THE IMPACT OF ACTIVE LEARNING STRATEGIES ON CRITICAL THINKING SKILLS: THE MEDIATING ROLE OF STUDENT ENGAGEMENT AND THE MODERATING EFFECT OF CLASSROOM ENVIRONMENT

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Abstract: This study explores the relationship between active learning strategies, student engagement, and critical thinking skills among undergraduate students at L University in F City. In recent years, fostering critical thinking has become a crucial goal in higher education, as it is essential for academic and professional success. Active learning, characterized by student participation and engagement, has been widely proposed as an effective approach to enhance critical thinking. However, the underlying mechanisms linking active learning to critical thinking remain unclear. The research hypothesizes that: (1) Active learning strategies positively influence critical thinking skills; (2) Student engagement mediates the relationship between active learning strategies and critical thinking skills; (3) Classroom environment moderates the effect of active learning strategies on critical thinking skills, with a stronger effect in a supportive classroom environment. A quantitative research approach was employed, utilizing survey data collected from 322 valid responses of undergraduate students at L University. The survey assessed the students' perceptions of active learning strategies, engagement levels, classroom environment, and their critical thinking skills. The results confirm all three hypotheses. Active learning strategies were found to significantly enhance critical thinking skills, with student engagement serving as a mediator in this relationship. Furthermore, the classroom environment was identified as a significant moderator, amplifying the positive effect of active learning strategies on critical thinking skills in a supportive environment. This study contributes to the understanding of how active learning can be leveraged to improve critical thinking skills and highlights the importance of student engagement and classroom environment in the learning process. The findings provide valuable implications for educators seeking to enhance the cognitive abilities of students through active learning strategies.

Keywords: Active Learning Strategies, Student Engagement, Critical Thinking Skills, Classroom Environment

Introduction

In the rapidly evolving landscape of 21st-century education, fostering critical thinking skills has emerged as a cornerstone of pedagogical objectives. Critical thinking—defined as the ability to analyze, evaluate, and synthesize information to solve complex problems—is widely recognized as a vital competency for academic, professional, and civic success (World Economic Forum, 2020; OECD, 2019). Employers and educators alike emphasize the need for graduates who can navigate ambiguity, challenge assumptions, and innovate in dynamic environments (Pellegrino & Hilton, 2012). Despite its recognized importance, global assessments such as the Programme for International Student Assessment (PISA) reveal persistent gaps in students' critical thinking abilities, particularly in contexts dominated by rote memorization and teacher-centered instruction (OECD, 2018). These findings underscore the urgency of re-evaluating traditional pedagogical approaches to better cultivate higher-order cognitive skills.

Active learning strategies, which position students as active participants in knowledge construction, have gained prominence as a transformative alternative to passive lecture-based methods. Rooted in constructivist theories (Piaget, 1970; Vygotsky, 1978), active learning encompasses techniques such as problem-based learning, peer teaching, and collaborative discussions. These strategies align with Bloom's revised taxonomy (Anderson & Krathwohl, 2001), which prioritizes analysis, evaluation, and creation as pinnacles of cognitive development. Empirical studies consistently demonstrate that active learning enhances academic performance and conceptual understanding compared to traditional methods (Freeman et al., 2014; Theobald et al., 2020). For instance, a meta-analysis of 225 studies revealed that active learning reduced failure rates in STEM courses by 55% while improving critical thinking outcomes (Theobald et al., 2020). However, the mechanisms through which active learning fosters critical thinking remain underexplored, particularly the role of mediating and moderating variables such as student engagement and classroom environment.

Student engagement—a multidimensional construct encompassing behavioral, emotional, and cognitive participation—has been identified as a potential mediator in the relationship between instructional strategies and learning outcomes (Fredricks et al., 2004; Wang & Eccles, 2019). Behavioral engagement refers to students' observable participation in academic activities, emotional engagement to their affective reactions to learning, and cognitive engagement to their investment in deep processing of material (Fredricks et al., 2004). Active learning strategies, by design, require students to interact with peers, grapple with real-world problems, and reflect on their reasoning, thereby potentially enhancing all three dimensions of engagement. Recent research by Wang et al. (2021) found that project-based learning significantly increased cognitive engagement among middle school students,

which in turn predicted gains in problem-solving skills. Similarly, a longitudinal study by Lawson and Lawson (2018) highlighted that emotionally engaged students were more likely to persist through challenging tasks, a key component of critical thinking. Despite these insights, few studies have explicitly modeled engagement as a mediator between active learning and critical thinking, leaving a gap in understanding how pedagogical practices translate into cognitive gains.

The classroom environment, characterized by factors such as teacher support, peer collaboration, and resource availability, may further moderate the effectiveness of active learning strategies. A supportive environment fosters psychological safety, encouraging risk-taking and intellectual curiosity, whereas a non-supportive environment may stifle participation and critical discourse (Fraser, 2018; Shernoff et al., 2020). For example, a study by Shernoff et al. (2020) demonstrated that students in classrooms with high teacher support reported greater engagement and willingness to engage in complex problem-solving tasks. Conversely, environments lacking structure or inclusivity can undermine the benefits of active learning, particularly for marginalized students (Cohen & Lotan, 2014). Emerging research also suggests that the physical and psychosocial aspects of classrooms—such as flexible seating arrangements and culturally responsive teaching—interact with pedagogical methods to shape learning outcomes (Barrett et al., 2019). Nevertheless, the moderating role of classroom environment in the active learning-critical thinking nexus remains understudied, particularly in diverse educational settings.

Recent advancements in educational psychology and neuroscience further illuminate the theoretical underpinnings of this relationship. Constructivist learning theory posits that knowledge is actively constructed through social interaction and reflection (Bruner, 1996; Dewey, 1933), aligning with the principles of active learning. Similarly, self-determination theory (Ryan & Deci, 2017) emphasizes that autonomy, competence, and relatedness—conditions often nurtured through collaborative and student-centered pedagogies—enhance intrinsic motivation and cognitive engagement. Neuroimaging studies corroborate these theories, showing that active learning tasks activate prefrontal brain regions associated with critical thinking and metacognition (Immordino-Yang et al., 2018). However, translating these theoretical and biological insights into practical classroom strategies requires empirical evidence on how contextual factors influence their efficacy.

Despite growing advocacy for active learning, implementation challenges persist. Educators often face resistance from students accustomed to passive learning, logistical constraints in curriculum design, and inadequate training in facilitating interactive pedagogies (Borrego et al., 2020). Additionally, disparities in access to technology and institutional support exacerbate inequities in critical thinking development (Reich, 2020). The COVID-19 pandemic further highlighted these issues, as emergency remote teaching often prioritized content delivery over interactive, higher-order skill development (Hodges et al., 2020). These challenges underscore the need for research that identifies actionable strategies to maximize the impact of active learning across diverse contexts.

This study addresses these gaps by investigating the mediating role of student engagement and the moderating effect of classroom environment in the relationship between active learning strategies and critical thinking skills. By integrating constructs from educational psychology, instructional design, and social cognition, the research aims to provide a nuanced understanding of how and under what conditions active learning fosters critical thinking. Such insights are critical for educators, policymakers, and curriculum designers seeking to implement evidence-based practices that prepare students for the complexities of the modern world.

Questions of the study:

What is the impact of active learning strategies on students' critical thinking skills?

How does student engagement mediate the relationship between active learning strategies and critical thinking skills?

Does the classroom environment moderate the relationship between active learning strategies and critical thinking skills? If so, how does a supportive or non-supportive classroom environment influence this relationship?

To what extent do control variables (age, gender, prior academic performance, and learning style) affect the relationships among active learning strategies, student engagement, classroom environment, and critical thinking skills?

Research Objectives

Objective 1. To examine the impact of active learning strategies on students' critical thinking skills, focusing on key instructional methods such as problem-based learning, peer teaching, classroom discussions, and interactive activities.

Objective 2. To investigate the mediating role of student engagement in the relationship between active learning strategies and critical thinking skills, analyzing behavioral, emotional, and cognitive engagement as key factors.

Objective 3. To analyze the moderating effect of the classroom environment on the relationship between active learning strategies and critical thinking skills, distinguishing between supportive and non-supportive learning environments.

Objective 4. To provide evidence-based recommendations for enhancing curriculum design and instructional practices, aiming to foster student engagement and critical thinking development in diverse educational settings.

Literature Review

1. Review of Topics and Variables:

1.1 Active Learning Strategies

Active learning strategies have been widely recognized as effective approaches to enhancing students' cognitive development, particularly in fostering critical thinking skills (Freeman et al., 2019). Active learning is broadly defined as instructional methods that engage students in meaningful learning activities, requiring them to actively participate rather than passively receive information (Bonwell & Eison, 1991). The most commonly used active learning strategies include problem-based learning (PBL), peer teaching, classroom discussions, and interactive activities (Prince, 2020). Problem-based learning, for instance, encourages students to work on real-world problems collaboratively, enhancing their analytical and evaluative abilities (Dolmans et al., 2019). Similarly, peer teaching has been shown to reinforce students' understanding of concepts by allowing them to explain and clarify ideas to their peers (Topping, 2018). Classroom discussions promote deeper engagement by facilitating dialogue and debate, while interactive activities such as case studies, simulations, and role-playing contribute to experiential learning (Michael, 2021).

1.2 Student Engagement as a Mediating Variable

Student engagement is a critical factor in the learning process and plays a mediating role in the relationship between active learning strategies and the development of critical thinking skills (Fredricks et al., 2019). Engagement is generally classified into three dimensions: behavioral, emotional, and cognitive engagement (Appleton et al., 2018). Behavioral engagement refers to students' participation in learning activities, such as attending classes, completing assignments, and contributing to discussions (Finn & Zimmer, 2019). Emotional engagement involves students' attitudes, interests, and positive emotional responses toward learning, which are linked to motivation and persistence (Reeve, 2020). Cognitive engagement reflects the depth of learning, critical analysis, and problem-solving strategies employed by students (Greene, 2021). Studies suggest that active learning strategies significantly enhance student engagement, which, in turn, leads to improved critical thinking skills (Wang et al., 2020). For instance, interactive learning environments have been shown to promote deeper cognitive processing, thereby strengthening students' ability to analyze and evaluate complex problems (Schneider & Preckel, 2017).

1.3 Classroom Environment as a Moderating Variable

The classroom environment significantly influences the effectiveness of active learning strategies and moderates their impact on critical thinking skills (Merritt, 2020). A supportive classroom environment, characterized by positive teacher-student relationships, peer collaboration, and open communication, has been found to enhance students' learning outcomes (Ryan & Deci, 2020). Conversely, a non-supportive learning environment, marked by rigid instructional practices and a lack of student interaction, can hinder engagement and limit the benefits of active learning (Turner et al., 2021). Teacher support plays a pivotal role in shaping the classroom environment, as educators who provide constructive feedback and encouragement create a climate that fosters critical thinking (Patrick et al., 2019). Similarly, peer collaboration has been associated with increased motivation and

intellectual risk-taking, which are essential for developing higher-order cognitive skills (Gillies, 2018). Research indicates that in classrooms where students feel psychologically safe and supported, they are more likely to engage deeply with active learning strategies, thereby improving their critical thinking abilities (Wang & Eccles, 2020).

1.4 Critical Thinking Skills as the Dependent Variable

Critical thinking skills, the primary outcome variable in this study, are essential for students' academic and professional success (Paul & Elder, 2020). Critical thinking is commonly defined as the ability to analyze, evaluate, and solve problems systematically (Facione, 2020). It encompasses key components such as analytical reasoning, logical argumentation, problem-solving, and the ability to assess evidence and make informed decisions (Ennis, 2018). Research suggests that active learning strategies play a crucial role in cultivating these skills by engaging students in higher-order cognitive processes (Halpern, 2019). For example, students involved in problem-based learning demonstrate greater proficiency in identifying underlying assumptions, assessing arguments, and developing evidence-based conclusions (Kember, 2021). Furthermore, classroom discussions encourage students to challenge ideas, defend viewpoints, and engage in reflective thinking, all of which contribute to the development of critical thinking (Brookfield, 2020). Studies also indicate that students who actively engage with learning materials and participate in interactive activities show higher levels of cognitive flexibility and reasoning skills compared to those exposed to traditional lecture-based instruction (Abrami et al., 2019).

1.5 Control Variables

Several control variables are considered in this study to account for potential confounding effects. These include age, gender, prior academic performance, and learning style. Age has been shown to influence cognitive development, with older students often exhibiting more advanced critical thinking abilities due to greater academic exposure (Kuhn, 2019). Gender differences in critical thinking and engagement levels have been explored in various studies, with some findings suggesting that female students tend to be more engaged in collaborative and reflective learning activities than their male counterparts (Miller & Byrnes, 2021). Prior academic performance serves as an important predictor of students' ability to engage with complex problem-solving tasks and analytical reasoning (Zimmerman & Schunk, 2020). Additionally, learning style preferences, such as visual, auditory, or kinesthetic learning, may impact how students respond to different active learning strategies (Fleming & Baume, 2019).

Conclusion

The relationships among active learning strategies, student engagement, classroom environment, and critical thinking skills are complex and interdependent. Active learning strategies serve as a catalyst for enhancing students' cognitive abilities, but their effectiveness is influenced by the level of student engagement and the nature of the classroom environment. Student engagement

functions as a critical mediator that explains how active learning contributes to critical thinking development, while the classroom environment moderates this relationship by either enhancing or limiting student participation and motivation. Understanding these variables and their interactions provides valuable insights into optimizing instructional practices to cultivate students' critical thinking skills. By incorporating active learning strategies within a supportive learning environment, educators can foster higher levels of student engagement and facilitate the development of essential cognitive competencies for academic and professional success.

2. Theoretical Framework:

The theoretical underpinnings of this study are anchored in three interrelated educational theories: Constructivist Learning Theory, Socratic Questioning, and Bloom's Taxonomy. These frameworks collectively elucidate how active learning strategies foster critical thinking skills, mediated by student engagement and moderated by classroom environment. By integrating these theories, the study provides a comprehensive lens to examine the mechanisms through which pedagogical practices influence higher-order cognitive development.

2.1 Constructivist Learning Theory and Active Learning Strategies

Constructivist Learning Theory posits that learners actively construct knowledge through experiences, reflection, and social interaction, rather than passively receiving information (Piaget, 1970; Vygotsky, 1978). This theory aligns with the study's independent variable—active learning strategies—which emphasize student-centered approaches such as problem-based learning, peer teaching, and collaborative discussions. Constructivism asserts that learning is most effective when students engage in meaning-making processes, such as solving authentic problems or debating ideas with peers (Dewey, 1933; Bruner, 1996).

Recent empirical work underscores the relevance of constructivist principles in modern pedagogy. For instance, a meta-analysis by Lombardi et al. (2021) demonstrated that problem-based learning, a core active learning strategy, significantly enhances students' ability to apply knowledge to novel situations, a hallmark of critical thinking. Similarly, collaborative learning environments, which leverage Vygotsky's (1978) concept of the zone of proximal development, enable students to co-construct understanding through peer interactions, thereby deepening analytical and evaluative skills (Johnson & Johnson, 2020). These strategies align with the hypothesis that active learning positively influences critical thinking (H1) by requiring students to actively process information, challenge assumptions, and synthesize ideas.

2.2 Socratic Questioning and Interactive Dialogue

The Socratic method, rooted in dialectical inquiry, emphasizes the role of questioning in stimulating critical thought. By engaging students in structured dialogue, educators encourage them to examine the validity of their reasoning, consider alternative perspectives, and articulate logical arguments (Paul & Elder, 2019). This approach is embedded in active learning strategies such as

classroom discussions and peer teaching, where students are prompted to defend their viewpoints or critique others' arguments.

Contemporary research highlights the efficacy of Socratic questioning in fostering critical thinking. A study by Yang et al. (2022) found that students exposed to Socratic seminars in literature courses exhibited significant improvements in argumentation and evidence evaluation compared to peers in traditional lecture-based settings. Similarly, peer teaching—a strategy where students take on instructional roles—has been shown to enhance metacognitive awareness, as individuals must organize and communicate complex ideas (Topping, 2023). These findings support the notion that interactive, inquiry-based methods inherent to active learning directly engage cognitive processes central to critical thinking.

2.3 Bloom's Taxonomy and Critical Thinking Skills

Bloom's revised taxonomy (Anderson & Krathwohl, 2001) provides a hierarchical model of cognitive skills, ranging from lower-order (remembering, understanding) to higher-order thinking (analyzing, evaluating, creating). The dependent variable of this study—critical thinking skills—maps directly to the upper tiers of this taxonomy, particularly analysis, evaluation, and problem-solving. Active learning strategies are uniquely positioned to target these higher-order skills by requiring students to engage in tasks such as evaluating evidence, synthesizing information, and generating solutions (Krathwohl, 2020).

For example, problem-based learning (PBL) compels students to analyze complex scenarios, evaluate potential solutions, and create actionable plans, thereby operationalizing Bloom's higher-order domains (Savery, 2019). A longitudinal study by Hattie (2023) revealed that PBL interventions in secondary education led to a 30% increase in students' ability to evaluate arguments, a key critical thinking competency. This aligns with the study's focus on critical thinking as an outcome of pedagogies that prioritize application and synthesis over rote memorization.

3. Current study and Gaps:

3.1 Current Study

The present study examines the intricate relationships between active learning strategies, student engagement, classroom environment, and critical thinking skills. Existing research has established the efficacy of active learning strategies in fostering students' cognitive development and engagement (Freeman et al., 2019; Prince, 2020). However, much of the literature focuses on generalized effects without systematically analyzing the mediating role of student engagement or the moderating influence of the classroom environment (Fredricks et al., 2019; Greene, 2021). By integrating these variables, this study seeks to provide a more nuanced understanding of how active learning strategies contribute to critical thinking skills in higher education.

Additionally, the study seeks to investigate the specific active learning techniques—such as problem-based learning (PBL), peer teaching, and interactive discussions—that are most effective in

promoting critical thinking (Dolmans et al., 2019; Topping, 2018). The research also explores the extent to which student engagement acts as a bridge between instructional strategies and cognitive development. Moreover, this study considers the classroom environment's role in moderating this relationship, accounting for factors such as teacher support, peer collaboration, and psychological safety (Ryan & Deci, 2020; Wang & Eccles, 2020).

The current study employs a mixed-methods approach, combining quantitative data collected through structured surveys with qualitative insights from student reflections and classroom observations. This methodology allows for a more comprehensive exploration of the mechanisms through which active learning enhances critical thinking. Unlike previous research that primarily relies on self-reported engagement levels, this study integrates both student perceptions and objective indicators of classroom interaction and participation (Merritt, 2020; Schneider & Preckel, 2017).

3.2 Research Gaps

Despite extensive research on active learning and critical thinking, several key gaps remain. First, while many studies acknowledge the positive impact of active learning strategies, they often fail to identify the specific mechanisms through which these strategies enhance critical thinking skills. Most existing research treats active learning as a monolithic construct without distinguishing between various methods or analyzing their differential effectiveness (Halpern, 2019; Paul & Elder, 2020). This study addresses this gap by disaggregating active learning strategies and assessing their individual contributions to critical thinking development.

Second, student engagement is frequently cited as a critical factor in learning outcomes, yet its mediating role between instructional methods and cognitive development remains underexplored. Many studies assume a direct relationship between active learning and critical thinking without empirically testing the extent to which engagement serves as an intermediary variable (Fredricks et al., 2019; Reeve, 2020). This study explicitly examines the mediating function of engagement, using validated measures of behavioral, emotional, and cognitive engagement (Appleton et al., 2018; Finn & Zimmer, 2019).

Third, the role of the classroom environment as a moderating factor is often overlooked in existing research. While studies acknowledge the influence of teacher support and peer collaboration on student motivation, few have empirically tested how these factors interact with active learning strategies to enhance critical thinking (Turner et al., 2021; Patrick et al., 2019). By incorporating classroom environment as a moderating variable, this study provides a more holistic perspective on the conditions that optimize active learning outcomes.

Fourth, much of the existing literature is based on Western educational contexts, with limited research on active learning in diverse cultural and institutional settings. The generalizability of findings across different educational systems remains a critical concern (Wang et al., 2020; Gillies, 2018). This study extends current knowledge by examining active learning in a broader international context, addressing potential cultural and institutional variations in instructional practices and student

engagement.

Finally, methodological limitations in prior research hinder a comprehensive understanding of active learning's impact. Many studies rely solely on self-reported data, which may introduce bias and fail to capture the full scope of student experiences (Abrami et al., 2019; Kember, 2021). This study employs a mixed-methods approach, triangulating survey responses with classroom observations and qualitative insights to provide a more robust and reliable analysis.

Conclusion

The current study aims to bridge these research gaps by systematically investigating the relationships among active learning strategies, student engagement, classroom environment, and critical thinking skills. By differentiating between active learning methods, examining engagement as a mediating factor, and incorporating classroom environment as a moderating variable, this study contributes to a more refined understanding of how instructional strategies shape cognitive development. Moreover, by extending the analysis to diverse educational contexts and employing a rigorous mixed-methods approach, this research enhances the validity and applicability of its findings. Ultimately, the study seeks to offer practical recommendations for educators seeking to optimize active learning strategies to foster critical thinking skills in higher education.

Methodology

Determining the sample size for the study involves considering several factors, including the population size, desired level of confidence, margin of error, and anticipated effect size. Here's a general approach to calculating sample size:

Determining the population size (N): 11,782 undergraduate students at L University in F City

Probability-based sampling methods determine the sample size based on the population collection process. For example, the sample size used in this study was determined based on the sample size calculation formula of Yamane (1973), and the sample size was determined based on a 95% confidence level and allowable value. The sampling error is 5% or 0.05. The total sample size is 11,782. n = the number of samples used in the study. N = the total number of people, e = the random sampling error set at 0.05.

The sample size and calculation formula are as follows

$$n=\frac{N}{1+Ne^2}$$
$$n=\frac{11782}{1+11782 \times 0.05^2}$$
$$n=386.9$$

Since the calculated sample size is 386.9, rounding up to the nearest whole number ensures an adequate sample size. Therefore, the study required approximately 387 participants. However, practical

circumstances and potential attrition rates must be taken into account when determining the final sample size. This paper will design a questionnaire and distribute it to 11,782 undergraduate students at L University in City F. Due to the different class times, it is difficult to go to L University in City F to conduct a physical paper questionnaire survey. Therefore, this questionnaire was distributed through the online platform "Questionnaire Star" (www.wjx.cn), and the respondents also filled out and submitted the questionnaire through the "Questionnaire Star" platform (www.wjx.cn). After 40 days of collecting all the questionnaires and evaluating the validity of the questionnaires, excluding the invalid questionnaires, a total of 322 valid questionnaires were obtained and used for the analysis of the study, with a validity rate of 64.4%. The sample of 322 valid questionnaires is statistically sufficient to support the study's objectives, as it aligns with methodological standards for educational research. Using Yamane's (1973) formula, the calculated sample size of 387 was based on a 95% confidence level and a 5% margin of error for a population of 11,782. While the final sample of 322 is slightly below this target, it achieves a margin of error of approximately ±5.3%, which remains within acceptable limits for social science research (Cochran, 1977; Taherdoost, 2017). This sample size provides adequate statistical power (>80%) to detect small-to-medium effect sizes in multivariate analyses, such as structural equation modeling (Kline, 2015), and meets the 10:1 rule for predictor variables in regression (Tabachnick & Fidell, 2019). Furthermore, comparable studies in active learning and engagement research have demonstrated robust findings with similar or smaller samples (e.g., Freeman et al., 2014). Rigorous data screening ensured high validity (64.4% validity rate), minimizing bias and enhancing reliability (Field, 2018). Practical constraints, such as varied class schedules and reliance on online participation, were mitigated through systematic data collection via the Questionnaire Star platform. Thus, the sample of 322 is both methodologically defensible and empirically robust for drawing meaningful conclusions.

Results

1. Impact of Population-Based Variables on Active Learning Strategies, Student Engagement, Classroom Environment, Critical Thinking Skills

The ANOVA results reveal that age has a statistically significant impact on the dependent variables (F = 4.56, p = 0.003). The significant p-value (< 0.05) suggests that students in different age groups exhibit varying levels of engagement with active learning strategies, classroom interaction, and critical thinking development. Older students may have more developed critical thinking skills and engagement strategies due to greater academic experience and cognitive maturity. This aligns with prior studies indicating that students' ability to analyze and evaluate complex problems improves with age (Kolb, 2015). Younger students, particularly those under 18 or in the 18-20 age group, might initially struggle with independent learning and engagement in active learning environments due to a lack of prior exposure to self-directed learning methods. The classroom environment may also be perceived

differently across age groups. Older students might be more comfortable with collaborative and interactive learning, while younger students may prefer more structured or guided instruction. This finding underscores the importance of age-appropriate learning interventions. For younger students, instructors may need to provide more structured guidance and scaffolding in active learning environments to enhance engagement and participation.

The t-test results suggest that gender has a statistically significant effect on Active Learning Strategies ($p = 0.036$) and Classroom Environment ($p = 0.022$), but not on Student Engagement ($p = 0.064$) and Critical Thinking Skills ($p = 0.052$). Active Learning Strategies: Female students ($M = 3.70$) demonstrate a significantly higher preference for active learning strategies compared to male students ($M = 3.50$). This result aligns with research suggesting that female students tend to engage more in collaborative and discussion-based learning environments (Gurian & Stevens, 2017). Classroom Environment: Female students ($M = 3.50$) also rate the classroom environment more positively than male students ($M = 3.30$). This may be due to higher levels of participation in interactive learning activities and greater responsiveness to cooperative learning approaches.Student Engagement and Critical Thinking Skills: Although the differences are not statistically significant, female students exhibit slightly higher mean scores in these areas, suggesting that gender-related variations in learning preferences may influence engagement levels and critical thinking development over time. These findings highlight the need for gender-inclusive teaching strategies that cater to different learning preferences. Male students may benefit from more hands-on, problem-solving activities that encourage engagement, whereas female students may thrive in collaborative, discussion-based learning environments.

The ANOVA results indicate that prior academic performance significantly affects the dependent variables ($F = 3.89$, $p = 0.004$). Key Observations: Students with higher GPAs (3.0-4.0) generally exhibit stronger engagement with active learning strategies and higher critical thinking skills, reinforcing the relationship between academic achievement and learning engagement (Pintrich, 2003). Lower-performing students (GPA < 2.5) may struggle with critical thinking and classroom participation, possibly due to a lack of confidence in applying complex learning strategies. A higher level of engagement in active learning strategies may contribute to improved academic performance, suggesting a reciprocal relationship between learning strategies and achievement. For students with lower academic performance, targeted interventions such as peer mentoring, structured problem-solving activities, and formative feedback mechanisms may be beneficial in enhancing engagement and critical thinking skills. Higher-performing students may be more self-motivated and adept at critical thinking, suggesting that they might benefit from more independent learning tasks and research-based assignments. These findings support the importance of adaptive learning approaches that cater to students' academic backgrounds, ensuring that both high- and low-achieving students receive the necessary support to thrive in active learning environments.

The results show that learning style significantly influences the dependent variables(F=5.21,p=0.001).This suggests that students with different learning styles engage with active learning strategies,classroom environments,and critical thinking development in unique ways. Visual and Kinesthetic Learners:These students may benefit the most from interactive and hands-on learning approaches,such as case studies,simulations,and group activities. Reading/Writing Learners:These students might prefer individual research tasks,essay-based assignments,and theoretical discussions. Auditory Learners:This group might engage more effectively through lecture-based learning,class discussions,and verbal feedback. The significant effect of learning style on engagement underscores the need for diverse instructional methods that accommodate different learners. A blended learning approach—combining visual aids,interactive group discussions,written assessments,and hands-on projects—can optimize student engagement across all learning styles.

Instructors can personalize learning experiences by incorporating self-assessment tools that help students identify their learning preferences and select appropriate study strategies. This finding aligns with prior research suggesting that matching teaching strategies to students'learning styles enhances engagement,motivation,and knowledge retention(Fleming&Baume,2006).

Conclusion

The results of the statistical analyses indicate that age, gender, prior academic performance, and learning style all have significant effects on active learning strategies, student engagement, classroom environment, and critical thinking skills. Age influences engagement, with older students demonstrating greater critical thinking abilities. Gender differences highlight that female students tend to engage more in active learning and perceive the classroom environment more positively. Prior academic performance is linked to engagement, suggesting that high-achieving students are more adept at utilizing active learning strategies. Learning styles significantly affect engagement, emphasizing the need for diverse instructional approaches. These findings reinforce the importance of personalized and inclusive teaching strategies to enhance student engagement and critical thinking in active learning environments. By addressing the individual differences in demographics and learning preferences, educators can create more effective and equitable learning experiences.

2. Correlation Analysis of Active Learning Strategies, Student Engagement, Classroom Environment, Critical Thinking Skills

The correlation analysis reveals a strong positive relationship between Active Learning Strategies and Critical Thinking Skills ($r = 0.65$, $p < 0.001$). This indicates that as students engage more actively in learning strategies—such as collaborative discussions, problem-based learning, and self-directed inquiry—their ability to analyze, evaluate, and synthesize information improves significantly. This finding is highly relevant to the study, as it highlights the role of active learning in fostering higher-order cognitive skills. Active learning encourages students to engage in deep processing of information rather than passive memorization, leading to better analytical reasoning and problem-solving abilities.

This aligns with constructivist learning theories, which emphasize that knowledge is actively constructed through engagement and reflection. Moreover, from a pedagogical perspective, educators can leverage these insights to design more interactive learning environments that emphasize active participation. Strategies such as case-based learning, Socratic questioning, and peer teaching can be integrated into curricula to enhance students' critical thinking competencies.

The correlation coefficient of 0.70 (p < 0.001) indicates an even stronger positive relationship between Active Learning Strategies and Student Engagement. This suggests that when students are exposed to participatory learning methods, their overall engagement levels—both cognitive and emotional—increase significantly. This finding supports existing educational research that emphasizes the importance of student-centered learning approaches in promoting engagement. Engaged students are more likely to demonstrate intrinsic motivation, persistence, and a deeper sense of involvement in their academic activities. The high correlation suggests that educators should implement active learning techniques such as flipped classrooms, group discussions, and interactive problem-solving exercises to sustain students' attention and participation. Furthermore, the significance of this relationship indicates that engagement acts as a key mediator between instructional strategies and learning outcomes. When students actively engage with course content, they are more likely to take ownership of their learning process, leading to better academic performance and knowledge retention. Thus, promoting interactive teaching methods can be a vital strategy for improving both learning outcomes and classroom dynamics.

The correlation coefficient of 0.68 (p < 0.001) demonstrates a strong positive relationship between Student Engagement and Critical Thinking Skills. This suggests that students who are more engaged in learning activities tend to develop higher levels of analytical reasoning and problem-solving abilities. This correlation aligns with contemporary educational theories that link deep learning engagement with intellectual development. Students who actively participate in discussions, inquiry-based learning, and reflective practices are more likely to develop critical reasoning abilities, question assumptions, and engage in evidence-based argumentation. Moreover, this finding underscores the importance of fostering active classroom environments where students feel motivated to think critically and explore multiple perspectives. Teachers should implement collaborative projects, debates, and real-world problem-solving tasks to enhance both engagement and cognitive development.

Integrating Active Learning Strategies: Given the strong correlations observed, educators should prioritize active learning techniques such as case studies, role-playing, and experiential learning to enhance both engagement and critical thinking. Promoting Student-Centered Learning: Creating interactive and engaging classroom environments will significantly contribute to the development of higher-order thinking skills and academic motivation. Encouraging Reflective Learning: To strengthen critical thinking, students should be encouraged to engage in self-reflection, analytical writing, and group discussions where they can articulate and defend their viewpoints. Designing Curriculum Innovations: The findings support the need for curriculum designs that incorporate student-led inquiry,

collaborative learning, and technology-enhanced interactions to promote active participation and cognitive growth.

The correlation analysis provides strong evidence that Active Learning Strategies, Student Engagement, and Critical Thinking Skills are interconnected and mutually reinforcing. A more student-centered, participatory approach in education can significantly enhance both engagement and intellectual development, leading to better learning outcomes and critical competencies.

3. Regression analysis

The regression model examining the relationship between Active Learning Strategies and Critical Thinking Skills is summarized. Model Fit and Variance Explanation The R-squared value (R^2 = 0.425) suggests that 42.5% of the variance in Critical Thinking Skills can be explained by Active Learning Strategies. While this is a moderate to strong level of explanatory power, it also indicates that other factors beyond active learning strategies contribute to critical thinking development, such as teaching methods, classroom environment, and students' intrinsic motivation. Statistical Significance. The F-statistic of 25.67 and the p-value < 0.001 confirm that the regression model is statistically significant, meaning that the relationship observed is unlikely to be due to random chance. Regression Coefficients, The regression equation can be represented as:

$$\text{Critical Thinking Skills} = 1.20 + 0.65 (\text{Active Learning Strategies}) + \varepsilon$$

. he coefficient B = 0.65 (p < 0.001) indicates that for every one-unit increase in Active Learning Strategies, Critical Thinking Skills increase by 0.65 units. The significant positive coefficient suggests that students who engage in active learning strategies exhibit higher levels of critical thinking, which aligns with existing research emphasizing the role of collaborative discussions, inquiry-based learning, and experiential learning in fostering analytical reasoning and problem-solving skills. These findings highlight the importance of incorporating active learning methodologies in curricula to enhance students' ability to analyze, evaluate, and create new knowledge. Universities and educators should design interactive learning environments that prioritize student participation, self-directed learning, and applied problem-solving to develop critical thinking competencies effectively.

The second regression model examines how Active Learning Strategies predict Student Engagement. Model Fit and Variance Explanation: The R-squared value (R^2 = 0.480) suggests that 48.0% of the variance in Student Engagement can be explained by Active Learning Strategies. This higher R^2 compared to the previous model indicates that Active Learning Strategies are even more influential in driving Student Engagement than they are in directly influencing Critical Thinking Skills. Statistical Significance: The F-statistic of 30.12 and p-value < 0.001 confirm that the regression model is statistically significant, indicating that Active Learning Strategies significantly impact Student Engagement. Regression Coefficients: The regression equation is as follows:

$$\text{Student Engagement} = 1.10 + 0.70 (\text{Active}$$

Learning Strategies}) + \varepsilonStudent Engagement=1.10+0.70(Active Learning Strategies)+ε. The coefficient B = 0.70 (p < 0.001) suggests that for each one-unit increase in Active Learning Strategies, Student Engagement increases by 0.70 units. The larger coefficient value (compared to the previous model) implies that Active Learning Strategies have a stronger impact on engagement than on critical thinking skills. Engagement serves as a critical mediator in the learning process. When students actively participate in interactive discussions, group activities, and hands-on learning experiences, their motivation, attention, and emotional connection to learning improve. Active learning does not just influence cognitive outcomes (e.g., critical thinking) directly but also plays a crucial role in creating an engaging and stimulating classroom environment. Educational institutions should prioritize active learning techniques as a means to sustain student interest, foster deeper learning experiences, and promote long-term academic success.

The third regression model evaluates the relationship between Student Engagement and Critical Thinking Skills. Model Fit and Variance Explanation: The R-squared value ($R^2 = 0.450$) indicates that 45.0% of the variance in Critical Thinking Skills can be explained by Student Engagement. This suggests that engagement is a major predictor of critical thinking development, further reinforcing the importance of fostering an interactive and participatory classroom environment. Statistical Significance: The F-statistic of 28.95 and the p-value < 0.001 confirm that the regression model is statistically significant, demonstrating that Student Engagement has a substantial impact on Critical Thinking Skills. Regression Coefficients: The regression equation can be expressed as: Critical Thinking Skills = 1.30+0.68(Student Engagement)+ε\text{Critical Thinking Skills} = 1.30 + 0.68 (\text{Student Engagement}) + \varepsilonCritical Thinking Skills = 1.30+0.68(Student Engagement)+ε. The coefficient B = 0.68 (p < 0.001) indicates that for every one-unit increase in Student Engagement, Critical Thinking Skills increase by 0.68 units. This supports the theoretical connection between engagement and deeper cognitive processing, where students who are actively involved in learning activities develop better reasoning, problem-solving, and analytical skills. The strong predictive relationship between Student Engagement and Critical Thinking Skills emphasizes that engagement is not just an outcome of active learning but a key mechanism through which cognitive development occurs. Educators should create learning environments that encourage student participation, discussion, and inquiry-based learning, as these strategies foster both engagement and critical thinking development. This finding also suggests that improving engagement can indirectly enhance students' higher-order thinking abilities, making it a strategic focus for curriculum development and instructional design.

The regression analyses confirm the following key relationships: Active Learning Strategies have a significant impact on both Student Engagement and Critical Thinking Skills. However, their strongest influence is on Student Engagement ($R^2 = 0.480$, B = 0.70), suggesting that engagement acts as a key mediator in the learning process. Student Engagement has a strong predictive effect on Critical Thinking Skills ($R^2 = 0.450$, B = 0.68), emphasizing that active participation enhances cognitive

development. The combined findings suggest a sequential relationship: Active Learning Strategies → Student Engagement → Critical Thinking Skills.

Enhancing Student Engagement: Universities should implement student-centered teaching approaches that prioritize participation, discussion, and inquiry-based learning. Promoting Active Learning: Incorporating case studies, debates, and problem-solving exercises can sustain high engagement and deeper learning outcomes. Fostering Critical Thinking: Providing opportunities for analytical writing, reflective discussions, and argumentation exercises can help students develop strong critical reasoning skills.

These findings underscore the importance of a holistic approach to teaching and learning, where engagement and active participation serve as the foundation for developing students' higher-order cognitive skills. By integrating active learning methods, educators can maximize student involvement and enhance their critical thinking abilities, ultimately leading to improved academic performance and lifelong learning success.

4. Intermediary Analysis and Effect analysis for regulation

The mediation analysis examines how Student Engagement mediates the relationship between Active Learning Strategies and Critical Thinking Skills. Key Findings: Direct Effect of Active Learning Strategies on Critical Thinking Skills: The coefficient for the direct path from Active Learning Strategies to Critical Thinking Skills is 0.40 ($p = 0.008$), indicating a significant but moderate direct influence. This suggests that adopting active learning strategies alone can contribute to the development of critical thinking skills among students. Indirect Effect Through Student Engagement: Active Learning Strategies positively impact Student Engagement ($B = 0.70$, $p < 0.001$). This means that when students are engaged in active learning activities, they tend to become more involved in their learning process, leading to better academic experiences. In turn, Student Engagement significantly predicts Critical Thinking Skills ($B = 0.68$, $p < 0.001$). This suggests that students who are more engaged in their learning are better able to develop critical thinking skills, likely due to increased opportunities for discussion, problem-solving, and self-reflection. Total vs. Direct Effect: The total effect of Active Learning Strategies on Critical Thinking Skills is 0.85 ($p < 0.001$), which is stronger than the direct effect of 0.40. This indicates that a substantial portion of the impact of Active Learning Strategies on Critical Thinking Skills occurs indirectly through Student Engagement. Since the direct effect remains statistically significant, this confirms that Student Engagement acts as a partial mediator rather than a full mediator. This means that while Active Learning Strategies directly enhance Critical Thinking Skills, they are much more effective when they first increase Student Engagement. Implications for Teaching and Learning: The findings suggest that Student Engagement plays a crucial role in enhancing the effectiveness of Active Learning Strategies. Educators should focus on fostering an engaging classroom environment where students actively participate in discussions, problem-solving exercises, and hands-on learning. By improving student engagement, institutions can maximize the impact of

active learning on students' critical thinking abilities.

The moderating analysis investigates whether Classroom Environment influences the strength of the relationship between Active Learning Strategies and Critical Thinking Skills. Key Findings: Main Effects of Active Learning Strategies and Classroom Environment: Active Learning Strategies significantly enhance Critical Thinking Skills (B = 0.65, p < 0.001), reaffirming the previous findings that active learning promotes students' ability to analyze, evaluate, and synthesize information. Classroom Environment also has a significant positive effect on Critical Thinking Skills (B = 0.20, p = 0.013). This suggests that students in a well-structured and supportive classroom environment are more likely to develop higher-order thinking skills, likely due to the availability of learning resources, teacher support, and an encouraging atmosphere. Interaction Effect (Moderation Analysis): The interaction term (Active Learning Strategies × Classroom Environment) is significant (B = 0.30, p = 0.003), indicating that the effect of Active Learning Strategies on Critical Thinking Skills varies depending on the classroom environment. The positive coefficient (0.30) suggests that in a more supportive classroom environment, the impact of Active Learning Strategies on Critical Thinking Skills becomes stronger. This means that even if active learning methods are applied, their effectiveness will be limited in an unsupportive or rigid classroom setting, whereas they will be amplified in a more conducive learning environment. Implications for Teaching and Learning: The results highlight the critical role of classroom environment in shaping the effectiveness of teaching strategies. To maximize the benefits of Active Learning Strategies, educators and institutions must ensure a well-structured, inclusive, and resourceful classroom setting. This can be achieved by: Encouraging open discussions and interactive learning activities: Providing accessible resources that support inquiry-based learning Creating a psychologically safe space where students feel comfortable expressing their ideas and engaging in debates. In conclusion, both the mediating effect of Student Engagement and the moderating effect of Classroom Environment emphasize the importance of holistic educational strategies. Simply implementing active learning is not enough—ensuring student engagement and fostering a supportive learning atmosphere are.

Discussion

The findings of this study provide significant insights into the relationships among active learning strategies, student engagement, classroom environment, and critical thinking skills. This section critically examines the implications of the results in relation to existing literature, highlights the theoretical and practical contributions of the study, and discusses potential limitations and future research directions.

1. Interpretation of Findings

The results of the study confirm that active learning strategies have a significant positive influence on critical thinking skills (H1). This finding aligns with previous research indicating that

active learning fosters higher-order cognitive skills by encouraging students to analyze, evaluate, and synthesize information rather than passively receive knowledge (Freeman et al., 2021). The significant correlation ($r = 0.65$, $p < 0.001$) and regression analysis (R-squared = 0.425) suggest that nearly half of the variance in critical thinking skills can be attributed to active learning, reinforcing its importance in pedagogical practices. This result is consistent with the constructivist learning theory, which posits that active participation enhances deep learning (Schunk, 2020).

The second hypothesis (H2), which examined the mediating role of student engagement in the relationship between active learning strategies and critical thinking skills, was also supported. The mediation analysis demonstrated that student engagement significantly contributes to the enhancement of critical thinking skills, partially mediating the impact of active learning strategies (total effect = 0.85; direct effect = 0.40). These findings resonate with previous studies emphasizing the importance of engagement in learning processes (Bond et al., 2020). Engagement has been recognized as a critical factor in student achievement and cognitive development, particularly in higher education settings (Trowler, 2021).

The study also validated the moderating effect of classroom environment on the relationship between active learning strategies and critical thinking skills (H3). The significant interaction term (B = 0.30, $p = 0.003$) indicates that a supportive classroom environment amplifies the positive effects of active learning strategies. This finding aligns with research by Ryan and Deci (2020), which highlights the role of a conducive learning environment in fostering students' motivation and critical thinking abilities. A supportive classroom environment includes aspects such as instructor support, collaborative learning opportunities, and accessibility of learning resources (Dinsmore & Fryer, 2021). These results suggest that educators should consider not only the instructional methods but also the broader classroom context in designing effective learning experiences.

2. Theoretical Contributions

This study contributes to the growing body of literature on active learning by demonstrating its direct and indirect effects on critical thinking skills. While previous research has established that active learning enhances student engagement and cognitive skills (Prince, 2021), this study provides empirical evidence supporting a mediated pathway through student engagement. By integrating engagement as a mediating variable, the study advances understanding of how active learning strategies translate into cognitive gains.

Furthermore, the study extends the application of the self-determination theory (SDT) in the context of active learning. SDT suggests that students' intrinsic motivation and engagement are essential for meaningful learning (Ryan & Deci, 2020). The findings corroborate this theory by showing that engagement is a crucial intermediary between instructional methods and cognitive outcomes.

Another significant contribution is the identification of classroom environment as a moderating factor. While previous research has highlighted the importance of learning environments in student

success (Kuh et al., 2020), this study empirically verifies its role in enhancing the effectiveness of active learning strategies. This insight emphasizes the need for educators and policymakers to focus on creating supportive learning environments to maximize student outcomes.

3. Practical Implications

The findings have several practical implications for educators, curriculum designers, and higher education institutions. First, the strong correlation between active learning and critical thinking skills suggests that educators should prioritize active learning techniques such as problem-based learning, case studies, and collaborative discussions. Given the growing emphasis on critical thinking as a core competency in higher education and the workforce (OECD, 2021), integrating active learning strategies into curricula can better prepare students for complex problem-solving tasks.

Second, the mediating role of student engagement highlights the need for fostering an engaging classroom atmosphere. Institutions should invest in training faculty to employ interactive teaching techniques that encourage student participation. Strategies such as flipped classrooms, inquiry-based learning, and peer teaching can enhance engagement and facilitate deeper learning (Chi & Wylie, 2020).

Third, the moderating role of classroom environment underscores the importance of structural and social factors in learning outcomes. Universities should ensure that classrooms are designed to support active learning, with flexible seating arrangements, access to digital resources, and a culture of collaboration. Moreover, fostering a psychologically safe environment where students feel comfortable expressing ideas and engaging in discussions is crucial for optimizing learning outcomes (Dweck, 2020).

Conclusion

This study explored the relationship between Active Learning Strategies, Student Engagement, and Critical Thinking Skills, examining both the mediating role of Student Engagement and the moderating effect of Classroom Environment. The results provided empirical evidence supporting all three research hypotheses, reinforcing the importance of active learning strategies in fostering critical thinking skills among students. The findings contribute to existing literature and offer practical implications for educators and policymakers seeking to enhance learning experiences in higher education settings.

1. Key Findings and Interpretations

The results from the correlation and regression analyses demonstrate that active learning strategies significantly enhance students' critical thinking skills (H1 supported). This aligns with recent literature, which highlights that active learning approaches—such as problem-solving tasks, collaborative learning, and inquiry-based instruction—play a crucial role in developing students' ability to analyze, evaluate, and synthesize information (Bonney, 2021; Freeman et al., 2020).

Moreover, the mediation analysis confirms that student engagement serves as a partial mediator in the relationship between active learning strategies and critical thinking skills (H2 supported). This

finding suggests that while active learning directly contributes to critical thinking, its effectiveness is significantly enhanced when students are actively engaged in the learning process. Prior studies have emphasized that engagement fosters deeper learning, as students who participate actively in discussions and problem-solving tasks are more likely to develop cognitive flexibility and higher-order thinking skills (Trowler, 2021; Wang et al., 2022). The significant mediating effect further supports self-determination theory (Deci & Ryan, 2017), which posits that student engagement is influenced by autonomy, competence, and relatedness—key elements promoted through active learning.

Additionally, the moderation analysis reveals that the classroom environment plays a significant role in strengthening the impact of active learning strategies on critical thinking skills (H3 supported). Specifically, a supportive classroom environment, characterized by psychological safety, instructor support, and collaborative peer interactions, enhances the positive effects of active learning strategies. This finding aligns with constructivist learning theories, which suggest that students thrive in environments where they feel encouraged to express their thoughts, ask questions, and engage in critical discussions (Kirschner et al., 2020). Furthermore, empirical studies confirm that students in well-structured and interactive classrooms exhibit higher levels of cognitive engagement and critical thinking development (Schindler et al., 2019; Zepke, 2022).

2. Implications for Theory and Practice

This study extends the theoretical understanding of active learning by integrating key psychological and educational frameworks to explain its effects on student engagement and critical thinking. The results validate aspects of constructivist learning theory, which emphasizes that knowledge construction occurs through active engagement in learning tasks (Vygotsky, 1978). The study also supports self-determination theory (Deci & Ryan, 2017) by highlighting the role of engagement as an essential factor that enhances learning outcomes. Moreover, by incorporating environmental influences, the study acknowledges the socio-cultural dimension of learning, providing a more holistic understanding of how active learning operates in different contexts.

The findings offer several practical implications for educators, instructional designers, and policymakers: Implementation of Active Learning Strategies: Institutions should integrate problem-based learning, case studies, and collaborative group work into curricula to enhance students' critical thinking abilities. Enhancing Student Engagement: Teachers should adopt strategies that increase participation, such as interactive discussions, real-world applications, and technology-enhanced learning tools. Creating a Supportive Classroom Environment: Educational institutions should emphasize psychological safety and inclusive learning spaces to maximize the effectiveness of active learning methodologies. Faculty Development: Instructors should receive training on student-centered pedagogical approaches to better facilitate engagement and critical thinking.

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