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INTEGRATING AI IN FLIPPED CLASSROOM MODEL FOR ENHANCING COLLEGE STUDENTS' CRITICAL THINKING SKILLS IN READING COMPREHENSION

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Abstract: Integrating A.I. into the flipped classroom model for critical thinking in reading comprehension provides a powerful combination that can significantly enhance student learning outcomes. A.I. tools can improve critical thinking and reading comprehension by providing instant feedback, encouraging active learning, and adjusting the learning experience to the specific needs of each student. Using the critical thinking framework, we used a quasi-experimental method to enhance students' critical thinking skills in reading comprehension. We analyzed the pretest and post-test results using paired t-tests. The reading comprehension class had 47 fourth-semester students. The study found that incorporating A.I. into the flipped classroom model improved students' critical thinking skills for reading, including accuracy, clarity, precision, depth, relevance, and logic, with a mean score of 76.542 compared to 35.841 in the pretest. Students perceived the adoption of this paradigm as effective for self-directed learning. This study suggests that a supportive teaching environment that allows students to self-study before class can effectively combine the use of artificial intelligence in flipped classrooms with critical thinking skills in reading comprehension. Additionally, students had favorable opinions of the A.I. integration, emphasizing its capacity to give individualized learning experiences and immediate feedback. The findings imply that incorporating A.I. into the flipped classroom can effectively boost students' critical thinking skills in reading. The study adds to the expanding corpus of studies on the potential of AI in education, emphasizing its ability to improve student learning outcomes.

Keywords; *AI, flipped classroom, critical thingking skill, reading comprehension*

Introduction

The field of information and communication technology is expanding at an accelerating rate. One outcome of the advancements in information and communication technology is the internet, which people can easily access through various media platforms at any time and from any location. The internet allows information to travel quickly. These advancements significantly affect human life in several areas, including education.

Reading comprehension is an essential skill in education; it is vital for students to comprehensively grasp and actively interact with diverse texts in different fields of study. Nevertheless, a significant number of students encounter difficulties in understanding written texts, primarily as a result of insufficient teaching methods and limited chances for engaging in interactive learning experiences. One innovative teaching method that has shown promise in addressing these issues is the flipped classroom model. This model involves inverting standard

teaching methods by assigning homework that introduces new concepts and using class time for active learning, such as discussions and problem-solving. It has been demonstrated that this approach improves student engagement and learning outcomes (Li, Bing, Peng, Miaomiao, 2021, Gonzalez and Terrell , 2023).

There is enormous potential to improve reading comprehension skills through the flipped classroom model's incorporation of artificial intelligence (AI). Artificial intelligence (AI) can tailor individualized learning experiences to specific students' needs through real-time feedback and coaching. Participating in interactive and immersive learning activities might help students improve critical thinking skills and a better understanding of complex literature (Mollick, 2024). Moreover, Gonzales and Terrel (2023) stated that AI-powered tools can make analyzing reading comprehension performance data easier and highlight students' strong and weak points. With this data, educators can modify their teaching intructions to meet the needs of each student better and close any knowledge gaps.

In recent years, the flipped classroom model has garnered significant attention as a method of improving student engagement, learning, and critical thinking skills by reversing the traditional classroom structure. This model involves students accessing lecture materials outside of class and participating in interactive activities during class time (Nouri, 2016; Chen et al., 2014; Sarkar et al., 2019). The potential to further enhance these benefits, particularly in reading comprehension, is present through integrating artificial intelligence (AI) into the flipped classroom paradigm (Nouri, 2016). This aligns with Al-Samarraie et al. (2019), who state that interest in applying artificial intelligence (AI) in education is rising, especially in light of the flipped classroom paradigm. The flipped classroom model, in which students use their own time to obtain course materials and participate in active learning during class, has been shown to encourage critical thinking and student engagement. By merging the advantages of the flipped classroom with artificial intelligence's capabilities, teachers may be able to design a more customized and flexible learning environment that develops students' reading comprehension and critical thinking abilities.

Recent research has demonstrated the potential for AI-driven technology to revolutionize the educational landscape. (Chichekian and Benteux, 2022) AI-powered solutions can customize individualized feedback, adaptive learning paths, and intelligent tutoring systems to meet the specific needs of each student. Beyond the global context, research in the Arab world has focused on the use of AI in education, with studies investigating the impact of artificial intelligence methods for constructing teacher preparation programs and improving teachers' professional development (Alzahrani, 2022; Douali et al., 2022; AalSaud, 2021; Aldosari, 2020). These findings imply that incorporating artificial intelligence into the flipped classroom approach could significantly impact students' learning outcomes. Thus, to support struggling readers in college environments. Providing these learners with the individualized attention they need in large class sizes might be challenging. However, chatbots—a recent development in artificial intelligence (AI)—offer intriguing new approaches to addressing these demands. Integrating chatbots with AI capabilities into educational settings can help struggling readers understand what they read (Seung, 2024). Seung (2024) also stated that Chatbots powered by artificial intelligence are complex software applications that mimic user conversations using machine learning and natural language processing. These conversational agents can comprehend and react to user input, offering pupils an engaging educational resource. Chatbots can help with various tasks in educational environments, including interactive reading exercises, question-answering, and tutoring.

Therefore, the study will primarily investigate the potential of AI integration in the Flipped classroom model. The aim is to enhance students' critical thinking in the reading classroom, a key area of academic development.

Method

This study uses quasi-experimental procedures with- a group pre-test and post-test design. The rationale behind the choice of technique is that the study aims to evaluate the effects of using AI as a reading comprehension learning tool in the flipped classroom learning model to improve students' critical thinking abilities. We conducted six weeks of meetings to evaluate the students' critical thinking for critical reading. The study included 47 participants enrolled in the English education study program at a private institution in Bandung Regency, Indonesia. The students were registered for the fourth semester, which included six sessions, each lasting 100 minutes.

This experiment employed two instruments.

The critical thinking for critical reading rubric served as the study's first research tool. The research tool relied on Paul and Elder's (2009) critical thinking for the critical reading rubric, which includes six reading evaluation prompt elements: logic, accuracy, precision, depth, clarity, and relevance. The reading evaluation rubric contains a maximum of four points and a minimum of one. According to the rubric, accuracy identifies the main idea and concepts when reading. The clarity component assesses the ability to understand information, such as facts, figures, or examples used to support concepts in reading. The accuracy component clarifies the capacity to distinguish vocabulary specific to the subject matter.Furthermore, the depth component improves the ability to express the complexities of comprehension. The relevance component emphasizes the ability to identify and reach a conclusion. Finally, the logic component emphasizes applying concepts and knowledge to larger contexts. The reading comprehension test was based on a handout that included preliminary questions, scanning, skimming, understanding, vocabulary building, and inference. We conducted the assessment using descriptive statistics in SPSS version 26. Students can assess their critical thinking skills during reading with the help of the reading assessment prompts. This study compared students' critical thinking skills for reading comprehension before and after implementing AI in the flipped classroom model.

The researchers created a questionnaire to evaluate students' perceptions of AI usage in flipped classes. The questionnaire was based on relevant computer technology use studies (Osodo et al., 2010; Heller et al., 2005; Kerly et al., 2006; Newhouse, 2002), and some were adapted from Karimi and Sanavi's (2014) study on the effect of flipped classroom instruction on EFL learners' reading comprehension. The questionnaire comprised 20 items, each numbered from 1 to 20. We developed measures to assess students' attitudes towards using AI in their flipped classrooms to improve critical thinking and reading comprehension.

For data analysis, students were graded on the reading exercises in the reading comprehension handout. The study's objectives examined the test data, beginning with the normality test. We produced descriptive statistics for the pre-test and post-test mean scores. Finally, a paired sample test was done to assess the impact of AI in a flipped classroom paradigm on students' critical thinking and reading comprehension. This was done to address the first study topic. The questionnaire data was also evaluated and computed using statistical techniques to address the second study question. The questionnaires' mean scores varied from neutral (3) to agree (4) on a Likert scale of highly agree (5), agree (4), neutral (3), disagree (2), and strongly disagree (1).

Table 1. T-test of Faired Sample Statistics

		MEAN	N	Std. Deviation	Std. Eror Mean
Pair 1	Pre-test	35.841	47	4.94245	.76143
	Post-test	76.542	47	4.82413	.75243

Table 2. Paired samples test (pre and post-tests in one group)

		95% Confidence Interval of the Difference							
		MEAN	Std. Deviation	Std. Eror Mean	Lower	upper	t	df	sig. (2 tailed)
Pair 1	Pre-test		6.081	1.845	-17.509	-8.519	-6.910	10	.000
	Post-test	14.364							

Mean Score of Pre-Test on Students' Critical Thinking

The researcher used a reading comprehension test to assess students' critical thinking skills. The pre-test asked the students 20 questions before receiving treatment. Table 3 presents descriptive statistics on students' critical thinking when reading without AI integration.

Table 3. Descriptive Statistics Of Students' Critical Thinking In Reading Comprehension Without Ai Integration In Flipped Classroom

	N	Minimum	Maximum	Mean	Std. Deviation
Accuracy	47	42	65	30.42	4.483
Clarity	47	40	65	26.34	4.025
Precision	47	40	70	30.14	4.278
Depth	47	30	60	24.23	3.172
Relevance	47	30	60	24.56	3.124
Logic	47	30	60	26.58	3.453
Valid N	47				
(Listwise)					

Mean Score of Pre-Test on Students' Critical Thinking

Following traditional teaching methods, the researcher implemented the flipped classroom model, which integrates artificial intelligence into reading comprehension lessons for four weeks. After using the flipped classroom teaching paradigm, Table 4 shows how students' critical thinking for critical reading has improved:

Table 4. Descriptive Statistics Of Students' Critical Thinking In Reading Comprehension With Ai Integration In Flipped Classroom

Deviation	N	Minimum	Maximum	Mean	Std. Deviation
Accuracy	47	70	85	75.542	7.2726
Clarity	47	70	80	74.366	7.3654
Precision	47	60	80	70.257	7.2443
Depth	47	70	80	70.295	7.2112
Relevance	47	65	80	68.842	7.2143
Logic	47	60	75	65.365	8.2573
Valid N	47	65	75	65.806	8.8776
(Listwise)					

Students' Perception of the Use of AI in Flipped Classroom Teaching Model

The second research question aimed to determine the students' perception of the AI integration in the flipped classroom teaching model about their literacy abilities. Table 5 displays the attributes of students' perceptions of the flipped classroom instruction model

Table 5. The Mean Scores Of Students' Perceptions Of Using Ai In The Flipped Classroom Teaching Model.

Items of Questionnaire	Mean Score
The chatbot clarifies concepts that I find difficult	4.00
The chatbot is simple to use	4.00
I can access the chatbot whenever I need support	4.18
The chatbot offers useful feedback on my work	3.88
The chatbot encourages me to think critically about the topic	3.25

Using the chatbot enhances my understanding of the course material	4.11
After chatting with the chatbot, I'm more eager to participate in class	3.97
The chatbot allows me to do a more in-depth analysis of the material	3.86
Interacting with the chatbot inspires me to challenge my assumptions	3.84
The chatbot has improved my critical thinking skills	4.00
I believe that chatbots are an excellent addition to the flipped classroom	4.14
The chatbot effectively meets my learning needs	3.64
My performance on reading exams has improved as I have more time to implement what I've learned in class	3.29
I feel completely in control of my learning in flipped classroom	3.82
The flipped classroom teaching technique boosts confidence in learning	4.21

Discussion

Table 1 illustrates the pre-test and post-test results for the AI integration in the flipped classroom teaching model intervention. The objective was to compare the mean score difference between students' critical thinking for reading comprehension before and after using AI in a flipped classroom teaching approach. Students showed considerable progress in critical thinking skills and reading comprehension, with a mean score of 76.542 compared to 35.841 on the pre-test. Previous research has shown that chatbots can help build critical thinking skills in various learning environments. Chatbots efficiently enable cooperation, modelling, and problem-solving, all promoting essential thinking (Chang, Hwang et al., 2022; Chang, Kuo et al., 2022; Subramaniam, 2019). The basic thinking variables align with Paul and Elder's (2009) criteria for critical reading.

Table 2 illustrates the significance of a paired sample t-test when comparing pre-test and post-test results in one group. The Sig value (.000) was less than 0.05, leading to rejecting the null hypothesis. The study found that incorporating AI into a flipped classroom teaching approach improved students' post-test performance. The study accepted the alternative hypothesis, indicating a significant difference in students' critical thinking scores between the pre-test and post-test.

As indicated in Table 3, many students (47 in total) needed better accuracy in identifying the principal goal of reading, with a mean score of 30.42. They demonstrated significant inaccuracy, expressing erroneous beliefs about the reading material. Some needed to be more accurate regarding the stated goals and notions. Students sparingly used the reading text's facts, figures, and examples for clarity. With a mean score of 30.14, students demonstrated poor precision, a lack of usage of content-specific terminology, and apparent errors. Most pupils also needed a greater comprehension of the depths of creating connections between purpose and concepts in the reading (24.23). Students demonstrated low relevance to the reading material's basic conclusion, with a mean score of 24.56. The final feature of critical thinking for critical reading is logic, with most students showing poor application of contexts and contents to other broad contexts (25.58). The findings suggested that students needed better critical thinking in critical reading before AI integration in the flipped classroom. Additionally, students needed more time to study the subject matter and apply their prior knowledge. Critical thinking for reading comprehension necessitates additional work and consistent practice.

Meanwhile, according to Table 4, the mean score indicated that students' critical thinking and reading comprehension improved when the lecturer integrated AI into the flipped classroom teaching paradigm. Before the deployment of AI in flipped classrooms, students' minimum degree of critical thinking in reading comprehension improved. The difference in minimum and maximum scores occurred before and after the post-exam, indicating that students' critical thinking and reading comprehension improved during the test. In terms of accuracy, most students could correctly identify the goal and topic of the reading text (74.36). In the traditional method of teaching reading, students demonstrated a poor level of accuracy in determining the primary goal of the reading. In clarity, students improved their ability to correctly apply facts, figures, or

examples from the reading text (70.25). They needed a significant level of accuracy with wrong concepts, particularly when getting the core ideas before AI was applied in the flipped classroom. Some pupils demonstrated that they could use some precision to add content-specific language. They can also accurately paraphrase (70.29). In the traditional method of teaching reading, they found it challenging to rephrase the phrases with evident errors.

Furthermore, after using the flipped classroom teaching style, students could understand the relationships between the purpose, concepts, and supporting elements in the reading (68.84). In contrast, earlier, they needed a greater understanding of the depths of creating connections on those features in the text. Students could relate to basic conclusions, although it was confined to the broad framework of concepts (65.36). The final attribute of critical thinking for critical reading demonstrated students' growth in applying concepts and content to broad contexts. Students understood the rationale behind some concept applications but continued using generic notions (65.80). Students' critical thinking and reading comprehension improved significantly after transitioning from a traditional classroom to a flipped classroom with an AI teaching approach. They watched and analyzed the materials and completed the assignments at home before incorporating AI into the flipped classroom teaching format. According to Salloum et al. (2019), AI, particularly chatbots, can provide scaffolding support to students during their independent online learning times, resulting in a more sustainable learning experience in which students are actively engaged and supported in their learning goals, the lecturer facilitates the learning process, and technology becomes an integral enabler of the learning environment. Neo et al. (2022) The findings revealed that fourth-semester students can increase their critical thinking skills in reading comprehension after a series of integrated AI implementations in the flipped classroom learning paradigm.

Students perception according to the table 5 above, students generally rate the integration of artificial intelligence, particularly chatbots, in a flipped classroom positively, with high scores suggesting success in various areas. It simplifies complex topics (mean score of 4.00), is straightforward to use (mean score of 4.00), and is available when assistance is required (mean score of 4.18). These characteristics indicate that the chatbot is user-friendly and easily accessible, which is critical for improving the learning experience. Additionally, the chatbot provides helpful feedback on students' work (mean score of 3.88); however, there is a need for growth in this area. It stimulates participants to question their presumptions (mean score of 3.84), although it encourages critical thinking to a lesser level (mean score of 3.25). These results indicate a moderate influence on the development of critical thinking abilities, suggesting the potential for the chatbot to enhance its ability to foster more sophisticated analytical skills. The chatbot significantly improved course material comprehension, as indicated by the mean score of 4.11. Furthermore, the chatbot has shown efficacy in increasing participants' eagerness to participate in classroom activities, as evidenced by a mean score of 3.97. This improvement in engagement and comprehension is critical for achieving optimal learning outcomes.

The chatbot, with a mean score of 3.86, effectively facilitates comprehensive subject analysis. It also fosters deeper engagement with the information, as evidenced by its mean score 4.00 in promoting critical thinking skills. While there is room for improvement, these scores underscore the chatbot's significant achievement in subject analysis and its ability to promote critical thinking skills. Students perceive chatbots as a valuable addition to the flipped classroom, with a mean score of 4.00. They also believe that the chatbot effectively supports their learning objectives, scoring an average of 4.10. These high ratings indicate that the chatbot functions well as a learning aid. Compared to other areas, the chatbot's influence on reading exam performance (mean score of 3.64) and the sense of control in a flipped classroom (mean score of 3.29) are less pronounced. This suggests that, despite the chatbot's advantages, supplementary variables may affect academic performance and the perception of control over learning. Positive perceptions of the flipped classroom teaching method increase students' confidence in their learning ability (mean score 3.82). This shows that the chatbot and teaching approach work together to produce a positive learning environment that boosts students' self-esteem.

Conclusion

English language teaching and learning in higher education should prioritize critical thinking to prepare students for 21st-century life skills beyond their subject of study. This study found that using a flipped classroom teaching paradigm increased students' critical thinking in reading

skills, notably accuracy, clarity, precision, depth, relevance, and logic.

The presented table indicates that students typically have a favourable opinion of using artificial intelligence, especially chatbots, in flipped classrooms; high scores indicate success in various areas (Owoc et al., 2021). (Gurrib & Kamalov, 2023) (Kuhail and others, 2022). (Gurrib & Kamalov, 2023) (Kuhail and others, 2022). (Peng & Li, 2022). Studies have demonstrated the effectiveness of chatbots in fostering personalized learning and elevating student engagement and involvement levels. They utilize various artificial intelligence techniques, such as natural language processing (Merelo et al., 2023). One of the most critical factors in enhancing the learning experience is the chatbot's perceived ease of use and accessibility (Okonkwo & Ade-Ibijola, 2021). Furthermore, the chatbot offers valuable feedback on students' assignments, prompts users to challenge their assumptions, and promotes critical thinking—though the latter could use some work (Neji et al., 2023). According to Neji et al. (2023), the implementation of chatbots significantly improved participants' comprehension of course material and heightened enthusiasm for classroom activities, demonstrating the positive impact of chatbots on learning outcomes. These results are critical for achieving the best possible learning outcomes. The way the chatbot efficiently supports critical thinking abilities and extensive subject analysis further highlights its notable accomplishments in these domains (Okonkwo & Ade-Ibijola, 2021). According to Neji et al. (2023), students view chatbots as a beneficial addition to flipped classrooms, feeling that they effectively enhance their learning.

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