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Decoding Critical Thinking and Learning Interest: An Analytical Inquiry into Primary Learners' Cognitive Profiles

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Abstract. Critical thinking skills and learning interest are increasingly recognized as essential priorities in schools worldwide. Although research in this emerging field is expanding, the current state of students' critical thinking skills and learning interest remains insufficiently explored. This study investigates the classification and underlying factors influencing critical thinking skills and learning interest among 250 fourth-grade students from five elementary schools in Trenggalek Regency, East Java. A quantitative descriptive survey design was employed. Data collection involved two main instruments:

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standardized assessments of critical thinking and structured questionnaires on learning interest, supported by documentary analysis. The findings indicate a concerning trend: most students demonstrated low levels of both critical thinking skills and learning interest. Further analysis identified several contributing factors, including student engagement, instructional quality, school environment, parental involvement, and broader systemic influences from educational stakeholders. These results underscore the urgent need for comprehensive and multi-level educational reforms to support cognitive and motivational development in elementary education. The study calls for continued research and discussion on specific factors affecting the development of critical thinking skills and learning interest.

Keywords: Critical thinking skills; learning interests; categories; influencing factors

1. Introduction

Science education at the elementary level functions not only as an introduction to fundamental concepts but also as a foundational framework that shapes how young learners understand, question, and engage with their surroundings. For children aged 7 to 12, this stage represents a critical period for developing scientific literacy. As highlighted by (Alberts, 2022), increased instructional time in science for students aged 5 to 18 is essential to develop investigative competence, scientific reasoning, and everyday problem-solving capacities.

Furthermore, a modern approach to science education extends beyond the acquisition of content; it fosters critical and collaborative thinking, which are essential skills for promoting sustainable development and pro-environmental behaviour (Trott & Weinberg, 2020). In addition, critical thinking has been widely recognized as a core cognitive competency in science education (Siew & Mapeala, 2016). Equally pivotal is students' intrinsic motivation, or learning interest, which has also been shown to significantly impact academic performance (Guler, 2013).

Furthermore, science instruction plays a vital role in developing students' foundational scientific literacy and higher-order cognitive skills, particularly critical thinking. This competency is essential for addressing the complexities of modern scientific, technological, and global challenges. Critical thinking enables learners to analyse information systematically, solve complex problems, make informed decisions, and communicate their understanding clearly and accurately (Ilkorucu et al., 2022).

This cognitive competency involves complex processes such as logical reasoning, reflective judgment, evaluative synthesis, and the restructuring of knowledge frameworks which is also supports the development of innovative and contextually appropriate solutions (Kinoshita, 2022; López-Fernández et al., 2023). The development of these competencies aligns closely with the global agenda for 21st-century skills, which highlights the importance of preparing students to navigate a volatile, uncertain, complex, and ambiguous (VUCA) world. The Assessment and Teaching of 21st Century Skills (ATC21S) initiative categorizes these essential competencies into four key domains: ways of thinking, ways of working, tools for working, and living in the world (Griffin et al., 2012; Sutiani et al., 2021)

Science education provides an intellectually rich context for developing and applying critical thinking skills. The scientific method includes essential cognitive processes such as systematic inquiry, empirical observation, data interpretation, hypothesis formulation, experimental design, and evidence-based evaluation. Each of these elements contributes to the foundation of critical reasoning (National Science Teacher Association, 2011). Beyond procedural knowledge, sustained interest in science has been shown to foster favourable dispositions toward the discipline, thereby enhancing intrinsic motivation and shaping students' long-term academic and career trajectories in STEM fields (Hofstein & Mamlok-Naaman, 2011).

Critically, the development of critical thinking enhances students' intellectual engagement and is positively associated with their academic achievement in science. A growing body of empirical research supports its dual role as both a catalyst for deeper cognitive processing and a contributor to sustained interest and improved learning outcomes (Jackson et al., 2023; Toli & Kallery, 2021).

Moreover, learning interest is a key affective and motivational construct that strongly influences the quality of the learning process and is directly associated with academic achievement. Extensive research highlights its multifaceted nature, showing that it is shaped by both internal dispositions and external educational contexts, which collectively affect student motivation, engagement, and performance (Fadliyana et al., 2023; Herpratiwi & Tohir, 2022; Nasution & Pasaribu, 2021; Supriyadi, 2022; Yusnidar et al., 2024). In science education, fostering student interest involves the integration of cognitive, emotional, and behavioral factors.

Research has identified several characteristics associated with increased interest, including sustained attention, active participation, personal satisfaction, instructional coherence and repetition, curiosity driven exploration, and positive emotional involvement (Arends & Kilcher, 2010; Ernawati et al., 2022; Hasanati & Purwaningsih, 2021; Rotgans & Schmidt, 2017). These dimensions collectively create a motivational climate that supports academic perseverance, promotes deeper conceptual understanding, and encourages sustained engagement with scientific content.

The need to cultivate students' critical thinking skills and learning interest in science education is widely recognized, particularly in line with global educational initiatives that emphasize future-oriented competencies. However, a growing body of empirical evidence reveals a persistent gap between these educational goals and actual classroom practices. Although critical thinking is broadly endorsed as a fundamental component of scientific literacy, research consistently reports that students demonstrate low levels of critical thinking in practice (Jannah & Atmojo, 2022). The instructional process intended to develop these skills often remains insufficiently responsive, especially when students encounter complex, open-ended problems that demand higher-order reasoning (Anggraeni & Suratno, 2021). Observations of student learning indicate that many students have limited understanding of scientific concepts and face difficulties in applying them to problem-solving situations. These challenges are often accompanied by passive learning behaviours and low levels of engagement (Amalia et al., 2021). Moreover, key indicators of critical thinking, such as inference, evaluation, and explanation, are either insufficiently addressed or ineffectively operationalized in classroom practice (Ikhtiana, 2023).

The existence observations highlight a widespread pedagogical challenge: many learners display passive behaviour and a reluctance to engage in complex reasoning. Their reliance on rote memorization and transcription, without meaningful conceptual understanding or connection to real-world experience, reflects a significant gap in deep learning. The class teacher further reported that students often struggle with analytical thinking, particularly when faced with unfamiliar or varied problem scenarios.

Classroom discussions are typically dominated by a small group of outspoken students, while the majority remain silent and do not contribute original ideas. This lack of broad engagement hinders the development of essential higher-order thinking skills. These findings point to the need for a more systematic and targeted assessment of students' abilities across specific dimensions of critical thinking, in order to inform the design of effective, evidence-based interventions (Febri et al., 2019).

Moreover, empirical evidence highlights a concerning trend of declining student interest in science learning. Recent studies report that key indicators of learning interest, such as curiosity, engagement, and emotional involvement, are often underdeveloped or not effectively integrated into classroom instruction (Andira et al., 2022; Yolanda & Meilana, 2021). In many cases, learning interest remains peripheral in educational assessment and planning, often subordinated to cognitive outcomes despite its well-documented role in facilitating motivation and performance (Wiradarma et al., 2021).

Observational evidence also indicates that students often exhibit passive behavior during classroom activities, including limited questioning and low responsiveness when asked to process or present learned information. These patterns reflect disengagement and a weak emotional connection to the learning process (Maidan et al., 2020). This decline in motivational engagement is reflected in large scale assessments. The 2022 PISA results show that Indonesia's average science literacy score was 383, significantly below the OECD average of 485, and representing a decline from the 2018 benchmark (OECD, 2023).

Classroom observations consistently reveal widespread student apathy. Learners appear disengaged through blank expressions, lack of focus, and participation in unrelated activities. These behaviours reflect a clear absence of interest in the learning process. When assigned tasks that require independent inquiry, most students complete them mechanically without evident curiosity or meaningful engagement. Student interviews confirm this pattern. Many describe the lessons as monotonous, overly difficult, or disconnected from real-life situations. Teachers also report persistent difficulty in encouraging active participation and developing learner independence. These challenges hinder the growth of conceptual understanding and critical thinking skills. The evidence indicates not only a gap in academic performance but also a deeper motivational problem that requires urgent pedagogical and policy attention.

Recent research data provides a critical warning, pointing to systemic weaknesses that require immediate, evidence-based educational reform. The significant decline in Indonesia’s PISA science scores in 2022 underscores the urgent need for a comprehensive diagnostic assessment of students’ critical thinking skills and learning motivation. Addressing these challenges demands more than surface-level solutions. It requires the development of targeted, research-driven strategies that align with the specific cognitive and emotional profiles of students. A key step in this process is the structured assessment of critical thinking proficiency across core domains: interpretation, analysis, evaluation, inference, explanation, and self-regulation, as defined by (Facione et al., 1994), while also identifying contextual factors that support or limit the development of these skills.

In addition, this study examines students’ learning interest by assessing key affective and behavioural indicators. These include active participation, enjoyment, satisfaction, attentiveness, and engagement during classroom activities (Arends & Kilcher, 2010) alongside their underlying determinants. Putting up together, these two areas of investigation aim to build a strong evidence base that can guide the development of effective and contextually appropriate educational interventions. The goal is to improve both cognitive growth and motivational engagement in primary science education.

This current study is guided by four interrelated objectives: (1) to assess the current levels of critical thinking skills among elementary students in the context of science education; (2) to identify and examine the main factors that influence the development of these skills; (3) to evaluate students’ interest and engagement in science learning; and (4) to investigate the key factors that shape and maintain students’ learning interest. These objectives aim to provide a comprehensive understanding of the cognitive and motivational elements that are essential for improving science education at the primary level.

2. Materials And Methods

2.1 General Background

This study used a descriptive quantitative research design to examine the characteristics, frequencies, trends, and categories within the target population. Through numerical and statistical analysis, the research provides an objective and measurable account of the observed phenomena (Creswell, 2014). This method provides data that clearly represent students' critical thinking skills, their interest in science learning, and the factors that influence both. Data collection further took place during the even semester of the 2023/2024 academic year.

2.2 Participants

The study involved 250 fourth-grade students and their science teachers from five elementary schools in Trenggalek Regency, East Java. In addition, two classes were randomly selected from each school, with 25 students in each class.

2.3 Instrument and Procedures

This study employed a quantitative descriptive survey method to examine students' critical thinking skills and learning interest, along with the factors that influenced them. The research procedure began with obtaining official approval from the Trenggalek Regency Department of Religious Affairs and the principals of five participating madrasahs: MI Walisongo Trenggalek, MI Riyadlatul Ulum Pogalan, MI Qomarul Hidayah Tugu, MI Miftahul Huda Sumberingin, and MI Huda Rejowinangun. After approval was granted, the research team conducted orientation sessions with school administrators and teachers to explain the study's objectives and data collection procedures.

This study employed a single instrument comprising two core components: a critical thinking test and a learning interest questionnaire. The critical thinking assessment was carefully constructed using real classroom problem indicators to capture students' cognitive abilities in a meaningful context. It featured six open-ended questions aligned with Facione's (1990) six domains of critical thinking, including interpretation, analysis, evaluation, inference, explanation, and self-regulation.

Before field use, the instrument underwent expert validation by three specialists in educational assessment and cognitive psychology, who evaluated its clarity, relevance, indicator alignment, and potential for bias. Their feedback informed targeted revisions which resulted in strong content validity (CVI= 0.85) and high reliability (α= 0.82). Students' responses were then scored using a standardized rubric to determine their critical thinking proficiency levels.

The learning interest questionnaire used in this study was developed based on indicators of learning interest problems found in the field. This approach ensured that the instrument could effectively and efficiently measure changes in students' interest in learning. The questionnaire was created using a five point Likert scale and was based on the theories of learning interest from (Arends & Kilcher, 2010; Sari et al., 2021; Tran, 2019).

It consisted of 15 statements, both positive and negative, that measured five main indicators of learning interest: active participation, enjoyment and pleasure, satisfaction and pride, attention and memory of material, and involvement in learning activities. Experts reviewed the instrument to assess its validity and reliability, providing suggestions for improvement. After revisions were made, the questionnaire was declared valid and reliable for research use. Students' total scores were used to classify their level of learning interest.

This study used documentation analysis by referring to various supporting sources to collect data on the factors that influenced students' critical thinking skills and interest in learning. The research sample was selected using a simple random sampling technique from the list of all fourth-grade students in Trenggalek Regency. The final sample included 250 students from five elementary schools in the Trenggalek district.

Data collection was carried out through in-class sessions administered by the researcher. Before the instruments were given, participants received clear explanations regarding the study objectives and procedures for completing the instruments. After data collection, the responses were processed systematically, which included (1) encoding and organizing the data, (2) scoring the critical thinking assessments using standardized rubrics, and (3) entering the questionnaire responses into SPSS version 31 with a dual verification process to ensure accuracy. The dataset was then analysed using descriptive statistical methods to answer the research questions related to students' levels of critical thinking proficiency and their profiles of learning interest.

2.4 Data Analysis

The data collected from the critical thinking assessments and learning interest questionnaires were analysed using descriptive statistical methods. All statistical procedures were conducted using SPSS version 31, with critical thinking scores computed based on standardized scoring rubrics. From these analyses, students' critical thinking abilities were categorized into distinct proficiency levels according to the classification framework presented in Table 1 (Azwar, 2021).

Learning interest data were obtained by totalling the responses to the questionnaire. To examine the level of learning interest, descriptive statistics such as mean, median, mode, and standard deviation were calculated for both the overall score and each individual indicator. The frequency distribution and percentage of scores were also analysed to understand how students’ learning interests were distributed across the sample. The levels of students’ learning interest were classified into several categories, as shown in Table 2 (Azwar, 2021).

In addition to the descriptive analysis of primary data obtained from critical thinking tests and learning interest questionnaires, this study also included an analysis of secondary data from various supporting sources to explore factors that may influence both variables. The secondary data comprised previous research reports, scientific journal articles, academic books, education policy documents, and national education statistics. The findings from this secondary analysis were then combined with the results of the primary data analysis, specifically the levels of students' critical thinking abilities and their interest in learning. This integration of primary and secondary data offered a more comprehensive perspective on the possible influences shaping students’ cognitive and motivational development.

3. Results

3.1 Critical Thinking Skills

Data on students' critical thinking skills were assessed through six open ended questions aligned with Facione's 1990 core competencies: interpretation, analysis, evaluation, inference, explanation, and self-regulation. The instrument was administered during supervised research sessions, and total scores were calculated and classified into five proficiency levels using standardized normative criteria (Azwar, 2021). The categorization of students' critical thinking skills is presented in Table 1.

Table 1: Critical Thinking Ability Test Analysis

No	Score Range	Frequency	Frequency Percentage	Category
1	$x \leq 4.5$	52	21%	Very Low
2	$4.5 < x \leq 7.5$	97	39%	Low
3	$7.5 < x \leq 10.5$	91	36%	Medium
4	$10.5 < x \leq 13.5$	10	4%	High
5	$x > 13.5$	0	0%	Very High
Average Score			6.6	Low

As presented in Table 1, the critical thinking assessment produced a mean score of 6.6, which placed the overall performance in the "Low" category based on Azwar's (2021) classification. The distribution of scores showed that 21% of students fell into the "Very Low" category, 39% in "Low," 36% in "Medium," 4% in "High," and 0% in "Very High." This reflects a right-skewed distribution, with a majority of students (60% combined) performing below the medium level. Notably, no students reached the highest level of proficiency. Additional analysis of performance by individual critical thinking indicators is illustrated in Figure 1.

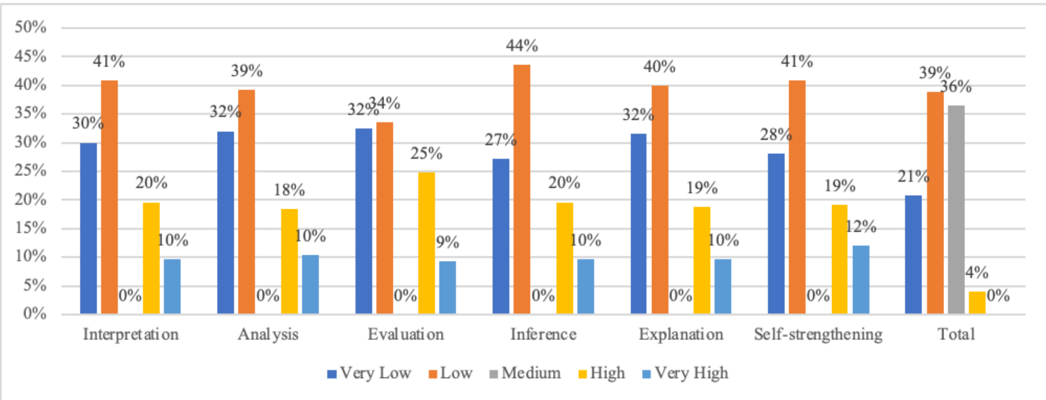

Figure 1: Critical Thinking Ability Analysis per Indicator

Figure 1 presents the frequency distribution of students' critical thinking ability levels across six indicators: interpretation, analysis, evaluation, inference, explanation, and self-strengthening. For the interpretation indicator, the percentages were Very Low (30%), Low (41%), Medium (0%), High (20%), and Very High (10%). The analysis indicator followed a similar pattern, with Very Low (32%), Low (39%), Medium (0%), High (18%), and Very High (10%). In the evaluation indicator, the distribution was Very Low (32%), Low (34%), Medium

(0%), High (25%), and Very High (9%). The inference results showed Very Low (27%), Low (44%), Medium (0%), High (20%), and Very High (10%). For explanation, the percentages were Very Low (32%), Low (40%), Medium (0%), High (19%), and Very High (10%). Lastly, self-strengthening recorded Very Low (28%), Low (41%), Medium (0%), High (19%), and Very High (12%).

Given the high proportion of students demonstrating low to very low critical thinking abilities, this study sought to explore potential causative factors. A comprehensive document analysis was conducted using relevant educational journal articles, primarily sourced from Google Scholar and Scopus, to identify various influences on students' critical thinking. This process resulted in eight relevant articles, which highlighted several key factors, including the application of innovative learning models, teacher instructional strategies, student engagement levels, learning environments, and the integration of critical thinking within curriculum content (Chen et al., 2025), learner-focused strategies (Styers et al., 2018), the SETS model (Usmeldi et al., 2017), augmented reality-based interactive multimedia (Syawaludin et al., 2019), digital learning (Hussein et al., 2019), contextual learning (Ramdani et al., 2021; Risdianto et al., 2020), and collaboration skills (Stephenson et al., 2019). A more comprehensive discussion of these influencing factors is presented in a later section

3.2 Interest in Learning

Data on students' learning interests was gathered through a questionnaire consisting of 15 statements designed during the research observation phase. The questionnaire was developed based on five key indicators of learning interest: active participation, liking and enjoyment, satisfaction and pride, tendency to pay attention and retain material, and involvement in learning activities. Students' responses were scored in total and then categorized into five levels of learning interest using statistical analysis (Azwar, 2021). The categorization of students' learning interests is presented in Table 2.

Table 2: Analysis of Learning Interest Questionnaire

No	*Score Range*	*Frequency*	*Frequency Percentage*	*Category*
1	$x \leq 26.25$	*73*	*29%*	*Very Low*
2	$26.25 < x \leq 33.75$	*96*	*38%*	*Low*
3	$33.75 < x \leq 41.25$	*80*	*32%*	*Medium*
4	$41.25 < x \leq 48.75$	*1*	*0%*	*High*
5	$x > 48.75$	*0*	*0%*	*Very High*
Average Score			*37.5*	*Medium*

Table 2 presents the distribution of students' learning interest levels based on the questionnaire results. With an average score of 37.5 (Medium category), the data shows a skewed pattern. The largest proportion of respondents (38%) fell into the Low category, followed by 32% in the medium category and 29% in the Very Low category. No students were classified in the High or Very High categories (both 0%), indicating a notable lack of strong learning engagement. Although the average score suggests a moderate level of interest, the distribution highlights that most students display limited to low enthusiasm for learning. A more detailed analysis by individual indicators is presented in Figure 2.

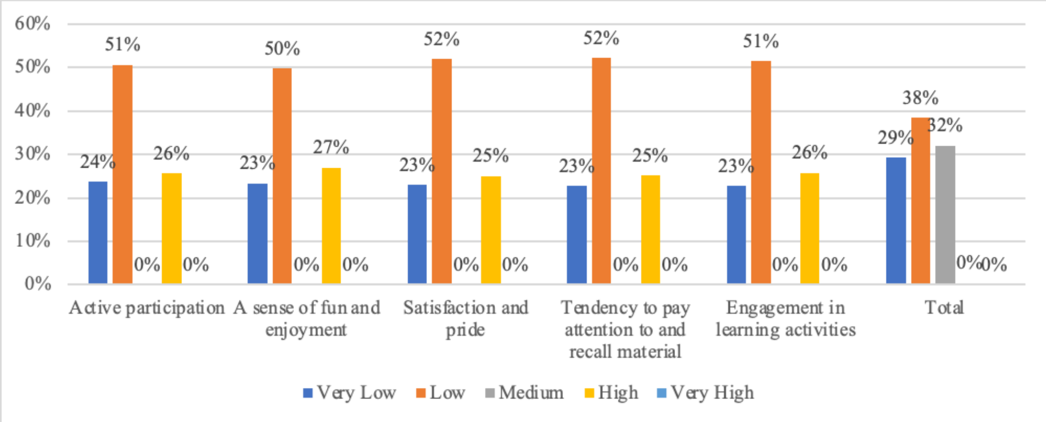

Figure 2: Analysis of Learning Interest per Indicator

Figure 2 displays the frequency distribution of students' learning interest levels across five key indicators. The data reveal a consistent pattern across all dimensions: approximately 50–52% of students fall into the Low interest category, while 23–24% show Very Low engagement. Notably, no students (0%) demonstrated Medium or Very High interest levels in any category. The High interest group accounts for 25–27% of respondents, with the highest proportion observed in the Liking and Pleasure indicator (27%).

Furthermore, knowing the majority of low student learning interest, this study was motivated to explore its underlying causes. A systematic document analysis was conducted using relevant educational journal articles sourced from Google Scholar and Scopus to identify key factors influencing student engagement. This rigorous process yielded five relevant articles, which collectively highlighted several primary determinants, including active student involvement, teacher facilitation strategies, learning environment quality, instructional model effectiveness, and student motivation dynamics (Penuel et al., 2022), technology-based learning (Hong et al., 2017), parental engagement (Halim et al., 2018), authentic learner experiences (Aivelo & Huovelin, 2020), and innovative game-based learning (Bressler et al., 2021). A more thorough discussion of these factors is provided in the subsequent section.

4. Discussion

This study analyses the level of critical thinking skills and learning interest of students, as well as the factors that influence them, based on document analysis of related journal articles. The urgency of science learning in education emphasizes the growth and development of students in emotional, cognitive, and psychomotor domains. Success in achieving the goals of science learning depends on cooperation among all education stakeholders, including students.

Elementary school students are expected to develop competence in analysing factual environmental data, which is a fundamental skill that connects science education with the enhancement of critical thinking. At the same time, intrinsic motivation, especially learning interest, is an essential factor that supports the achievement of learning objectives. The next section presents a detailed analysis of the research findings that explore these interconnected aspects.

4.1 Critical Thinking Skills

The findings of this study show that a substantial number of students have underdeveloped critical thinking skills, with only a small percentage reaching high levels of proficiency, as presented in Table 1 and Figure 1. A detailed analysis of core indicators such as interpretation, analysis, evaluation, inference, explanation, and self-regulation supports this trend, revealing consistently low performance across all dimensions. These results highlight the urgent need to examine the underlying factors that hinder the development of critical thinking in primary education. To support this investigation, the study includes a comprehensive review of the existing literature and synthesizes empirical evidence on the pedagogical, cognitive, and contextual factors that influence students' critical thinking abilities.

Critical thinking consists of essential higher order cognitive skills that are crucial for meaningful engagement in science learning. These abilities, which include analysis, evaluation, and synthesis of information, serve as the foundation for conceptual understanding, scientific reasoning, and effective problem solving (Siew & Mapeala, 2016). Despite their importance, recent evidence shows that students’ critical thinking skills remain underdeveloped in primary education. Addressing this gap requires the intentional inclusion of pedagogical innovations in instructional practices. These approaches not only improve the quality of teaching but also create learning environments that promote deeper cognitive engagement and support students in reaching essential educational goals.

An increasing number of studies highlight the effectiveness of specific interventions in enhancing critical thinking. For instance, (Chen et al., 2025) highlights the transformative potential of inquiry based learning combined with virtual laboratory experiences, which engage students in authentic scientific investigation and encourage reflective, analytical thinking. These models provide structured yet adaptable frameworks that stimulate metacognitive awareness and support the development of critical reasoning skills.

Likewise, the integration of the Science Environment Technology Society model in science education has been shown to significantly improve students’ critical thinking dispositions by connecting scientific concepts to real world contexts and interdisciplinary perspectives (Usmeldi et al., 2017). By embedding these strategies into classroom practice, teachers can cultivate a learning culture that systematically nurtures critical thinking as both a process and an outcome (Styers et al., 2018).

An increasing number of studies emphasize the transformative potential of technology enhanced learning in supporting the development of students’ critical thinking skills. Empirical evidence shows that the use of interactive augmented reality media can effectively stimulate critical engagement and promote higher order reasoning (Syawaludin et al., 2019), while digital science learning platforms significantly improve critical thinking performance among elementary students by offering dynamic, inquiry-driven experiences (Hussein et al., 2019). Furthermore, pedagogical models that integrate local cultural wisdom, such as the 5E instructional model adapted to community values, have shown promise in making science learning more meaningful and relevant. These approaches not only strengthen students’ connection to the content but also encourage deeper critical reflection by grounding abstract concepts in familiar cultural contexts (Ramdani et al., 2021) and ethnoscience-based approaches (Risdianto et al., 2020) have also been shown to enhance students’ ability to critically analyze and connect scientific concepts to real-life settings.

In parallel, peer collaboration and cooperative learning structures play a vital role in fostering dialogic reasoning, reflective judgment, and collaborative problem-solving (Stephenson et al., 2019). Synthesizing these findings, four main factors emerge as key contributors to the development of students’ critical thinking skills: (1) the use of active learning strategies that focus on students; (2) the purposeful integration of educational technologies; (3) the application of instructional materials that are culturally and contextually relevant; and (4) the structured promotion of peer interaction. When these elements are incorporated into a unified instructional approach, they help establish a learning environment that supports the growth of critical thinking in science education.

4.2 Interest in Learning

The study found a consistent decline in students' interest in learning. Most students showed low engagement, and only a small number reached high levels, as indicated in Table 2 and Figure 2. This pattern appeared across all measured indicators and reflected a widespread motivational issue rather than a few isolated cases. These findings show the importance of examining the key factors that reduce students' interest, especially in science education. To address this issue, the study reviewed relevant empirical literature and identified psychological, instructional, and contextual factors that affect student motivation. This analysis serves not only to diagnose the problem but also to support the creation of interventions based on evidence that can improve interest in learning and lead to better educational results.

Moreover, learning interest serves as a central factor in science education, with both immediate and long-term effects on students' academic progress (Penuel et al., 2022). Empirical studies report a negative correlation between learning interest and cognitive and emotional barriers, particularly cognitive anxiety and extrinsic cognitive load. Higher levels of interest are associated with lower psychological stress and reduced mental burden during the learning process. This relationship illustrates the complex connection between emotional engagement and cognitive functioning. Learning interest does not remain constant; it is shaped by internal student characteristics and by external instructional conditions.

Among these, instructional design plays a key role. Pedagogical models that combine cognitive stimulation with emotional appeal, especially in environments supported by technology, have proven effective in increasing student motivation, improving attention, and encouraging deeper engagement

(Hong et al., 2017). These approaches contribute not only to knowledge development but also to positive emotional experiences that help sustain long-term interest in science learning.

Parental involvement is also recognized as an important external factor that influences students' interest in science learning. Studies show that parents with positive views of science education are more likely to provide active support for their children's engagement with scientific content. This support contributes to a learning environment that encourages interest in science both at home and in school (Halim et al., 2018). In addition, students' exposure to authentic, hands-on scientific experiences, such as involvement in real world science projects, strengthens interest in science by providing opportunities for autonomy, agency, and active roles throughout the stages of scientific inquiry (Aivelo & Huovelin, 2020).

Moreover, the implementation of innovative, game-based learning designs has emerged as an effective strategy to stimulate long-term engagement and enjoyment in science education, particularly by merging playfulness with pedagogical rigor (Bressler et al., 2021). Overall, the evidence shows that students' interest in learning develops through a network of connected influences. These include active student participation, mental and emotional preparedness, well-designed instruction, purposeful use of technology, encouragement from parents, exposure to real world scientific experiences, and the use of creative and engaging teaching approaches.

5. Conclusion

The results of this study reveal a widespread trend of underperformance in students' critical thinking skills, with most students demonstrating low proficiency and only a small number showing advanced abilities. A detailed analysis of core indicators such as interpretation, analysis, evaluation, inference, explanation, and self-regulation supports this finding which reveals a consistent pattern of weakness across all aspects of critical reasoning. This overall deficiency can be linked to several factors, including limited use of active learning methods focused on students, insufficient incorporation of digital and instructional technologies, inadequate application of contextually relevant learning materials, and a lack of organized opportunities for peer collaboration.

The study also reveals a significant lack of student interest in learning, with most students showing low motivation and only a few maintaining consistent engagement. A detailed analysis of key indicators, such as active participation, emotional involvement, and attentiveness, confirms this pattern and indicates a general disinterest in the learning process. This disengagement is influenced by several interconnected factors, including limited student involvement, inadequate cognitive and emotional readiness, ineffective instructional design, minimal use of educational technology, low parental support, lack of real-world learning experiences, and limited application of innovative teaching methods.

Finally, this study indicates that students' critical thinking skills and interest in learning science still require substantial improvement. Therefore, the findings can serve as a basis for efforts to enhance both aspects by identifying contributing factors and exploring innovative learning approaches as potential solutions. The scope of this study was limited to fourth-grade students in primary schools in Trenggalek District, East Java. It did not account for other possible factors that may have influenced students' responses to the critical thinking test and learning interest questionnaire.

The results underscore the need for integrative and progressive educational reforms aimed at fostering cognitive and motivational development in primary education. Further research is needed to examine the specific factors that influence critical thinking skills and learning interest.

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