JOURNAL OF INNOVATION AND RESEARCH IN PRIMARY EDUCATION | ISSN 2829-775X
Vol. 4, No. 4, 2025, 1936-1946
https://doi.org/10.56916/jirpe.v4i4.1888

Enhancing Critical Thinking Skills through Contextual Teaching and Learning

Mitha Restu Saputri
Universitas PGRI Palembang, Palembang, Indonesia

Yusni Arni
Universitas PGRI Palembang, Palembang, Indonesia

Patricia H.M Lubis*
Universitas PGRI Palembang, Palembang, Indonesia

***Corresponding Author:** patricialubis@univpgri-palembang.ac.id

Keywords
contextual teaching and learning
critical thinking skills
elementary education
quasi-experimental
constructivist learning

Article History
Received 2025-06-24
Accepted 2025-09-02

Abstract
Critical thinking skills are essential for elementary students' academic success and twenty-first-century workforce preparation. However, many Indonesian elementary schools still employ teacher-centered approaches that limit students' active engagement and critical thinking development. This study aimed to determine the effect of the Contextual Teaching and Learning (CTL) model on critical thinking skills of fourth-grade students at SDN Sumber Agung. A quasi-experimental design with Nonequivalent Control Group Design was employed, involving 56 fourth-grade students selected through simple random sampling. The experimental group (n=28) received CTL instruction, while the control group (n=28) was taught using conventional teacher-centered methods. Critical thinking skills were assessed using a validated 15-item multiple-choice test based on six indicators: focus, reason, inference, situation, clarify, and overview. The instrument demonstrated good reliability (Cronbach's alpha = 0.756). Data were analyzed using Independent Sample T-Test after verifying normality and homogeneity assumptions. N-Gain analysis was conducted to determine practical effectiveness. The Independent Sample T-Test revealed significant differences between groups ($t = 3.752$, $p < 0.001$), with the experimental group achieving higher posttest scores ($M = 81.92$) compared to the control group ($M = 69.81$). N-Gain analysis showed the experimental group attained moderately effective improvement (63.11%) while the control group showed ineffective gains (32.23%). The CTL model significantly enhances students' critical thinking skills compared to conventional teaching methods. These findings validate constructivist learning theory and provide empirical evidence for implementing contextualized approaches in Indonesian elementary education to develop essential critical thinking capabilities.

INTRODUCTION

Education serves as a fundamental human endeavor designed to cultivate intelligent and character-driven young generations, encompassing comprehensive development of psychological abilities, thinking skills, and holistic personal character (Hakim, 2020). The success of learning processes depends on meaningful interactions between teachers and students, ensuring knowledge is not merely transmitted but actively applied (Dewi et al., 2024). Professional educators require specific competencies that facilitate smooth execution of their duties, shaping students' characteristics and fostering desired learning objectives (Yasin, 2022).

Natural Science (IPA) particularly demands students' critical thinking capabilities, involving systematic study of natural phenomena encompassing living and non-living entities (Siswanto & Susanto, 2022). Effective science instruction in elementary schools proves crucial for expanding students' knowledge, focusing on conceptual understanding and activities designed to optimize students' attitudes and skills through systematic discovery. Science teaching extends beyond theoretical approaches, requiring teachers to connect scientific applications to daily life through concrete evidence (Adim et al., 2020).

Critical thinking represents a multifaceted cognitive process comprising skills in both cognitive and affective domains, enabling individuals to evaluate statements logically during problem-solving (Ennis, 1989; Facione, 1990; Halpern, 2003). It encompasses the capacity to pose insightful questions, involving interpretation, analysis, and synthesized justification (Hilsdon, 2010). Critical thinking constitutes decision-making activities aimed at interpreting, predicting, analyzing, and evaluating information (Abrami et al., 2015; Ennis, 1993). It involves implementing information in new situations and analyzing phenomena (Aizikovitsh-Udi & Cheng, 2015). In strategic contexts, critical thinking applies knowledge to identify issues, evaluate actions, and implement chosen courses (Baldwin et al., 2011). Students with critical thinking abilities can systematically solve complex problems (Chukwuyenum, 2013; Peter, 2012), making it essential for academic learning and daily activities. Critical thinking can be developed through guidance at all educational levels using effective strategies (Abrami et al., 2015).

The theoretical foundation stems from constructivist learning theory, emphasizing that learners actively construct knowledge as they make sense of experiences. The constructivist orientation assumes "learners are not empty vessels waiting to be filled, but active organisms seeking meaning" (Driscoll, 2000). Learning requires mind, body, activity, and setting interaction (Wilson, 2001). Knowledge construction occurs within social contexts including culture's symbols, tools, and language (Vygotsky, 1978). Situated learning theory contends that perception, thinking, and doing occur together in reciprocal relationships with social context (Lave & Wenger, 1991). These contexts function as communities of practice connected by socially constructed webs of belief (Wenger, 1998). Learning occurs developmentally through interpersonal processes (Rogoff, 1990), with teachers as facilitators. Adult learning draws on constructivist orientation through meaning-making of experience (Merriam et al., 2006), providing "a powerful and egalitarian way of viewing knowledge production" (Hansman, 2001).

Contextual Teaching and Learning (CTL) aligns with constructivist principles by connecting academic subjects to real-world applications. CTL encourages student engagement by helping teachers connect topics to practical applications (Welerubun et al., 2022). This approach provides hands-on experience incorporating students' talents, experiences, and backgrounds (Rafsanjani et al., 2022). CTL's goal aligns with constructivism, creating conditions for effective learning (Perin, 2011). In formal settings, contextualized learning utilizes real-world materials meaningful to learners (Jacobson et al., 2003), while in technical education, it integrates academic and occupational skills (Ambrose et al., 2013). Students engage when connecting knowledge to life applications (Berns & Erickson, 2001). Contextualization promotes short-term achievement and longer-term advancement (Perin, 2011).

Recent studies demonstrate CTL's positive impact on critical thinking across educational contexts. Annisa and Fatmahanik (2023) found STEM-based CTL enhanced logical thinking in science. Dewi et al. (2023) revealed ethnoscience-based CTL improved critical thinking and learning outcomes. Hakim and Sari (2022) demonstrated CTL enhanced higher-order thinking in writing, while Lestari et al. (2021) showed mathematics CTL improved critical thinking and character. Noviastuti and Aini (2024) confirmed culture-based CTL effectiveness, and Oktaviani, Shoffa, and Kristanti (2023) demonstrated improved mathematical critical thinking. Putri and Indarini (2023) found concrete media-assisted CTL enhanced abilities and outcomes. Rahmawati et al. (2023) demonstrated significant improvements through CTL implementation. Sarwari and Kakar (2023) provided international evidence from Afghanistan. Shintia et al. (2023) confirmed positive impact in social studies, and Umairoh and Kurniasih (2021) showed GeoGebra-assisted CTL improved mathematical critical thinking.

Despite research supporting CTL effectiveness, gaps remain regarding specific impact on elementary students' critical thinking in Indonesian contexts. Current observations at SDN Sumber Agung reveal low critical thinking skills with limited active participation during lessons, stemming from Teacher-Centered Learning approaches. Only 53.84% of students achieved minimum mastery criterion

while 46.15% fell below standards, highlighting needs for effective models encouraging active participation and student-centered learning (Rahmi et al., 2023).

CTL addresses this challenge by linking learning to students' real-life contexts at school, home, and community (Melinda, 2020). This proves effective for nurturing critical thinking because students connect knowledge to everyday experiences. CTL emphasizes discovery of real-life learning rather than passive knowledge transfer (Haryani, Fakhrudin, & Lubis, 2022). Through constructivist foundations, CTL creates innovative, active classroom atmospheres. Teachers can motivate deeper engagement and meaningful learning because lessons connect to relevant real-world situations (Marimar, Fakhrudin, & Lubis, 2023).

This research significance extends beyond pedagogical improvements, addressing twenty-first-century preparation concerns. Critical thinking became essential for contemporary workers in competitive global economy (Hart Research Associates, 2016; Whorton et al., 2017). In healthcare and engineering, employees must make independent judgments about complex situations (U.S. Department of Labor, 2012). However, educators and employers express concerns about student preparedness (Association of American Colleges and Universities, 2011). Policy makers emphasize critical thinking training in education standards globally (European Higher Education Area, 2011; U.S. Department of Education, 2006). Institutions strive fostering critical thinking through improved practices (Arum & Roksa, 2011; Huber & Kuncel, 2016). Assessment tools document learning outcomes and identify improvement areas (Kuh et al., 2014).

This study aims to determine CTL model effects on critical thinking skills at SDN Sumber Agung, addressing identified gaps by providing empirical evidence in Indonesian elementary contexts while contributing to international research and offering practical insights for educators seeking to enhance students' critical thinking through innovative approaches.

METHODS

This study employed a quantitative research approach using a quasi-experimental design with a Nonequivalent Control Group Design. According to Sugiyono (2024), this design includes a control group but cannot fully control external variables that may influence the experiment. The design involved two groups for comparison, with both groups receiving pretest and posttest assessments to determine initial skill levels and assess differences between experimental and control classes.

The research population comprised all fourth-grade students at SDN Sumber Agung, located in Keluang District, Musi Banyuasin Regency, South Sumatra Province. A total sample of 56 students was selected through simple random sampling technique, which allows samples to be selected randomly without considering strata within the population (Sugiyono, 2024). The sample was divided into two groups: 28 students in the experimental group (Class IV B) who received instruction using the Contextual Teaching and Learning model, and 28 students in the control group (Class IV A) who were taught using the conventional Teacher-Centered Learning method. The research was conducted during the even semester of the 2024/2025 academic year over a one-month period.

Critical thinking skills were measured using a learning outcome test based on six specific indicators established by Setiana and Purwoko (2020): focus, reason, inference, situation, clarify, and overview. The instrument consisted of multiple-choice questions administered as both pretest and posttest assessments. Initially, 20 test items were developed, with 15 items validated through expert judgment and item analysis procedures. The validated instrument demonstrated acceptable reliability with a Cronbach's alpha coefficient of 0.756, indicating good internal consistency. Test items were further analyzed based on discrimination indices and difficulty levels to ensure appropriate psychometric properties. The discrimination analysis helped identify items that effectively differentiated between high and low-performing students, while difficulty analysis ensured items had appropriate challenge levels for the target population.

Data collection procedures involved multiple methods to ensure comprehensive assessment. The primary data collection method was testing, supplemented by observation and documentation

techniques. Pretests were administered to both groups before treatment implementation to establish baseline critical thinking abilities and verify group equivalence. The experimental group then received instruction using the CTL model, which emphasized connecting learning materials to real-world contexts and students' daily experiences. The control group received conventional instruction through teacher-centered approaches focusing on direct knowledge transmission. Following the treatment period, posttests were administered to both groups using the same validated instrument to measure changes in critical thinking skills.

Prior to hypothesis testing, prerequisite statistical analyses were conducted to verify data assumptions. Normality testing was performed using the Shapiro-Wilk test to determine whether data distributions met normal distribution requirements. The homogeneity test employed Levene's test to assess variance equality between experimental and control groups. These prerequisite tests ensured the appropriateness of parametric statistical procedures for subsequent analyses.

The main statistical analysis employed an Independent Sample T-Test to examine differences in critical thinking skills between experimental and control groups. This test was selected because it is appropriate for comparing means between two independent groups with interval data. The significance level was set at α = 0.05, with the alternative hypothesis (Ha) accepted if the significance value was less than 0.05. Additionally, N-Gain analysis was conducted to determine the extent of improvement in critical thinking skills before and after treatment implementation. The N-Gain test calculated the normalized gain scores to assess the effectiveness of the CTL intervention by comparing pretest-posttest differences while accounting for initial ability levels. Data analysis was performed using SPSS software to ensure accuracy and reliability of statistical computations. Effect size calculations were also conducted to determine the practical significance of observed differences between groups.

RESULTS AND DISCUSSION

Results

The implementation of the Contextual Teaching and Learning (CTL) model was evaluated through systematic data analysis to determine its effect on students' critical thinking skills at SDN Sumber Agung. Prior to conducting the main analysis, prerequisite statistical tests were performed to ensure the appropriateness of parametric procedures for hypothesis testing.

The first prerequisite examination involved testing the normality of data distribution using the Shapiro-Wilk test. As presented in Table 1, the normality test results demonstrate that all data sets meet the normal distribution assumption required for parametric analysis.

Table 1. Normality Test Results

Group	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest Control	0.149	26	0.145	0.927	26	0.066
Posttest Control	0.143	26	0.182	0.927	26	0.067
Pretest Experimental	0.129	26	0.200	0.947	26	0.196
Posttest Experimental	0.137	26	0.200	0.939	26	0.127

The Shapiro-Wilk test results indicate that all significance values exceed the 0.05 threshold, specifically showing significance values of 0.066 for the control group pretest, 0.067 for the control group posttest, 0.196 for the experimental group pretest, and 0.127 for the experimental group posttest. These results confirm that the data from both pretest and posttest assessments in both experimental and control groups follow normal distributions, satisfying the normality assumption for subsequent parametric testing.

Following the normality verification, a homogeneity test was conducted to examine whether the experimental and control groups possessed equal variances, ensuring the validity of between-group comparisons. Table 2 presents the results of Levene's test for homogeneity of variances.

Table 2. Homogeneity Test Results

Levene Statistic	df1	df2	Sig.
0.494	1	50	0.486

The homogeneity test yielded a significance value of 0.486, which exceeds the 0.05 criterion, indicating equal variances between the control and experimental groups. This result confirms that the data satisfy the homogeneity assumption, validating the use of Independent Sample T-Test for hypothesis testing.

With both prerequisite conditions satisfied, the main hypothesis testing was conducted using Independent Sample T-Test to examine differences in critical thinking skills between students taught using CTL and those receiving conventional instruction. The comparative analysis focused on posttest scores to determine the treatment effect.

Table 3. Independent Sample T-Test Results

Test	F	Sig.	t	df	Sig.(2-tailed)	Mean Difference	Std. Error Difference
Equal variances assumed	0.494	0.486	3.752	50	0.000	12.115	3.229
Equal variances not assumed			3.752	50	0.000	12.115	3.229

The Independent Sample T-Test results reveal a statistically significant difference between groups, with t(50) = 3.752 and a two-tailed significance value of 0.000, which is substantially below the 0.05 threshold. The mean difference of 12.115 points between experimental and control groups, with a standard error of 3.229, indicates that students in the experimental group achieved significantly higher critical thinking scores than their counterparts in the control group. These findings lead to the rejection of the null hypothesis (H_0) and acceptance of the alternative hypothesis (H_a), confirming that the CTL model significantly affects students' critical thinking skills.

To further evaluate the practical significance of the intervention, N-Gain analysis was conducted to measure the extent of improvement in critical thinking skills from pretest to posttest in both groups. This analysis provides insight into the effectiveness of the CTL treatment beyond statistical significance.

Table 4. N-Gain Effectiveness Analysis

Group	Mean Pretest	Mean Posttest	N-Gain Percent	Category
Control	55.19	69.81	32.23	Ineffective
Experimental	53.85	81.92	63.11	Moderately Effective

The N-Gain analysis demonstrates markedly different improvement patterns between the two groups. The experimental group achieved an N-Gain score of 63.11%, categorized as moderately effective, indicating substantial improvement in critical thinking abilities following CTL implementation. In contrast, the control group attained only 32.23% N-Gain, falling into the ineffective category. The experimental group's mean posttest score of 81.92 compared to the control group's 69.81 further emphasizes the superior performance of students who received CTL instruction. These results provide compelling evidence that the CTL model not only produces statistically significant differences but also generates practically meaningful improvements in students' critical thinking capabilities.

Discussion

The findings of this study provide substantial evidence supporting the effectiveness of the Contextual Teaching and Learning model in enhancing students' critical thinking skills, aligning with the theoretical foundations established in constructivist learning theory. The statistically significant results ($t = 3.752$, $p < 0.001$) demonstrate that students who received CTL instruction achieved

markedly superior critical thinking performance compared to those taught through conventional teacher-centered approaches. This outcome strongly supports the constructivist principle that "learners are not empty vessels waiting to be filled, but active organisms seeking meaning" (Driscoll, 2000), as students in the experimental group actively constructed knowledge through meaningful real-world connections facilitated by the CTL approach.

The substantial mean difference of 12.115 points between groups, coupled with the experimental group's moderately effective N-Gain score of 63.11%, underscores the practical significance of implementing contextualized learning approaches. These results align with situated learning theory's contention that perception, thinking, and doing occur together in reciprocal relationships with social context (Lave & Wenger, 1991; Wilson, 2001). The CTL model's emphasis on connecting academic content to students' real-life experiences at school, home, and in the broader community created the social contexts that Wenger (1998) described as communities of practice, where students developed critical thinking through engagement in meaningful interpersonal and community processes.

The current findings demonstrate remarkable consistency with previous research examining CTL's impact on critical thinking across diverse educational contexts. The results parallel those reported by Annisa and Fatmahanik (2023), who found that STEM-based CTL effectively enhanced students' logical thinking abilities in science learning. Similarly, the significant improvement in critical thinking skills observed in this study aligns with Dewi, Dantes, and Gunamantha's (2023) findings, which revealed that ethnoscience-based CTL models significantly improved students' critical thinking abilities and science learning outcomes. The convergence of these findings across different CTL implementations suggests the robustness of contextualized approaches in fostering higher-order thinking skills.

Furthermore, the study's results echo the international evidence provided by Sarwari and Kakar (2023), who demonstrated CTL's effectiveness in developing critical thinking skills in Afghanistan's educational context, indicating the cross-cultural validity of contextualized learning approaches. The consistent pattern of positive outcomes across Indonesian and international contexts supports Perin's (2011) assertion that contextualization creates conditions for more effective learning by acknowledging that learners bring meanings and constructs to all new learning experiences.

The moderately effective categorization of the experimental group's N-Gain score (63.11%) corresponds with findings from multiple previous studies that employed similar effectiveness measures. Putri and Indarini (2023) reported comparable improvement levels when implementing CTL models assisted by concrete media, while Rahmawati et al. (2023) demonstrated significant improvements in students' critical thinking through CTL implementation using quasi-experimental methods. The consistency of these effectiveness measures across different contexts strengthens confidence in the CTL model's capacity to produce meaningful educational outcomes.

The theoretical alignment between study results and constructivist principles becomes particularly evident when examining the learning processes that occurred during CTL implementation. The experimental group's superior performance reflects the successful application of Vygotsky's (1978) conceptualization of knowledge construction within social contexts that include cultural symbols, tools, and language. By connecting science learning to students' daily experiences and local contexts, the CTL approach facilitated the type of meaning-making that Merriam, Caffarella, and Baumgartner (2006) identified as central to effective learning processes.

The study's outcomes also validate Hansman's (2001) assertion that theories of context-based learning provide "a powerful and egalitarian way of viewing knowledge production" (p. 49). The CTL model's success in enhancing critical thinking skills demonstrates how contextualized approaches can democratize learning by making academic content accessible and meaningful to all students, regardless of their prior academic achievement levels. This democratizing effect aligns with the contemporary educational imperative to prepare students with critical thinking skills essential for twenty-first-century challenges (Hart Research Associates, 2016; Whorton et al., 2017).

The practical implications of these findings extend beyond immediate classroom applications, addressing broader concerns about preparing students for contemporary workforce demands. The significant improvement in critical thinking skills observed through CTL implementation directly responds to employers' expressed concerns about graduates' preparedness for complex problem-solving scenarios (Association of American Colleges and Universities, 2011). By successfully developing students' abilities to analyze, evaluate, and synthesize information within meaningful contexts, the CTL approach contributes to addressing the critical thinking skills gap identified by policy makers and accrediting agencies globally (European Higher Education Area, 2011; U.S. Department of Education, 2006).

However, while the results demonstrate clear effectiveness of the CTL model, certain limitations warrant consideration for future research. The study's one-month duration, though sufficient to demonstrate significant effects, may not fully capture the long-term retention and transfer of critical thinking skills developed through contextualized learning approaches. Additionally, the focus on a single elementary school context, while providing valuable insights into Indonesian educational settings, suggests the need for broader replication across diverse demographic and geographic contexts to establish greater generalizability of findings.

CONCLUSION

This study provides compelling evidence that the Contextual Teaching and Learning (CTL) model significantly enhances critical thinking skills among fourth-grade students at SDN Sumber Agung. The statistical analysis revealed substantial differences between experimental and control groups ($t = 3.752$, $p < 0.001$), with the experimental group achieving a mean posttest score of 81.92 compared to 69.81 in the control group. The N-Gain analysis further demonstrated the practical significance of CTL implementation, with the experimental group attaining a moderately effective improvement level of 63.11% versus the control group's ineffective 32.23%.

These findings contribute significantly to the educational literature by providing empirical validation of constructivist learning theory within Indonesian elementary education contexts. The study extends previous research by demonstrating CTL's effectiveness specifically for developing critical thinking skills across six key indicators: focus, reason, inference, situation, clarify, and overview. The results align with international evidence while offering culturally specific insights for Southeast Asian educational settings.

The practical implications are substantial for elementary educators and curriculum developers. The CTL model offers a viable alternative to traditional teacher-centered approaches, enabling students to develop essential twenty-first-century skills through meaningful connections between academic content and real-world experiences. Educational institutions can implement CTL strategies to address contemporary workforce preparation demands while fostering deeper student engagement and improved learning outcomes.

However, several limitations warrant consideration. The study's one-month duration may not capture long-term retention effects of critical thinking skills development. The single-site focus limits generalizability across diverse demographic and socioeconomic contexts within Indonesia's varied educational landscape. Additionally, the quasi-experimental design, while appropriate, cannot control all external variables that may influence critical thinking development.

Future research should investigate CTL's long-term effects through longitudinal studies spanning multiple academic terms. Comparative studies across urban and rural settings would enhance understanding of contextual factors influencing CTL effectiveness. Additionally, research examining CTL implementation across different subject areas and grade levels would provide comprehensive insights into the model's broader educational applications. Investigation of teacher training requirements and implementation challenges would also inform effective professional development programs for CTL adoption.

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