



Implementation of the Flipped Classroom Model to Improve Cognitive Learning Outcomes in Biology Learning

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Article Information	ABSTRAK
Submitted: 30 – 11 – 2024 Accepted: 26 – 03 – 2025 Published: 31 – 03 – 2025	Pendidikan abad ke-21 menekankan pembelajaran yang berpusat pada peserta didik untuk mengembangkan kemampuan berpikir kritis, komunikasi, dan kolaborasi. Namun, pembelajaran biologi di kelas masih banyak menggunakan metode konvensional yang menempatkan guru sebagai sumber utama informasi. Pola tersebut menyebabkan siswa pasif dan kurang termotivasi sehingga berdampak pada rendahnya penguasaan konsep. Untuk mengatasi kondisi tersebut, diperlukan inovasi pembelajaran yang dapat meningkatkan partisipasi serta kemandirian belajar siswa. Salah satu alternatif yang relevan adalah model Flipped Classroom, di mana siswa mempelajari materi terlebih dahulu melalui media digital sebelum kegiatan tatap muka di kelas berlangsung. Penelitian ini bertujuan untuk meningkatkan pemahaman dan hasil belajar kognitif mahasiswa melalui penerapan model Flipped Classroom pada materi perubahan lingkungan. Penelitian ini menggunakan metode penelitian tindakan kelas (PTK) yang dilaksanakan dalam dua siklus dengan melibatkan 20 mahasiswa semester lima. Analisis data dilakukan melalui uji normalitas Kolmogorov-Smirnov untuk memastikan distribusi data, uji homogenitas Levene untuk menguji kesamaan varians, serta uji-t berpasangan (paired sample t-test) dengan taraf signifikansi 0,05 untuk mengetahui perbedaan hasil belajar antar siklus. Hasil penelitian menunjukkan peningkatan signifikan pada hasil belajar, dengan nilai rata-rata siklus I ($M = 305,91$) meningkat menjadi ($M = 459,55$) pada siklus II. Uji-t berpasangan menunjukkan adanya perbedaan signifikan antara kedua siklus ($t(10) = -9,34$, $p < 0,001$). Dengan demikian, penerapan model Flipped Classroom terbukti efektif dalam meningkatkan keterlibatan, pemahaman, dan hasil belajar kognitif mahasiswa pada pembelajaran biologi. Kata kunci: Flipped Classroom; Hasil Belajar; Perubahan Lingkungan.
Publisher	ABSTRACT
Program Studi Pendidikan Biologi, Fakultas Sains dan Teknologi, UIN Walisongo Semarang	<i>21st-century education emphasizes student-centered learning to develop critical thinking, communication, and collaboration skills. However, biology classrooms still largely rely on conventional methods that place the teacher as the primary source of information. This pattern leads to passive and unmotivated students, resulting in low conceptual mastery. To address this situation, learning innovations are needed that can increase student participation and independence in learning. One relevant alternative is the Flipped Classroom model, in which students first study the material through digital media before</i>

face-to-face classroom activities take place. This study aims to improve students' understanding and cognitive learning outcomes through the application of the Flipped Classroom model to the topic of environmental change. This study used a classroom action research (CAR) method implemented in two cycles involving 20 fifth-semester students. Data analysis was conducted using the Kolmogorov–Smirnov normality test to ensure data distribution, Levene's homogeneity test to test for equality of variance, and a paired sample t-test with a significance level of 0.05 to determine differences in learning outcomes between cycles. The results of the study showed a significant increase in learning outcomes, with the average value of cycle I ($M = 305.91$) increasing to ($M = 459.55$) in cycle II. A paired t-test showed a significant difference between the two cycles ($t(10) = -9.34, p < 0.001$). Thus, the application of the Flipped Classroom model was proven effective in increasing student engagement, understanding, and cognitive learning outcomes in biology learning.

Keywords: *Flipped Classroom; Learning Outcomes; Environmental Change.*

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INTRODUCTION

Education in the 21st century demands a paradigm shift from teacher-centered learning to student-centered learning. However, the reality on the ground shows that the learning process in Indonesia is still dominated by the teacher as the primary source of knowledge delivery. Conventional, lecture-oriented learning models are still frequently used, resulting in students tending to be passive, less participatory, and less engaged in the learning process (Aghaei et al., 2020; Crawford & Parsell, 2025). This creates a monotonous classroom atmosphere, makes the material difficult to understand deeply, and students struggle to connect concepts to real life (Ulwyiah & Indarti, 2018).

Futhermore, learning success is measured by the extent to which students are able to understand and apply the material independently. Effective learning should provide space for students to practice critical thinking, problem-solving, and reflective learning (MacKnight, 2021; Almulla, 2023; Xu et al., 2023). However, many students still have low reading interest and learning motivation, which tends to impact cognitive learning outcomes that are less than optimal (Minaz et al., 2018; Lo et al., 2020; Zhao et al., 2021).

Previous research has shown that technology-based learning and digital media can enhance learning activities and conceptual understanding (Abidin, 2019; Giawa, 2024; Sitorus et al., 2025). The Flipped Classroom is a learning model that can support this improvement. This model reverses traditional learning patterns by moving material delivery outside the classroom through instructional videos or online media, while face-to-face class time is used for discussion, problem-solving, and conceptual application (Cho et al., 2021; Polat & Karabatak, 2022; Sourg et al., 2023). This approach allows students to learn at their own pace, while the teacher acts as a facilitator, helping to deepen understanding during classroom activities (Han, 2022; Poulain et al., 2023).

Other research has also shown that implementing the Flipped Classroom can increase learning motivation (Minggi & Zatalini, 2018), student engagement

(Subagia, 2017), and academic achievement (Charisma et al., 2021). However, most of this research has been conducted in the context of exact science subjects or at the secondary school level, and has not been widely applied to conceptual Biology material, such as environmental change, for biology education students. This material demands analytical thinking skills and a deep understanding of the relationship between ecosystem concepts and the impacts of environmental change.

Given these conditions, this research is crucial to fill the gap in research regarding the effectiveness of implementing the Flipped Classroom model in improving students' cognitive learning outcomes in environmental change. It is hoped that the results of this study will provide empirical evidence that the Flipped Classroom model not only increases participation and learning motivation but also positively impacts students' conceptual understanding and cognitive achievement in Biology learning.

METHOD

This research used a classroom action research (CAR) approach aimed at improving learning processes and outcomes through the implementation of specific actions in two improvement cycles. CAR was chosen because it allows researchers to identify, plan, implement, and evaluate concrete actions in the classroom to increase learning effectiveness (Lamsari, 2019). Each cycle consists of four main stages: planning, action implementation, observation, and reflection.

The research was conducted from September to October 2024, with a total of four meetings for each cycle. The research subjects were 20 students, and the research objectives included: (1) improving the quality of the biology learning process through the implementation of the Flipped Classroom model, and (2) improving students' cognitive learning outcomes on environmental change.

The research consisted of two cycles, each encompassing the following four stages:

1. Planning

The researcher analyzed the curriculum to determine appropriate learning outcomes and materials. Then, the researcher developed learning tools such as a syllabus, teaching modules, student activity sheets, and research instruments in the form of learning outcome tests, observation sheets, and student response questionnaires. Learning videos were prepared for the pre-class phase in accordance with the characteristics of the Flipped Classroom model.

2. Implementation

Learning was conducted using the Flipped Classroom model. Students first studied the learning videos and supporting materials online before face-to-face sessions. Classroom activities focused on discussions, problem-solving, and clarifying unclear concepts.

3. Observation

During the learning process, the researcher and collaborators observed student activities and the implementation of the learning steps. Data was collected through observation sheets and cognitive evaluation results.

4. Reflection

After each cycle, the researcher analyzed the observation results and test scores to assess the achievement of learning objectives. If results did not meet the success indicators, improvements were made in the next cycle.

The data obtained were analyzed quantitatively and qualitatively. Qualitative analysis was used to describe the learning process and student engagement during the implementation of the Flipped Classroom model. Meanwhile, quantitative analysis was used to measure improvements in students' cognitive learning outcomes.

Statistical tests were conducted using SPSS software, including normality and homogeneity tests, and paired sample t-tests to determine significant differences between learning outcomes in Cycle I and Cycle II. The significance level used was $\alpha = 0.05$. Data were considered normally distributed if the p-value was > 0.05 , and significant differences were found if the p-value was < 0.05 . The results of this analysis served as the basis for drawing conclusions regarding the effectiveness of implementing the Flipped Classroom model in improving students' cognitive learning outcomes.

RESULTS AND DISCUSSION

Respondents' cognitive measurements used a multiple-choice test instrument consisting of 40 questions. The weight for each question is 2.5 so that the ideal score obtained by students if all answers are correct is 100. Improvement in cognitive abilities was obtained from the evaluation of Cycle I and Cycle II with the same questions. The test conducted in this study was a paired T-test. The results of the analysis that have been carried out used a normality test with the Kolmogorov Smirnov test to prove the data originating from a normal distribution. If the sig. value > 0.05 then the data of Cycle II according to the basic rules of decision-making for normality tests is normally distributed.

Table 1. Data Normality Test

	Statistic	dF	Sig.
Difference	.176	11	.200

Based on table 1, calculations using the SPSS application show that the results of the Kolmogorov Smirnov test indicate that the test data is normally distributed, $D(11) = 0.176$, $P = 0.200$. Data is normally distributed if $p > 0.05$. The next calculation is the homogeneity test using the paired t-test with results as in Table 2.

Table 2. Data Homogeneity Test

		Levene Statistic	df 1	df 2	sig
-	Based on mean	.476	3	7	.709
	Based on median	.154	3	7	.924
	Based on median and with adjusted df	.154	3	2,780	.920

Based on trimmed mean ,446 3 7 ,728

Based on Table 2. the results of the homogeneity test at a significance level of 0.05 obtained a Sig. value. The decision was taken based on the provision that if the significant value on the trimmed mean value is > 0.05 then the data is homogeneous, stated to have the same or homogeneous variance.

Tabel 3. Uji Paired Samples Statistic

Pair	Mean Difference	Std. Deviation	Std. Error Mean	95%	t	df	Sig. (2-tailed)
	Lower	Upper					
Cycle I – Cycle II	-153.64	164.30	16.44	-189.51 -117.77	-9.34	10	

Table 3 shows a significant difference in the average learning outcomes between Cycle I and Cycle II students, where Cycle II students' learning outcomes were higher than Cycle I students' learning outcomes. These results indicate that the Flipped Classroom learning model has a positive effect on the learning outcomes of 11th-grade high school students. This phenomenon is possible because Cycle II students can prepare and study the material in more depth regarding before and after as well as during class learning. So that during class, students have more practice in deepening the application of the material that has been taught, whereas students in Cycle I where learning still lacks in-depth material before and after and makes students dependent on what is explained by the teacher. The results of this study are relevant to research conducted by Olakanmi (2017) in (Putri et al., 2021), which proved that flipped classrooms have an effect on student learning outcomes, and (Minggui & Zatalini, 2018), which reported that the Flipped Classroom learning strategy using e-learning Classes has an effect on student learning outcomes (Figure 1).

Based on Figure 1, it can be clearly seen that student learning outcomes using the Flipped Classroom learning model in each cycle showed a significant increase from Cycle I to Cycle II, both in terms of average class scores and student completion percentages, which indicates positive developments in student learning outcomes from the first cycle to the second cycle. This is in accordance with what was stated by Charisma et al., (2021) that the Flipped Classroom learning model is best used to improve students' cognitive learning outcomes.

An analysis using a paired T-test was conducted to determine the effect of the Flipped Classroom learning model on high school students' cognitive abilities. This learning model makes classroom activities more effective and helps maximize the use of limited time during learning. According to Subagia (2017), implementing the Flipped Classroom model can increase the efficiency of the learning process, because learning activities that are usually carried out in class can be completed at home, and vice versa, activities that are usually done at home can be done in class. Thus, this model is in line with the 21st-century education system. The implementation of the Flipped Classroom provides many benefits for students, such as the ability to continue learning independently even though they are not present in

class, so they do not fall far behind their friends. In addition, learning becomes more planned and systematic because students study the material first at home before learning activities in class begin.

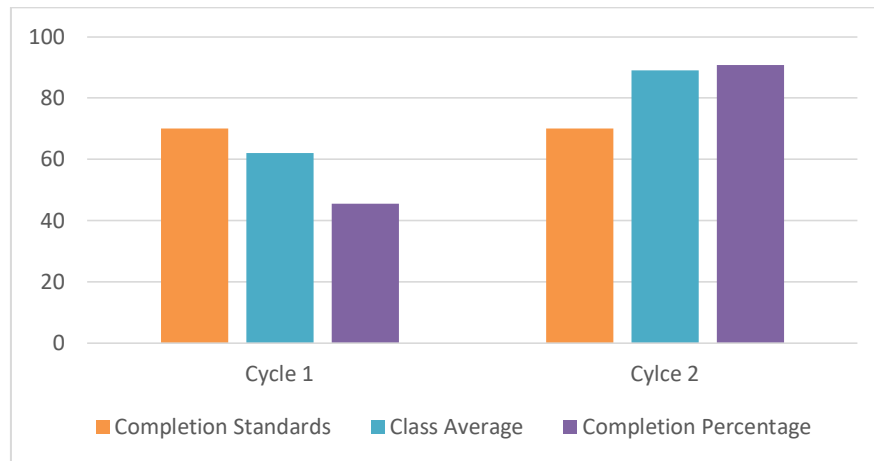


Figure 1. Learning Outcome Graph

Therefore, it can be concluded that the Flipped Classroom learning model has an effect on biology learning outcomes for students in class X1, phase F. Learning using this model encourages students to be more active and enthusiastic. This aligns with research by Abidin (2019), which shows that the Flipped Classroom model is designed to increase student engagement in the learning process. Students are required to participate more in learning with this model because it encourages collaboration among students, allowing them to complement each other's strengths and weaknesses. Active student participation is crucial to ensure that previously studied video material is not wasted. Implementing the Flipped Classroom model helps students become more actively involved in the learning process, making the material more meaningful and memorable.

The Flipped Classroom model is a learning model that can improve concentration, train listening skills, and enhance accuracy, as well as help students develop self-confidence without feeling embarrassed. This aligns with research conducted by Maolidah (2017), which states that this learning model emphasizes student activeness and optimal use of class time to encourage enthusiasm for learning and achieve desired learning outcomes. The Flipped Classroom model also encourages students to be more active during the learning process to achieve learning objectives.

This learning success is not without challenges. One obstacle encountered during the research was that not all students had the same level of motivation, so some students may not have completed assignments or prepared material well. This learning model was also being implemented for the first time with students, so they needed prior knowledge to implement the Flipped Classroom model. Students who experienced conventional learning models, often with teacher explanations, often became disengaged in class. However, this was overcome by providing

encouragement and guidance to students to maintain a serious focus throughout the learning process.

CONCLUSION AND RECOMMENDATION

Based on the research results, the application of the Flipped Classroom learning model to biodiversity material proved effective in improving students' cognitive learning outcomes. This improvement was evident in the increase in average test scores between cycles I ($M = 305.91$) and II ($M = 459.55$), with paired t-test results indicating a significant difference ($t(10) = -9.34$, $p < 0.001$). The homogeneity test at the 0.05 significance level also showed a Sig. (Based on trimmed mean) value > 0.05 , indicating homogeneity of the data. These results confirm that students who participated in learning using the Flipped Classroom model had a better understanding of concepts, were more active participants in learning activities, and were able to relate the material to real-world contexts compared to students who learned using conventional methods.

Based on these findings, this study recommends that the application of the Flipped Classroom model be expanded to other analytical and applicable biology materials, such as ecosystems, genetics, and environmental change. Furthermore, further research could integrate Flipped Classroom with project-based or inquiry-based learning approaches to hone students' higher-order thinking skills. Future studies are also recommended to involve a larger number of participants and different educational levels to broaden the generalizability of the results. Further research is also crucial to examine students' affective and motivational aspects, including learning independence and attitudes toward digital learning, which are key factors in the successful implementation of Flipped Classroom in the context of 21st-century biology learning.

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