by leveraging experiential learning and technology-

driven instruction. Riyanto et al. (2023) further substantiate these claims, showing that students in flipped-PBL settings significantly outperformed peers in analytical and evaluative tasks.

Constructivist theories offer a solid foundation for integrating PBL and FC. Recent research emphasizes that learning is an active process in which students construct knowledge through experiences and interactions (Robertson, 2022). A flipped-PBL environment aligns with this view, enabling students to explore theoretical concepts independently before applying them collaboratively to real-world problems (Samaila et al., 2024). Dewey's perspective on the value of experiential learning further supports this approach, emphasizing the importance of active engagement in meaningful tasks. These findings reinforce the constructivist principles underpinning the FC+PBL model, showcasing its potential to foster deeper learning and critical thinking ability in diverse educational contexts.

Empirical evidence also highlights the efficacy of PBL and FC in increasing critical thinking ability. Burce & Callo (2024) demonstrated that incorporating a flipped classroom strategy significantly increased students' critical thinking abilities in social science subjects. Similarly, Saputra & Mahariyanti (2024), observed that students taught using PBL exhibited superior critical thinking abilities, excelling in problem-solving and decision-making assessments.

In Indonesia, however, the adoption of these innovative approaches remains limited, particularly in statistical education. Traditional lecture-based methods dominate, creating passive learning environments that stifle critical thinking ability. Additionally, technological constraints and a lack of training for educators often hinder the implementation of models like PBL and FC. Cultural attitudes toward education, which often prioritize instructor-led learning, further complicate the shift to student-centered methodologies.

Given these challenges, the integration of PBL and FC offers a pathway to transformative change. By fostering collaboration, critical engagement, and active learning, this approach aligns with the demands of modern education. Recent studies have demonstrated the potential of this integrated model to enhance problem-solving competence, promote reflective thinking, and increase critical thinking ability (de Jong et al., 2022). For statistical education, where tasks like data interpretation and synthesis are fundamental, this integrated model not only increases critical thinking ability but also prepares students for the demands of the modern workforce.

This study determines the integration of the the Flipped Classroom model with Problem-Based Learning to increase critical thinking ability among university students learning statistics. The research aims to determine the effectiveness of this blended approach in increasing critical thinking ability through structured pre-class and in-class activities. Specifically, the objectives include identifying the

steps students take to process statistical data, analyzing their ability to interpret and synthesize data, and evaluating how this integrated model supports proposing actionable solutions to statistical problems. By focusing on critical thinking development, this study contributes to innovative pedagogical strategies tailored to the needs of higher education in Indonesia.

The findings reveal the novelty of the integrated approach, demonstrating its transformative impact on critical thinking ability. Students in the experimental group (Flipped Classroom combined with Problem-Based Learning) showed marked improvements in identifying and describing data processing steps, synthesizing and interpreting statistical information, and proposing practical solutions. This model fosters deeper engagement, analytical reasoning, and collaborative problem-solving, addressing challenges inherent in traditional learning methods. The results offer actionable insights for educators and policymakers, providing a framework for increasing critical thinking in statistical education and beyond, ultimately paving the way for a more effective and engaging higher education landscape in Indonesia.

METHOD

This study was conducted at Bhinneka University within a statistical education course, involving 60 students divided into two classes. The experimental group experienced a learning model that integrated the Flipped Classroom with Problem-Based Learning (PBL), while the control group engaged in traditional PBL methods. To ensure a fair comparison, both groups were matched for academic ability, minimizing potential confounding factors.

A mixed-methods approach was employed, combining quantitative and qualitative data to provide a comprehensive understanding of the intervention's impact. Quantitative data were collected through pre-tests and post-tests designed to assess critical thinking ability, requiring students to tackle statistical tasks involving analysis, synthesis, and evaluation (Reynders et al., 2020). These responses were evaluated using a validated rubric tailored for statistical education.

Qualitative data provided additional depth by capturing interaction dynamics, engagement levels, and problem-solving strategies through structured classroom observations and reflective journals. Classroom observations were conducted using an observation guide that focused on key indicators, such as participation frequency, collaboration patterns, and the quality of reasoning demonstrated during group discussions. The data from these observations were analyzed using thematic analysis, where recurring themes related to cognitive engagement and critical thinking development were identified and categorized. Reflective journals further enriched the findings by documenting students' reflections on their learning process throughout the intervention. The journals were analyzed through coding to extract themes that revealed students'

insights into their challenges, progress, and strategies for increasing critical thinking ability during the integration of the Flipped Classroom with Problem-Based Learning.

The experimental group participated in a carefully designed process that combined the strengths of the Flipped Classroom and PBL. Pre-class activities hosted on an online platform included video lectures, digital readings, and quizzes to introduce foundational concepts. In-class sessions focused on collaborative problem-solving using real-world statistical scenarios. This approach reflects the findings of Karjanto and Acelajado (2022), who demonstrated that flipped classrooms promote sustainable learning, cognitive gains, and improved attitudes by engaging students in active, preparatory learning tasks before class. The instructor played the role of a facilitator, encouraging inquiry and critical engagement. In contrast, the control group followed a conventional PBL approach, with all learning activities confined to the classroom and no pre-class preparation.

To determine the effectiveness of the integrated Flipped Classroom-PBL model, Analysis of Variance (ANOVA) was employed. ANOVA is a robust statistical tool for comparing differences in means across multiple groups or conditions. In this study, it was used to analyze pre-test and post-test scores both within each group and between the experimental and control groups. The analysis, conducted using SPSS 26 with a 5% significance level, provided insights into whether the observed changes in critical thinking ability were statistically significant.

The research design is depicted in the table below to provide a clear overview of the intervention and control conditions.

Table 1. Research Design

Group	Pre-Test	Treatment	Post-Test
Experimental Group	Yes	Flipped Classroom combined with Problem-Based Learning	Yes
Control Group	Yes	Problem-Based Learning only	Yes

The ANOVA results aimed to determine whether the Flipped Classroom-PBL combination had a measurable impact on increasing critical thinking ability among students compared to traditional PBL. By examining changes in pre-test and post-test scores, this study seeks to contribute to a deeper understanding of how integrated learning models can effectively increase critical thinking ability in statistical education.

RESULTS

The results of this study are presented with a focus on understanding the effectiveness of integrating the Flipped Classroom (FC) model with Problem-Based Learning (PBL) in increasing students' critical thinking ability. The analysis begins with the validation of assumptions,

including normality and homogeneity of variances, followed by hypothesis testing to compare the critical thinking ability between the PBL-only group and the FC+PBL group. The findings are then discussed in relation to the study's objectives, particularly the aim of identifying how the blended instructional model influences cognitive engagement and the development of critical thinking ability. This framework provides a foundation for interpreting the outcomes in the context of pedagogical innovations for higher education.

Normality Test

The Shapiro-Wilk test was conducted to determine whether the pretest and posttest scores for critical thinking ability in both the Problem-Based Learning (PBL) and PBL combined with Flipped Classroom (PBL+FC) groups followed a normal distribution. The results were clear and consistent, with p-values exceeding 0.05, affirming that all datasets were normally distributed.

Table 2. Normality Test Results

Class	Test	Statistic	df	Sig.
PBL	Pretest	0.942	30	0.105
	Posttest	0.945	30	0.124
PBL+FC	Pretest	0.941	30	0.094
	Posttest	0.939	30	0.085

These outcomes validate the assumption of normality, ensuring that the data met the prerequisites for conducting further statistical analyses with reliability and rigor.

Homogeneity of Variances

To ensure the reliability of the analysis, Levene's test was applied to assess the homogeneity of variances for both pretest and posttest data. The results were reassuring, with p-values exceeding 0.05, indicating that the variances were indeed homogeneous.

Table 3. Homogeneity Test Results

Test	Levene Statistic	df1	df2	Sig.
Pretest	2.646	1	58	0.109
Posttest	0.523	1	58	0.472

These findings affirm that the pretest and posttest datasets for critical thinking ability scores met the assumptions necessary for conducting ANOVA, providing a solid foundation for interpreting the results confidently.

Hypothesis Testing

To determine differences in critical thinking ability between the PBL and PBL+FC groups, an ANOVA was conducted. The results

painted a clear picture: the PBL+FC group significantly outperformed the PBL group on posttest scores, highlighting the superior effectiveness of this blended learning model. Interestingly, no significant interaction emerged between the learning model and levels of self-regulated learning (SRL), suggesting that the benefits of the PBL+FC approach extend consistently across varying SRL levels.

Table 4. ANOVA Results

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	28.675	3	9.558	34.881	0.000
Intercept	1381.210	1	1381.210	5040.416	0.000
Class (PBL vs PBL+FC)	25.823	1	25.823	94.234	0.000
Error	15.346	56	0.274		
Total	1519.125	60			
Corrected Total	44.021	59			

The ANOVA revealed a strikingly significant difference between the groups ($F = 94.234$, $p < 0.001$), reinforcing the role of the PBL+FC model in increasing critical thinking ability. Meanwhile, the absence of a significant interaction effect ($F = 0.491$, $p = 0.486$) indicates that this learning model's impact is robust and unaffected by students' levels of self-regulated learning. These findings underscore the adaptability and broad applicability of the PBL+FC model in promoting critical thinking ability across diverse learning profiles.

Qualitative Findings

Qualitative data provided additional depth by capturing interaction dynamics, engagement levels, and problem-solving strategies through structured classroom observations and reflective journals. Classroom observations were conducted using an observation guide that focused on key indicators, such as participation frequency, collaboration patterns, and the quality of reasoning demonstrated during group discussions. Observations revealed a vibrant classroom dynamic in the FC+PBL group, characterized by heightened collaboration, active participation, and a marked shift toward critical inquiry. Students were observed questioning assumptions, building on peers' ideas, and systematically analyzing problems to propose well-reasoned solutions. These behaviors underscored the blended model's impact on fostering a collaborative and inquiry-driven learning environment.

Reflective journals added another layer to this narrative, offering personal insights into students' journeys of increasing critical thinking ability. Many students described how they had grown in their ability to approach problems methodically, articulate their reasoning clearly, and critically evaluate diverse perspectives. These reflections were analyzed through coding to identify recurring themes, such as the development of self-regulated learning strategies, increased

confidence in tackling complex problems, and an enhanced capacity for critical analysis. These personal accounts echoed the trends seen in the quantitative data, underscoring the FC+PBL model's capacity to inspire deeper cognitive engagement and foster meaningfully increased critical thinking ability.

DISCUSSION

This study illuminates the transformative potential of blending the Flipped Classroom (FC) model with Problem-Based Learning (PBL) to nurture critical thinking ability among students. Quantitative analysis demonstrates that students in the PBL+FC group significantly outperformed their peers in the PBL-only group on posttest measures ($F = 52.546$, $p < 0.001$), with a mean score of 5.64 compared to 4.28. These results affirm the added value of this innovative hybrid approach, which combines pre-class content delivery with collaborative in-class problem-solving. The findings align with prior studies, such as research by Indrowati (2024) indicates that the flipped classroom offers greater flexibility and meaningfulness in learning activities, providing students with more space and time to construct their knowledge and abilities freely.

Complementary qualitative data enriches this foundation, revealing heightened engagement, collaborative problem-solving, and increased confidence in critical thinking ability within the PBL+FC group. Observations captured lively and purposeful interactions, while reflective journals documented students' growing ability to articulate reasoning and critically evaluate diverse perspectives. These findings echo the results of Domu et al. (2023), who found that PBL in an online flipped classroom context positively influenced statistical literacy and student satisfaction in project-based learning (Dwitias Sari et al., 2022).

The effectiveness of integrating FC and PBL lies in their synergy, with the flipped model addressing common challenges of PBL, such as limited classroom time for deep exploration. Pre-class preparation ensures that students arrive ready to engage in meaningful discussions and problem-solving tasks, a dynamic supported by research from Akhsani, (2023), who demonstrated that flipped classroom models enhanced mathematical problem-solving abilities compared to traditional methods. Similarly, Astuti et al., (2023) observed significant improvements in problem-solving abilities when using a flipped-PBL approach for high school students, emphasizing the model's adaptability across various educational levels.

The findings also align with the study by Orhan (2024), which demonstrated that the flipped classroom approach produces the greatest gains in critical thinking abilities and dispositions. This research underscores the importance of structured instructional design and expert validation in maximizing the benefits of flipped classroom environments combined with problem-based learning (PBL).

Nevertheless, this study is not without limitations. Its focus on critical thinking ability excluded other outcomes, such as creativity or teamwork. Additionally, the modest sample size and relatively short intervention period may limit generalizability. Triangulating qualitative data with additional sources could further enhance the robustness of the findings.

For educators, the integration of PBL and FC offers a proven strategy for increasing critical thinking ability, particularly in fields requiring analytical and problem-solving abilities. For researchers, this study provides a platform for future exploration of hybrid pedagogical models in diverse contexts. Overall, the PBL+FC model stands as a robust and adaptable framework for increasing critical thinking ability, empowering students to navigate the complexities of contemporary education with confidence and ability.

CONCLUSION

This study demonstrates the transformative potential of integrating the Flipped Classroom (FC) model with Problem-Based Learning (PBL) to increase critical thinking ability among university students in statistical education. The results show that students in the FC+PBL group significantly outperformed their peers in the PBL-only group, as evidenced by improved post-test scores and qualitative insights into engagement, collaboration, and analytical reasoning. The integration of FC and PBL leverages pre-class preparation and in-class problem-solving to create a dynamic and student-centered learning environment. This approach not only increases critical thinking ability but also prepares students to navigate complex challenges in academic and real-world contexts. These findings offer actionable insights for educators and policymakers seeking to implement innovative learning strategies to increase critical thinking ability in higher education.

REFERENCES

- Akhsani, L. (2023). The Effect of Blended Learning Type of Flipped Classroom on Mathematical Problem-Solving Ability in Solid Figures Topic. *Inovasi Matematika (Inomatika)*, 5(1), 16–27. <https://doi.org/10.35438/inomatika>.
- Astuti Anggraeni, D., Hakim, A., & Fitriyah Sulaeman, N. (2023). Problem-Solving Ability through Flipped-Problem Based Learning on Elasticity Materials for High School Student. *Physics Education Journal*, 6(1), 1–10. <http://jurnal.unipa.ac.id/index.php/kpej>.
- Burce, A. D., & Callo, E. C. (2024). Flipped classroom strategy in promoting critical thinking in social science. *World Journal of Advanced Research and Reviews*, 22(2), 2111–2137. <https://doi.org/10.30574/wjarr.2024.22.2.1638>.
- de Jong, N., van Rosmalen, P., Brancaccio, M. T., Bleijlevens, M. H., Verbeek, H., & Peeters, I. G. (2022). Flipped classroom formats

- in a problem-based learning course: Experiences of first-year bachelor European public health students. *Public health reviews*, 43, 1604795. <https://doi.org/10.3389/phrs.2022.1604795>.
- Domu, I., Pinontoan, K. F., & Mangelep, N. O. (2023). Problem-based learning in the online flipped classroom: Its impact on statistical literacy abilities. *Journal of Education and E-Learning Research*, 10(2), 336–343. <https://doi.org/10.20448/jeelr.v10i2.4635>.
- Dwitias Sari, R., Cintiya Manalu, I., Puji Annastasya, I., & Riviandy Harahap, S. (2022). Penerapan Model Flipped Classroom Pada SMK Tritech Informatika Medan. *Journal of Information & Communication Technology in Education*. 9(2). <https://doi.org/10.24114/jtikp.v9i2.41942>.
- Saputra, D., & Mahariyanti, E. (2024). Efektivitas Pembelajaran Ipa Menggunakan Model Pembelajaran Problem Based Learning Terhadap Kemampuan Berpikir Kritis. *Jurnal Asimilasi Pendidikan*, 2(1), 7-13. <https://doi.org/10.61924/jasmin.v2i1.24>.
- Houghton, J. (2023). Learning modules: problem-based learning, blended learning and flipping the classroom. *The Law Teacher*, 57(3), 271–294. <https://doi.org/10.1080/03069400.2023.2208017>.
- Indrowati, M. (2024). Improving Evaluation Abilities Through Flipped-Problem-Based Learning with Digital Storytelling Task: A Systematic Review. *Journal of Higher Education Theory & Practice*, 24(1). <https://doi.org/10.33423/jhetp.v24i1.6769>.
- Ivan, M., Ulfah, M., & Nilawijaya, R. (2023). An Exploration into the Impact of Flipped Classroom Model on Cadets' Problem-Solving Abilities: A Mix Method Study. *International Journal of Educational Methodology*, 9(4), 745-759. <https://doi.org/10.12973/ijem.9.4.745>.
- Jumhur, A. A., Avianti, R. A., Nurfitri, P. E., & Mahir, I. (2024). Implementation of problem-based learning to improve critical thinking ability of vocational students in Jakarta. *European Journal of Education and Pedagogy*, 5(5), 16-24. <https://doi.org/10.24018/ejedu.2024.5.5.860>.
- Karjanto, N., & Acelajado, M. J. (2022). Sustainable learning, cognitive gains, and improved attitudes in College Algebra flipped classrooms. *Sustainability*, 14(19), 12500. <https://doi.org/10.48550/arXiv.2210.15979>.
- Nugraheni, B. I., Surjono, H. D., & Aji, G. P. (2022). How can flipped classroom develop critical thinking abilities? A literature review. *International Journal of Information and Education Technology*, 12(1), 82–90. <https://doi.org/10.18178/ijiet.2022.12.1.1590>.
- Orhan, A. (2023). Comparing the Effectiveness of Online, Flipped, and In-Class Critical Thinking Instruction on Critical Thinking Abilities and Dispositions in Higher Education: Flipped

- Classroom Produces the Greatest Gains. *International Journal of Technology in Education*, 6(2), 238-259.
- Reynders, G., Lantz, J., Ruder, S. M., Stanford, C. L., & Cole, R. S. (2020). Rubrics to assess critical thinking and information processing in undergraduate STEM courses. *International Journal of STEM Education*, 7(1).
<https://doi.org/10.1186/s40594-020-00208-5>.
- Riyanto, M., Asbari, M., & Latif, D. (2024). Efektivitas problem based learning terhadap kemampuan berpikir kritis mahasiswa. *Journal of Information Systems and Management (JISMA)*, 3(1), 1-5. <https://doi.org/10.4444/jisma.v3i1.744>.
- Robertson, W. H. (2022). The Constructivist Flipped Classroom. *Journal of College Science Teaching*, 52(2), 3-5.
<https://doi.org/10.1080/0047231X.2022.12290644>.
- Samaila, K., Al-Samarraie, H., Tsong, C. K., & Alzahrani, A. I. (2024). A new guided flipped learning model for lifelong learning. *Interactive Learning Environments*, 1-15.
<https://doi.org/10.1080/10494820.2024.2412063>.
- Simanjuntak, M. P., Hutahaean, J., Marpaung, N., & Ramadhani, D. (2021). Effectiveness of problem-based learning combined with computer simulation on students' problem-solving and creative thinking abilities. *International Journal of Instruction*, 14(3).
<https://doi.org/10.29333/iji.2021.14330a>.
- Sointu, E., Hyypiä, M., Lambert, M. C., Hirsto, L., Saarelainen, M., & Valtonen, T. (2023). Preliminary evidence of key factors in successful flipping: predicting positive student experiences in flipped classrooms. *Higher Education*, 85(3), 503–520.
<https://doi.org/10.1007/s10734-022-00848-2>.