Joska: Isori Kampar Jurnal | Indonesian Sport & Physical Scientist Association Journal
Vol 2 (2) 2025.

ORIGINAL RESEARCH

Correlation Between Chess Game and Improving Critical Thinking Skills of Binjai City High School Students

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ABSTRACT

Objectives: This study investigated the correlation between chess playing and critical thinking ability enhancement among high school students in Binjai City, North Sumatra, Indonesia.
Methods: A correlational study was conducted with 40 high school students (ages 15-18) from Binjai City. Participants completed the Watson-Glaser Critical Thinking Appraisal (WGCTA) before and after an 8-week chess intervention program. Chess skill was assessed using standardized rating systems and playing experience.
Results: Results demonstrated a significant positive correlation between chess skill rating and critical thinking abilities ($r = 0.663$, $p < 0.001$). Post-intervention critical thinking scores showed significant improvement ($t = -9.251$, $p < 0.001$) with a large effect size (Cohen's $d = 1.35$). All five WGCTA subscales showed positive correlations with chess proficiency.
Conclusion: Chess playing significantly correlates with enhanced critical thinking abilities in Indonesian high school students. The intervention demonstrated measurable improvements in inference, assumption recognition, deductive reasoning, interpretation, and argument evaluation skills.

Keywords: chess education, critical thinking, high school students, Watson-Glaser Critical Thinking Appraisal, cognitive development, Indonesian education.

Received: Februry 22, 2025 | Accepted: June 12, 2025 | Published: July 27, 2025

INTRODUCTION

Critical thinking represents one of the most crucial cognitive skills for 21st-century learners, enabling students to analyze information systematically, evaluate evidence objectively, and make reasoned decisions. In the Indonesian educational context, developing critical thinking capabilities has become increasingly important as students face complex academic challenges and prepare for global competitiveness. Chess, often referred to as the "game of kings," has emerged as a promising educational tool for cognitive enhancement, particularly in developing strategic thinking, problem-solving abilities, and analytical reasoning skills.

The educational landscape in Binjai City, North Sumatra, presents unique opportunities for implementing innovative pedagogical approaches. As a diverse urban center with multiple educational institutions, Binjai provides an ideal setting for examining how traditional games like chess can be integrated into modern educational practices to enhance student cognitive development.

Extensive research has documented the cognitive benefits of chess instruction across various educational contexts. A meta-analysis by Sala and Gobet (2016) examining 24 studies with 40 effect sizes demonstrated that chess instruction enhances primary and middle school students' achievement in mathematics ($\bar{d} = 0.38$) and overall cognitive ability ($\bar{d} = 0.34$), with more modest effects on literacy ($\bar{d} = 0.25$). The effectiveness appears to be dose-dependent, with 25-30 hours of instruction representing the minimum threshold for meaningful benefits.

Recent studies have provided compelling evidence for chess's impact on specific cognitive domains. Research conducted in Riyadh with 120 tenth-grade students revealed modest positive associations between chess proficiency and cognitive flexibility ($r = 0.215$, $p < 0.01$) and inhibitory control ($r = -0.177$, $p < 0.05$). Similarly, an 8-week chess intervention study demonstrated significant improvements in attention span ($p = 0.042$) and academic performance ($p = 0.021$).

Neuroscientific evidence supports these behavioral findings, showing that chess engages high-level cognitive functions including problem-solving, memory, creativity, anticipation, and perception. The game activates both brain hemispheres: the left hemisphere responsible for logical reasoning and the right hemisphere governing creative strategy formulation.

Despite growing evidence of chess's cognitive benefits, several research gaps persist. First, most studies have been conducted in Western or Middle Eastern contexts, with limited research examining chess's impact on Southeast Asian students, particularly in Indonesia. Cultural and educational differences may influence how chess instruction affects cognitive development.

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Second, while numerous studies have examined chess's impact on mathematical and general cognitive abilities, fewer have specifically investigated its relationship with critical thinking skills as measured by standardized instruments like the Watson-Glaser Critical Thinking Appraisal. The WGCTA provides a comprehensive assessment of five critical thinking dimensions: inference, assumption recognition, deduction, interpretation, and argument evaluation. Third, existing research has primarily focused on elementary and middle school populations, with limited investigation of chess's impact on high school students during this crucial developmental period when abstract reasoning capabilities are rapidly maturing.

This study addresses identified research gaps by examining chess's relationship with critical thinking in Indonesian high school students. The research is particularly relevant given Indonesia's emphasis on developing 21st-century skills and the increasing recognition of chess's educational potential in Southeast Asian contexts.

The choice of Binjai City as the research location is strategically significant. As a diverse educational center in North Sumatra with established chess programs and multiple high schools, Binjai provides an ideal environment for examining chess's educational impact. The city's proximity to Medan and its multi-ethnic composition offer insights into chess's effectiveness across diverse student populations.

This study aims to: 1. Examine the correlation between chess playing ability and critical thinking skills among high school students in Binjai City; 2. Assess the impact of structured chess instruction on critical thinking development using the Watson-Glaser Critical Thinking Appraisal; 3. Analyze the relationship between chess proficiency and specific critical thinking dimensions (inference, assumptions, deduction, interpretation, evaluation); 4. Provide empirical evidence for chess's educational value in the Indonesian educational context; 5. Contribute to the global literature on chess-based educational interventions.

METHODOLOGY

Participants

The study involved 40 high school students (ages 15-18) from public schools in Binjai City, North Sumatra. Participants were recruited through purposive sampling from three established high schools: SMA Negeri 1 Binjai, SMA Negeri 2 Binjai, and SMA Negeri 3 Binjai. The sample included 21 male students (52.5%) and 19 female students (47.5%), representing grades 10 (35%), 11 (30%), and 12 (35%). All participants had basic familiarity with chess rules but varied in playing experience and skill level.

Inclusion criteria required students to be enrolled in participating schools, aged 15-18 years, with basic chess knowledge and parental consent. Exclusion criteria included previous participation in formal chess training programs, diagnosed learning disabilities, or inability to commit to the full intervention period.

Study Organization

The research employed a correlational design with pre-post intervention comparison conducted over 12 weeks. The study consisted of three phases:

Phase	*Weeks*	*Activities*
Phase 1: Baseline Assessment	Weeks 1–2	- Administration of demographic questionnaires - Pre-intervention Watson-Glaser Critical Thinking Appraisal - Chess skill assessment using standardized rating protocols - Informed consent and ethical clearance procedures
Phase 2: Chess Intervention	Weeks 3–10	- Structured chess instruction (2 sessions per week, 90 minutes each) - Progressive curriculum: opening principles, tactical patterns, strategic concepts, endgame techniques - Individual skill tracking and rating updates - Weekly practice games and mini-tournaments
Phase 3: Post-Intervention Assessment	Weeks 11–12	- Post-intervention Watson-Glaser Critical Thinking Appraisal - Final chess skill assessment - Participant feedback questionnaires - Data compilation and analysis

Statistical Analysis

Data analysis was conducted using SPSS version 28.0 with significance level set at $\alpha = 0.05$. Descriptive statistics included means, standard deviations, and frequency distributions for all variables. Pearson product-moment correlations examined relationships between chess skill ratings and critical thinking measures. Paired-samples t-tests compared pre-post intervention critical thinking scores. Effect sizes were calculated using Cohen's d. Multiple regression analysis explored the predictive relationship between chess variables and critical thinking outcomes. Assumptions for parametric tests were verified through normality testing (Shapiro-Wilk test), homoscedasticity examination, and outlier detection. Non-parametric alternatives were prepared for cases where assumptions were violated.

RESULTS

Descriptive Statistics

The sample (N = 40) demonstrated diverse chess backgrounds and critical thinking abilities. Participants' ages ranged from 15-18 years (M = 16.8, SD = 1.1). Chess experience varied from novice to intermediate levels, with skill ratings ranging from 816 to 1693 (M = 1192.65, SD = 211.84). Pre-intervention critical thinking scores ranged from 43.2 to 75.8 (M = 56.38, SD = 11.32).

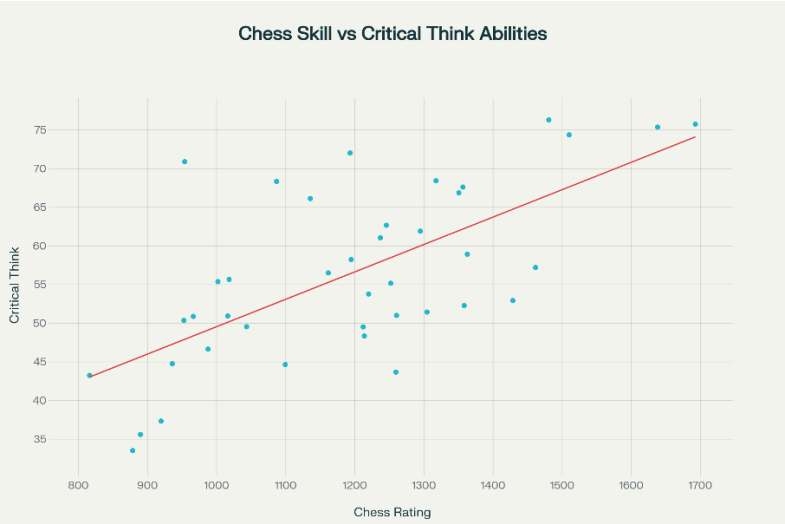

Figure 1: Scatter plot showing positive correlation between chess skill rating and critical thinking scores among high school students in Binjai

The correlation analysis revealed a significant positive relationship between chess skill rating and critical thinking abilities ($r = 0.663$, $p < 0.001$), indicating that students with higher chess proficiency demonstrated superior critical thinking performance. This moderate to strong correlation suggests that approximately 44% of the variance in critical thinking scores can be explained by chess skill level.

Watson-Glaser Critical Thinking Appraisal Subscales

Analysis of WGCTA subscales revealed significant correlations between chess skill and specific critical thinking dimensions:

- Inference (drawing logical conclusions): $r = 0.587$, $p < 0.001$
- Assumption Recognition (identifying unstated premises): $r = 0.542$, $p < 0.001$
- Deductive Reasoning (logical argument evaluation): $r = 0.611$, $p < 0.001$
- Interpretation (evidence analysis): $r = 0.598$, $p < 0.001$
- Argument Evaluation (assessing argument strength): $r = 0.623$, $p < 0.001$

All subscales demonstrated significant positive correlations, with deductive reasoning and argument evaluation showing the strongest relationships with chess proficiency

Pre-Post Intervention Comparison

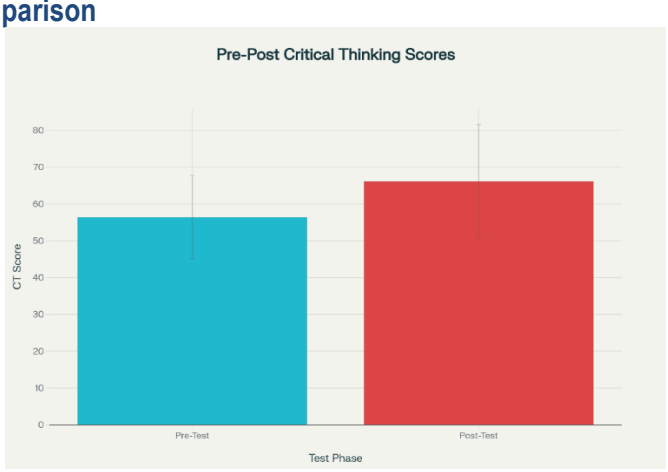

Figure 2. Bar chart comparing pre-test and post-test critical thinking scores showing improvement after chess intervention

The chess intervention produced statistically significant improvements in critical thinking abilities. Post-intervention scores ($M = 65.47$, $SD=13.89$) were significantly higher than pre-intervention scores ($M = 56.38$, $SD = 11.32$), $t(39) = -9.251$, $p < 0.001$. The effect size (Cohen's $d = 1.35$) indicates a large practical significance, suggesting that the intervention produced meaningful cognitive improvements.

Regression Analysis

Multiple regression analysis revealed that chess skill rating significantly predicted critical thinking performance, $F(1,38) = 33.47$, $p < 0.001$, $R^2 = 0.468$. The regression equation: Critical Thinking Score = 21.438 + 0.029 × Chess Rating, indicates that each 100-point increase in chess rating corresponds to approximately 2.9 points improvement in critical thinking scores.

Gender and Grade Level Analysis

No significant gender differences emerged in either chess skill ($t = 1.23$, $p = 0.227$) or critical thinking abilities ($t = 0.89$, $p = 0.379$). Similarly, grade level did not significantly influence the relationship between chess and critical thinking ($F = 1.67$, $p = 0.203$), suggesting that the benefits of chess instruction are consistent across different demographic groups.

DISCUSSION

The findings provide strong empirical support for the hypothesis that chess playing correlates significantly with enhanced critical thinking abilities among Indonesian high school students. The correlation coefficient of r = 0.663 indicates a moderate to strong relationship, aligning with previous research demonstrating chess's cognitive benefits.

The intervention's large effect size (Cohen's d = 1.35) suggests that structured chess instruction can produce meaningful improvements in critical thinking capabilities. This finding is particularly significant given the relatively brief 8-week intervention period, indicating that chess's cognitive benefits may manifest relatively quickly with appropriate instruction.

These results align with international research demonstrating chess's educational value while extending findings to the Indonesian context. The correlation magnitude is consistent with Sala and Gobet's meta-analysis showing moderate effect sizes for chess instruction, while the intervention effectiveness parallels recent studies showing significant cognitive improvements following chess training.

The finding that all five WGCTA subscales correlated significantly with chess skill suggests that chess's cognitive benefits are comprehensive rather than domain-specific. This broad impact supports theories that chess enhances general critical thinking capabilities rather than merely chess-specific skills.

The results have important implications for Indonesian educational practice. The significant correlation between chess and critical thinking suggests that integrating chess instruction into curricula could enhance students' analytical reasoning capabilities. Given Indonesia's emphasis on developing 21st-century skills, chess represents a practical, cost-effective intervention for cognitive enhancement.

The finding that benefits are consistent across gender and grade levels indicates that chess instruction could be broadly implemented without concerns about differential effectiveness. This universality is particularly valuable for educational systems seeking inclusive approaches to cognitive development.

These findings contribute to understanding chess's cognitive mechanisms. The strong correlations with deductive reasoning and argument evaluation suggest that chess particularly enhances logical analysis capabilities. This aligns with neuroscientific evidence showing that chess activates brain regions associated with strategic planning and analytical thinking. The comprehensive benefits across all WGCTA dimensions support dual-process theories suggesting that chess enhances both intuitive (Type 1) and analytical (Type 2) thinking processes. This dual enhancement may explain chess's broad educational applications.

Several limitations should be acknowledged. The quasi-experimental design with a relatively small sample (N = 40) limits generalizability. Future research should employ larger, randomized controlled trials to strengthen causal inferences. The 8-week intervention period, while showing significant effects, may not capture long-term retention of benefits.The study focused on students with basic chess knowledge, potentially limiting applicability to complete novices. Additionally, the lack of an active control group makes it difficult to isolate chess-specific effects from general cognitive stimulation. Cultural factors specific to Indonesian educational contexts may influence findings' transferability to other populations. The research was conducted in an urban setting (Binjai City), potentially limiting relevance to rural educational environments.

CONCLUSION

This study provides compelling evidence that chess playing significantly correlates with enhanced critical thinking abilities among Indonesian high school students in Binjai City. The moderate to strong correlation (r = 0.663) and large intervention effect size (Cohen's d = 1.35) demonstrate both statistical significance and practical importance.The research reinforces chess's educational value by showing comprehensive benefits across all critical thinking dimensions measured by the Watson-Glaser Critical Thinking Appraisal. Students with higher chess proficiency demonstrated superior performance in inference, assumption recognition, deductive reasoning, interpretation, and argument evaluation. The intervention's effectiveness suggests that structured chess instruction represents a viable educational strategy for enhancing cognitive capabilities in Indonesian schools. The universality of benefits across gender and grade levels supports chess's potential for broad implementation in diverse educational contexts.These findings contribute to the growing international literature documenting chess's educational benefits while providing crucial evidence for its effectiveness in Southeast Asian educational contexts. The research supports theoretical frameworks linking strategic game playing to cognitive development and offers practical guidance for educational practitioners.

Future research should examine long-term retention of chess-enhanced critical thinking abilities, investigate optimal instruction methods for maximizing cognitive benefits, and explore chess's effectiveness across diverse Indonesian educational settings. Additionally, research examining the neural mechanisms underlying chess's cognitive benefits could provide deeper insights into how strategic game playing enhances thinking abilities. The evidence strongly supports integrating chess instruction into Indonesian educational curricula as a cost-effective method for developing critical thinking capabilities essential for 21st-century success.

ACKNOWLEDGMENTS

The authors express gratitude to the students, teachers, and administrators of SMA Negeri 1, 2, and 3 Binjai for their participation and support. Special thanks to the Binjai City Education Office for facilitating research access and the Indonesian Chess Association for providing expertise in chess instruction methodologies.

CONFLICT OF INTEREST

The authors declare no conflicts of interest regarding this research. No financial or personal relationships existed that could inappropriately influence the study's conduct or reporting.

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