

The Effectiveness of the Technology-Based Flipped Classroom Model Integrated with TPACK in Improving Students' Critical Thinking Skills at Al Majidiyah Islamic Senior High School

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ABSTRACT

This study aims to examine the effectiveness of the technology-based *Flipped Classroom* model integrated with the TPACK framework in improving students' critical thinking skills at Al Majidiyah Islamic Senior High School. The study was motivated by the limited implementation of TPACK-integrated flipped classroom learning in Islamic secondary education, where conventional teacher-centered instruction still dominates and students' critical thinking skills remain underdeveloped. Previous studies have widely discussed flipped classrooms; however, few have specifically explored the integration of technology, pedagogy, and content knowledge through the TPACK framework to enhance higher-order thinking skills in madrasah contexts. This study employed a quantitative approach using a quasi-experimental design with a pretest-posttest control group design. The research participants consisted of two classes: an experimental class taught using the technology-based *Flipped Classroom* integrated with TPACK and a control class taught using conventional learning methods. Data were collected through pretests, posttests, and documentation. The research instruments were tested for validity and reliability, while data analysis was conducted using normality tests, homogeneity tests, paired sample t-tests, and independent sample t-tests. The findings showed a significant improvement in students' critical thinking skills after the implementation of the model. The experimental class achieved higher posttest and N-Gain scores compared to the control class, with significance values below 0.05. The main contribution of this study is the development of a student-centered learning model that effectively integrates technology, pedagogy, and content knowledge to foster critical thinking skills and support innovative 21st-century learning practices in Islamic education.

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1. INTRODUCTION

The development of information technology in the 21st century has brought significant changes to various aspects of life, including education. Previously conventional learning systems are now undergoing a transformation toward technology-based learning that is more flexible, interactive, and student-centered (Widia & Nasrullah, 2025). This transformation requires teachers not only to master learning materials but also to be able to integrate technology effectively into the learning process (Widyasari, Masykur, & Sugiharta, 2021). One relevant approach in this context is Technological Pedagogical Content Knowledge (TPACK), which emphasizes the importance of synergy between mastery of material (content), learning strategies (pedagogy), and technology (technology) in creating effective learning.

In the context of modern education, critical thinking skills are one of the key competencies that must be developed. These skills encompass the ability to analyze information, evaluate arguments, and make rational decisions when facing various problems (Andryani & Pangestu, 2025). This aligns with the demands of 21st-century education, which emphasizes the development of critical thinking, creativity, collaboration, and communication skills. However, in practice, the learning process in many schools is still dominated by teacher-centered lecture methods, resulting in students being less active in the learning process and under-developing critical thinking skills (Yogi Prasetyo, Yurniwati, 2025).

One learning innovation that can be used to improve students' critical thinking skills is the technology-based Flipped Classroom model integrated with the TPACK approach (Treasure, 2023). This learning model reverses the traditional learning pattern, where students first learn material outside of class through technological media such as learning videos, digital platforms, or learning management systems, while class time is used for discussion, analysis, and collaborative problem-solving (Hanifah Dwi Sulistiowati, Aruni Faza, 2025). The integration of TPACK in this model allows teachers to design learning that not only utilizes technology but also integrates it pedagogically and in accordance with the characteristics of the learning material (Sufriana Winda Pasaribu, 2024).

The use of a technology-based Flipped Classroom model integrated with TPACK provides students with opportunities for independent learning and preparation before attending class (Irna Septiani Maolidah, Toto Ruhimat, 2017). This allows classroom learning activities to focus on activities that encourage higher-order thinking skills such as analysis, evaluation, and synthesis. Research shows that appropriate technology integration in learning can increase student engagement and strengthen critical thinking skills through discussion and problem-solving activities.¹

Several previous studies have shown that the flipped classroom model has a positive impact on students' critical thinking skills. Research conducted by Ruslan Hasyim, et.al showed that implementing a flipped classroom significantly improved students' critical thinking skills, with scores increasing from the low to the high category (Hasyim, Akib, & Astini, 2024). Another study conducted by Susianti, et.al, also showed that the flipped classroom model had a positive effect on students' critical thinking skills through a quasi-experimental design. The results showed a significant difference between the experimental and control classes (Solihah & Padli, 2025a).

Furthermore, research by Syamsul Ghufron, confirms that integrating flipped classrooms with the TPACK approach can significantly improve students' critical thinking skills and creativity. This demonstrates that learning success depends not only on the use of technology, but also on teachers' ability to appropriately integrate technology with pedagogical strategies and learning materials (Syamsul Ghufron, Nafiah, Mustofa, Kaswadi, 2025).

In addition, the results of a literature review by Rizki Hanantri Ramadhan, show that the flipped classroom model supported by digital technology is an effective learning strategy in improving students' critical thinking skills because it encourages active student involvement in learning (Syamsul Ghufron, Nafiah, Mustofa, Kaswadi, 2025).

Although various studies have demonstrated the effectiveness of the flipped classroom model, the implementation of learning models integrated with the TPACK approach in madrasas remains relatively limited (Indah Sari Dewi, Nurul Husna, 2024). Many madrasas still use conventional learning

methods, thus limiting students' opportunities to optimally develop critical thinking skills. Therefore, research is needed that specifically examines the effectiveness of the technology-based flipped classroom model integrated with TPACK in improving students' critical thinking skills in madrasah (Agung, 2021).

Madrasah Aliyah Aliyah Al Majidiyah, as a religious-based secondary education institution, also faces challenges in improving the quality of learning to keep pace with developments in educational technology. Integrating technology into TPACK-based learning is a strategic step to improve the quality of the learning process and develop students' critical thinking skills (Faliyandra, Suarmika, Hidayat, Lestari, & Guna, 2021). Therefore, the implementation of a technology-based Flipped Classroom model integrated with TPACK is expected to be an innovative solution to improve students' critical thinking skills at Madrasah Aliyah Al Majidiyah.

Based on the description above, this study aims to evaluate the effectiveness of the technology-based Flipped Classroom model integrated with TPACK on improving students' critical thinking skills at Madrasah Aliyah Al Majidiyah. The research findings are expected to provide a more comprehensive understanding of the contribution of this innovative learning strategy in the context of religious education and serve as a reference for educational practitioners in designing more effective learning that focuses on developing students' critical thinking skills.

2. METHODS

This study uses a quantitative approach with a quasi-experimental design method. The design used is a Non-Equivalent Control Group Design, which involves two groups: an experimental group given the technology-based Flipped Classroom model treatment and a control group using a conventional learning model (Rukminingsih, Adnan, & Latief, 2020). The research design can be described as follows:

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Experiment	O ₁	X	O ₂
Control	O ₃	–	O ₄

Caption:

O1 = Pre-test (experimental group)

O2 = Post-test (experimental group)

O3 = Pre-test (control group)

O4 = Post-test (control group)

X = Treatment using the technology-based Flipped Classroom integrated with TPACK

This research was conducted at Madrasah Aliyah Al Majidiyah. The selection of the research location was based on the consideration that the madrasah has learning facilities that support the use of technology in the learning process and the need to improve students' critical thinking skills through technology-based learning innovations. The research subjects consisted of two classes selected using a purposive sampling technique (Sugiyono, 2013). The research sample consisted of 60 students, consisting of 30 students in the experimental class and 30 students in the control class. Sample selection was based on similar academic characteristics so that both groups had relatively similar levels of ability before the treatment was given (Sandu Siyoto, 2015). The variables in this study consist of independent variables and dependent variables. The independent variable is the technology-based Flipped Classroom model integrated with TPACK, while the dependent variable is students' critical thinking skills. These critical thinking skills include analysis, interpretation, evaluation, inference, and conclusion drawing (Untung, 2019).

Data collection techniques in this study were conducted through tests, observations, and documentation. Tests were used to measure students' critical thinking skills through pretests and posttests. Test questions were structured based on critical thinking skill indicators to measure students' ability to analyze, evaluate, and solve problems logically. Observations were conducted to determine

student activity and engagement during the learning process using the technology-based Flipped Classroom model integrated with TPACK. Meanwhile, documentation was used to obtain supporting data such as student lists, learning tools, and documentation of research activities (W.Gulo, 2002).

The research instruments used consisted of a critical thinking skills test and an observation sheet. Before being used in the study, the instruments were first tested for validity and reliability. The validity test was conducted using the Pearson Product Moment correlation to determine the feasibility of each question item. The question item was declared valid if the calculated r value was greater than the table r value. Furthermore, the reliability test was conducted using Cronbach's Alpha. The instrument was declared reliable if the Cronbach's Alpha value was greater than 0.70 (Sandu Siyoto, 2015).

The data obtained were then analyzed using statistical techniques. The Shapiro–Wilk test was used to determine whether the research data were normally distributed. A homogeneity test was then conducted to determine whether the variances of the two research groups were homogeneous. Furthermore, a paired sample t -test was used to determine the difference in pretest and posttest scores in the experimental class, while an independent sample t -test was used to determine the difference in posttest results between the experimental and control classes. Furthermore, this study also used the N-Gain test to determine the level of improvement in students' critical thinking skills after the implementation of the learning model (Sarwono, 2006).

The research was conducted in several stages. The first stage was preparation, which included the development of research instruments, instrument validation, and the preparation of technology-based learning media such as learning videos and digital platforms (Asep, 2018). The second stage was implementation, which included administering a pretest, implementing the TPACK-integrated technology-based Flipped Classroom model in the experimental class, and administering a posttest after the treatment was completed. The final stage was data analysis and the preparation of the research report (Johnson & Christensen, 2018).

The hypothesis in this study is that there is a significant influence of the implementation of the technology-based Flipped Classroom model integrated with TPACK on improving students' critical thinking skills at Madrasah Aliyah Al Majidiyah. Thus, this study is expected to contribute to the development of more innovative and effective technology-based learning in improving students' critical thinking skills

3. FINDINGS AND DISCUSSION

Implementation of the technology-based Flipped Classroom model Integrated with TPACK in Improving Students' Critical Thinking Skills in the learning process at Madrasah Aliyah Al Majidiyah

This study aims to describe and analyze the implementation of the technology-based Flipped Classroom model in the learning process at Madrasah Aliyah Al Majidiyah and its impact on students' critical thinking skills. The model was implemented over eight meetings in the experimental class.

1. Planning Stage

Teachers prepare learning materials in the form of Lesson Implementation Plans (RPPs), digital teaching materials, instructional videos uploaded through online learning platforms (such as Google Classroom and YouTube), and problem-based worksheets (Sawaluddin, Koisyahbudin, Imran Rido, 2022). The materials are provided to students before face-to-face sessions so they have the opportunity to learn the content independently (Nur'aini, 2021).

2. Implementation Stage

The implementation of learning takes place in two main phases, namely:

a. Pre-Class Phase (Pre-Class Activity)

Students access learning videos and digital teaching materials independently at home. Teachers provide prompting questions to ensure student engagement in understanding the initial material (Nurfaiza, 2024).

b. Class Phase (In-Class Activity)

Classroom time is used for group discussions, problem-solving, presentations of analytical results, and reflection (Sawaluddin, Imran Rido, Koiy Sahbudin Harahap, 2024). The teacher acts as a facilitator, guiding and deepening students' understanding (Hamid & Rahmad, 2025).

Based on observations of learning implementation, the model's implementation level reached the "very good" category, with an implementation percentage of 88–92%. Students demonstrated increased active participation, particularly in discussions and arguments.

3. Results of Improving Critical Thinking Skills

The pretest and posttest results showed significant improvement in the experimental class compared to the control class. The average N-Gain score in the experimental class was in the medium to high category, while the control class was in the low to medium category. The indicator that showed the most significant improvement was the analysis and evaluation aspect. This was evident in students' ability to identify arguments, link concepts, and provide logical reasoning for a problem (Wardani, Feronika, & Ardianti, 2024).

The results of the study indicate that the implementation of the technology-based Flipped Classroom model at Madrasah Aliyah Al Majidiyah was systematic and effective in improving students' critical thinking skills. This finding aligns with constructivism theory, which emphasizes that meaningful learning occurs when students actively construct their knowledge through social interaction and reflection. The Flipped Classroom model allows for a shift in the teacher's role from being an information center to a learning facilitator. In this context, students have broader opportunities for exploration, discussion, and in-depth analysis during face-to-face learning (Harahap & Sawaluddin, 2025). This condition aligns with the opinion that technology-based learning in the Flipped Classroom can increase students' cognitive engagement and higher-order thinking activities (Luciana, Rahayu, & Normansyah, 2024).

Previous research also supports these findings. Experimental studies have shown that implementing a flipped classroom significantly improves critical thinking skills compared to conventional learning (Unga Utami, Anik Ghufro, 2025). Furthermore, a recent meta-analysis concluded that the flipped classroom model is effective in improving learning outcomes and critical thinking skills, especially when combined with problem-based discussion strategies (Fatmiyati & Juandi, 2023).

In the context of madrasah learning, the implementation of this model provides space for the integration of reflective and analytical values, which align with the development of critical thinking skills in Islamic education. Other research also shows that technology-based learning at the secondary level can increase student motivation and learning independence, which ultimately contributes to improved critical thinking skills (Hasyim et al., 2024). However, several implementation challenges exist, such as limited internet access for some students and differences in their level of readiness for independent learning. This aligns with research findings that state that the effectiveness of Flipped Classroom is strongly influenced by technological readiness and student learning discipline (Solihah & Padli, 2025a).

Overall, the results of this study strengthen the argument that the technology-based Flipped Classroom model is an innovative learning strategy relevant for improving critical thinking skills at Madrasah Aliyah Al Majidiyah students. This model not only improves learning outcomes quantitatively but also changes the learning dynamics to be more interactive, collaborative, and oriented toward developing higher-order thinking skills.

The level of critical thinking skills of students at Madrasah Aliyah Al Majidiyah before and after the implementation of the technology-based Flipped Classroom model Integrated with TPACK.

1. Students' Critical Thinking Skills Level Before Implementing the Technology-Based Flipped Classroom Model Integrated with TPACK

Before implementing the technology-based flipped classroom learning model, researchers first conducted a pretest to determine the level of critical thinking skills of students at Madrasah Aliyah Al Majidiyah. This test was administered to students in both the experimental and control classes using an instrument that measures several indicators of critical thinking: analysis, interpretation, evaluation, inference, and conclusion-drawing. For more details, see the table below.

Table 1. Percentage of Students' Critical Thinking Skills Level (Pretest)

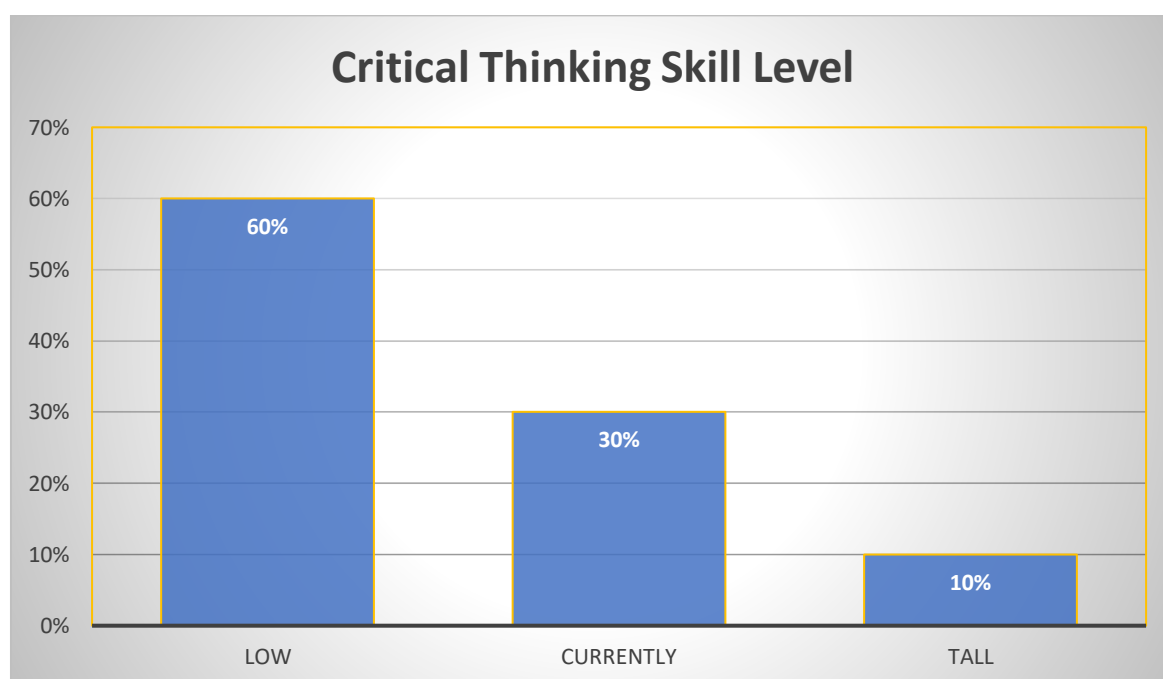
No	Critical Thinking Skills Category	Value Range	Number of Students	Percentage
1	Tall	80 – 100	3	10%
2	Currently	60 – 79	9	30%
3	Low	< 60	18	60%
	Amount		30	100%

Table 2. Percentage of Pretest Results Based on Critical Thinking Indicators

No	Critical Thinking Indicators	Average Score	Percentage	Category
1	Analysis	55.2	55%	Low
2	Interpretation	57.4	57%	Low
3	Evaluation	54.8	55%	Low
4	Inference	56.1	56%	Low
5	Conclusion Drawing	58.3	58%	Low
	Average	56.36	56%	Low

Critical thinking skill level

Figure 1. Percentage Diagram of Critical Thinking Level (Pretest)



The findings of this study indicate that before the implementation of the technology-based *Flipped Classroom* model, students' critical thinking skills were still relatively low. Based on the percentage data, 60% of students were categorized in the low category, 30% in the medium category, and only 10% in the high category. These findings suggest that the previous learning process had not optimally facilitated the development of higher-order thinking skills because learning activities were still dominated by teacher-centered instruction. As a result, students tended to receive information passively and had limited opportunities to analyze problems, evaluate information, and construct arguments critically (Li, 2024).

This condition can be analyzed through the constructivist learning theory proposed by Jean Piaget, which emphasizes that knowledge is actively constructed by learners through experience and interaction rather than passively transferred from teachers (Piaget, 2003). In conventional learning environments, students generally rely on teachers as the primary source of knowledge, limiting their opportunities to engage in exploration and independent inquiry. Consequently, students' cognitive development, particularly their critical thinking abilities, tends to remain at lower cognitive levels (Solihah & Padli, 2025a).

The low level of students' critical thinking skills before the implementation of the flipped classroom model is also consistent with the theory of higher-order thinking in Bloom's Taxonomy. In conventional classroom practices, learning activities often focus only on remembering and understanding information, while critical thinking requires students to reach higher cognitive levels such as analysis, evaluation, and creation. Since students were rarely involved in analytical discussion and problem-solving activities, their critical thinking skills were not sufficiently developed (Bloom, 2021).

After the implementation of the technology-based *Flipped Classroom* model integrated with learning technology, students' critical thinking skills improved significantly. This improvement occurred because students were given opportunities to study instructional materials independently through videos and digital platforms before attending class. Classroom time was then utilized for collaborative discussion, case analysis, and problem-solving activities. This finding supports the social constructivist theory developed by Lev Vygotsky, particularly the concept of social interaction in cognitive development (L.S.Vygotsky, 1978). According to Vygotsky, learning becomes more meaningful when students actively interact, exchange ideas, and collaboratively solve problems with peers and teachers. Through flipped classroom activities, students became more engaged in reflective thinking, argumentation, and analytical reasoning, which contributed to the improvement of their critical thinking skills (L.S.Vygotsky, 1978).

The results of this study are also supported by the TPACK framework developed by Punya Mishra and Matthew J. Koehler, which emphasizes the importance of integrating technology, pedagogy, and content knowledge in the learning process.⁴ In this study, technology was not merely used as a supporting medium but was integrated pedagogically to create meaningful learning experiences (C. M. J. Koehler & Mishra, 2015). The use of instructional videos and digital platforms enabled students to access learning materials flexibly and repeatedly, while classroom activities focused on collaborative inquiry and problem-solving. This integration strengthened students' understanding of concepts and facilitated deeper critical analysis.

Furthermore, the findings of this study align with multimedia learning theory proposed by Richard E. Mayer, which states that learning through the integration of visual and auditory information can improve students' comprehension and cognitive processing. The use of learning videos in the flipped classroom model helped students understand concepts more effectively before classroom discussions, enabling them to participate more actively and critically during learning activities (Mayer & Fiorella, 2022).

The results of this study are in line with previous studies conducted by Li, Solihah, and Padli, which found that technology-based flipped classrooms significantly improve students' critical thinking skills because learning becomes more interactive, collaborative, and student-centered

(Solihah & Padli, 2025b). Therefore, this study strengthens previous research findings that the implementation of the technology-based *Flipped Classroom* model can serve as an innovative learning solution for improving students' critical thinking skills in 21st-century education

2. Students' Critical Thinking Skills Level After Implementing the Technology-Based Flipped Classroom Model

Table 3. Percentage of Students' Critical Thinking Skills Level (Posttest)

No	Critical Thinking Skills Category	Value Range	Number of Students	Percentage
1	Tall	80 – 100	20	66.7%
2	Currently	60 – 79	8	26.7%
3	Low	< 60	2	6.6%
Amount			30	100%

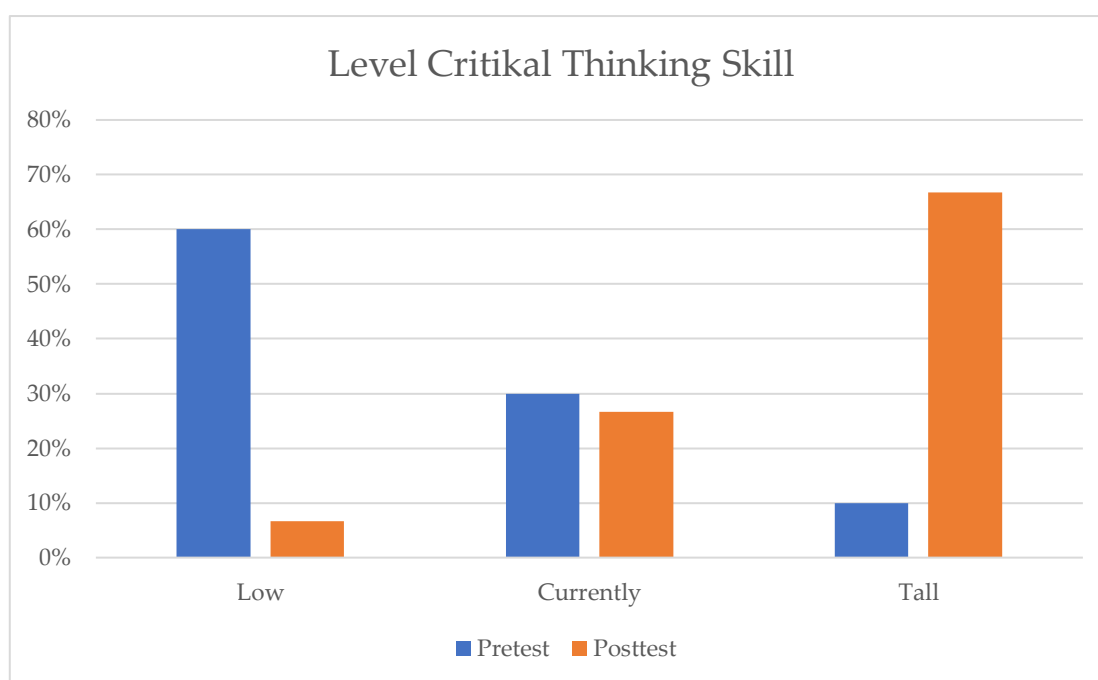
Table 4. Percentage of Posttest Results Based on Critical Thinking Indicators

No	Critical Thinking Indicators	Average Score	Percentage	Category
1	Analysis	84.2	84%	Tall
2	Interpretation	82.6	83%	Tall
3	Evaluation	83.4	83%	Tall
4	Inference	85.1	85%	Tall
5	Conclusion Drawing	86.3	86%	Tall
Average		84.32	84%	Tall

Table 5. Comparison of Pretest and Posttest Percentages

Category	Pretest	Posttest	Improvement
Tall	10%	66.7%	+56.7%
Currently	30%	26.7%	-3.3%
Low	60%	6.6%	-53.4%

Figure 2. Percentage Diagram of Critical Thinking Improvement



The findings of this study demonstrate that the implementation of the technology-based *Flipped Classroom* model integrated with the TPACK approach significantly improved students' critical thinking skills at Al Majidiyah Islamic Senior High School. The increase in the percentage of students in the high critical thinking category from 10% to 66.7%, along with the decrease in the low category from 60% to 6.6%, indicates that the learning model successfully created a more active, student-centered, and meaningful learning environment. These findings can be analyzed through several relevant educational theories that explain how learning processes contribute to the development of higher-order thinking skills (Hamid & Rahmad, 2025).

First, the findings strongly support the constructivist learning theory proposed by Jean Piaget. According to constructivist theory, learners actively construct knowledge through experience, exploration, and interaction with their environment rather than passively receiving information from teachers (Piaget, 2003). In the implementation of the flipped classroom model, students studied instructional materials independently through videos and digital platforms before attending class. This independent learning process enabled students to build prior understanding and connect new information with their existing cognitive structures. During classroom sessions, students engaged in discussions, problem-solving, and collaborative inquiry, which further strengthened their cognitive development and analytical abilities. Thus, learning became an active process of knowledge construction rather than simple memorization (Nurfaiza, 2024).

Second, the results of this study are also closely related to the social constructivism theory developed by Lev Vygotsky, particularly the concept of the *Zone of Proximal Development* (ZPD) (L.S.Vygotsky, 1978). Vygotsky emphasized that cognitive development occurs through social interaction and collaboration with others. In the flipped classroom environment, classroom activities focused on collaborative discussion, peer interaction, and guided problem-solving, allowing students to exchange ideas and learn from one another. The teacher acted as a facilitator who guided students in constructing deeper understanding through scaffolding activities. This interactional learning process encouraged students to evaluate arguments, justify opinions, and solve problems critically, thereby enhancing their critical thinking skills (Wardani et al., 2024).

Furthermore, the effectiveness of the technology-based flipped classroom integrated with TPACK can be understood through the TPACK framework introduced by Punya Mishra and Matthew J. Koehler. The TPACK framework explains that effective teaching requires the integration of technological knowledge, pedagogical knowledge, and content knowledge (C. M. J. Koehler & Mishra, 2015). In this study, the teacher did not merely use technology as a supplementary tool but integrated it strategically into the pedagogical process. Instructional videos, digital learning platforms, and collaborative online activities were designed to support the learning objectives and encourage critical thinking. The successful integration of these three domains created a learning environment that was interactive, flexible, and cognitively engaging. This confirms that technology becomes effective in education when it is pedagogically meaningful and aligned with learning content (C. M. J. Koehler & Mishra, 2015).

The findings also align with Bloom's Taxonomy, particularly in the domains of higher-order thinking skills, including analysis, evaluation, and creation (Bloom, 2021). Through flipped classroom activities, students were not only required to remember and understand concepts but also to analyze problems, evaluate information critically, and formulate logical conclusions during discussions and collaborative tasks. This indicates that the learning model successfully facilitated students in reaching higher cognitive levels. The classroom environment shifted from teacher-centered instruction toward inquiry-based and problem-oriented learning, which is essential for developing critical thinking in 21st-century education (Rizki Hanantri Ramadhan, Zaenuri, 2025).

In addition, the findings can also be explained through student-centered learning theory, which emphasizes learners' active participation in the learning process. The flipped classroom model gave students greater responsibility for their own learning because they were required to prepare independently before classroom sessions. This learning autonomy encouraged self-regulated learning,

responsibility, and reflective thinking. Consequently, students became more confident in expressing ideas, analyzing problems, and participating actively in classroom discussions (M. J. Koehler & Rosenberg, 2013).

The significant improvement in posttest scores and N-Gain values further demonstrates that integrating technology with appropriate pedagogical strategies positively affects students' cognitive development. The use of learning videos and digital platforms allowed students to learn at their own pace, revisit materials when necessary, and come to class better prepared for discussion. This supports multimedia learning theory, which states that combining visual and auditory information can enhance comprehension and knowledge retention. As a result, students gained deeper conceptual understanding, which contributed to stronger analytical and critical thinking abilities (Unga Utami, Anik Ghufron, 2025).

The findings of this study are consistent with previous studies conducted by Nurfaizi and Azizi, Susianti and Solihah, as well as other scholars who found that technology-based flipped classrooms improve critical thinking skills because learning becomes more interactive, collaborative, and student-centered (Nurfaiza, 2024). Therefore, this study strengthens previous research findings and confirms that the integration of the *Flipped Classroom* model with the TPACK framework is an effective educational innovation for improving students' critical thinking skills. The combination of independent learning, collaborative classroom interaction, and meaningful technology integration creates a learning environment that supports higher-order thinking and prepares students for the demands of 21st-century education (Astarina, Sujatna, & Heryono, 2024).

The effect of implementing the technology-based Flipped Classroom model on improving the critical thinking skills of students at Madrasah Aliyah Al Majidiyah

1. Instrument Validity Test

Validity testing was conducted to determine whether the critical thinking skills test instrument used in this study was truly capable of measuring the variables studied. Validity testing was conducted using Pearson Product Moment correlation with the aid of statistical applications.

Table 6. Instrument Validity Test Results

No Question	r count	r table (0.361)	Information
1	0.612	0.361	Valid
2	0.587	0.361	Valid
3	0.641	0.361	Valid
4	0.598	0.361	Valid
5	0.623	0.361	Valid
6	0.654	0.361	Valid
7	0.602	0.361	Valid
8	0.677	0.361	Valid
9	0.591	0.361	Valid
10	0.635	0.361	Valid

Based on the table, all the questions have a calculated r value $>$ r table, so it can be concluded that all the instrument items are valid and suitable for use in research.

2. Reliability Test

Reliability testing aims to determine the consistency of the research instrument. Reliability testing is conducted using Cronbach's Alpha.

Table 7. Reliability Test Results

Variables	Cronbach Alpha	Criteria	Information
Critical Thinking Skills	0.871	$>$ 0.70	Reliable

The Cronbach Alpha value of 0.871 indicates that the research instrument has a high level of reliability.

3. Pretest and Posttest Results

Table 8. Average Pretest and Posttest Scores

Class	Number of Students	Pretest	Posttest	Improvement
Experiment	30	58.6	85.3	26.7
Control	30	57.9	71.4	13.5

These results show that the improvement in the experimental class was higher than in the control class.

4. Normality Test

Normality tests were performed using Shapiro–Wilk.

Table 9. Normality Test Results

Data	Sig	Information
Experiment Pretest	0.148	Normal
Experiment Posttest	0.152	Normal
Pretest Control	0.137	Normal
Posttest Control	0.129	Normal

Because the significance value is > 0.05 , the data is declared to be normally distributed.

5. Homogeneity Test

Table 10. Results of Homogeneity Test

Data	Sig	Information
Pretest	0.267	Homogeneous
Posttest	0.241	Homogeneous

A significance value greater than 0.05 indicates that the variance of the two groupshomogeneous.

6. Paired Sample t-Test

This test is used to determine the difference between pretest and posttest scores in the experimental class.

Table 11. Paired Sample t-Test Results

Data	Mean Difference	Sig (2-tailed)	Conclusion
Pretest – Posttest Experiment	-26.7	0,000	Significant

Because the Sig value is < 0.05 , there is a significant difference between the pretest and posttest scores in the experimental class.

7. Independent Sample t-Test

This test was conducted to determine the differences in learning outcomes between the experimental class and the control class.

Table 12. Results of Independent Sample t-Test

Data	Sig (2-tailed)	Conclusion
Experimental vs Control Posttest	0,000	Significant

Because the Sig value is < 0.05 , it can be concluded that there is a significant influence of the application of the technology-based flipped classroom model on students' critical thinking skills.

The results of the study indicate that the implementation of the technology-based flipped classroom model significantly improved the critical thinking skills of students at Madrasah Aliyah Al Majidiyah. This can be seen from the significantly higher average posttest scores in the experimental class compared to the control class. The flipped classroom model provides students with the opportunity to study the material in advance through learning videos and digital platforms before classroom activities (Khasanah, 2023). Thus, classroom time can be utilized for discussions, case analysis, and collaborative problem-solving, which encourage the development of students' critical thinking skills. These results align with research showing that technology-based flipped classrooms can

improve students' critical thinking skills because learning becomes more active and student-centered (Hasyim et al., 2024).

Other studies have also found that the implementation of flipped classrooms significantly improves critical thinking skills through discussion-based learning activities and problem-solving. In addition, research conducted by Nurfaiza and Azizi shows that the integration of flipped classrooms with the TPACK technology approach can significantly improve students' critical thinking skills and creativity with a significance value of $0.000 < 0.05$. (Nurfaiza, 2024)

The results of other studies also state that the use of learning videos in flipped classrooms can improve students' conceptual understanding and critical thinking skills because students have more time to explore the material before participating in class learning (Faliyandra et al., 2021). Thus, the results of this study strengthen the findings of previous studies that the technology-based flipped classroom model is an effective learning innovation for improving students' critical thinking skills.

4. CONCLUSION

Based on the results of the study entitled "The Effectiveness of the Technology-Based Flipped Classroom Model Integrated with TPACK in Improving Students' Critical Thinking Skills at Al Majidiyah Islamic Senior High School," it can be concluded that the implementation of the technology-based Flipped Classroom model integrated with TPACK was effective in improving students' critical thinking skills. The learning process utilized instructional videos, digital learning platforms, and collaborative discussion activities that encouraged students to study independently before class and actively participate during classroom learning. Before the implementation of the model, students' critical thinking skills were relatively low, as indicated by difficulties in analyzing problems, presenting logical arguments, and drawing conclusions. After the implementation of the technology-based Flipped Classroom integrated with TPACK, students' critical thinking skills improved significantly, as reflected in the increase in posttest scores and N-Gain values. Statistical analysis through the paired sample t-test and independent sample t-test also showed a significance value of less than 0.05, indicating a significant effect of the learning model on students' critical thinking skills. This study strengthens the conceptual contribution of the TPACK framework by showing that effective technology-based learning depends on the integration of technology, pedagogy, and content knowledge. In addition, this research contributes to the development of innovative student-centered learning models that support higher-order thinking skills through active, collaborative, and technology-supported learning environments. Practically, the findings imply that the integration of TPACK into the Flipped Classroom model can be used as an effective learning innovation to improve the quality of learning and students' critical thinking skills in 21st-century education.

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