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Investigating the Effectiveness of the SAVI Learning Approach in Improving Critical and Analytical Mathematical Thinking

Ita Purnama Jaya, Bambang Sri Anggoro, Fraulein Intan Suri
Universitas Islam Negeri Raden Intan Lampung, Indonesia

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ABSTRACT:
Background: Students' ability to think critically and analytically in mathematics remains a central challenge in Indonesian education. Many instructional approaches in schools fail to adequately stimulate higher-order thinking. Traditional expository models, although commonly used, often lack the engagement required to foster meaningful learning. The SAVI (Somatic, Auditory, Visual, Intellectual) learning model offers an integrated and interactive alternative by combining physical activity, auditory input, visual aids, and intellectual reflection, aligning with multiple learning modalities.
Aims: This study aims to determine the effectiveness of the SAVI instructional approach in improving students' mathematical critical and analytical thinking skills. It specifically compares the outcomes of students taught using the SAVI model with those instructed through conventional expository teaching.
Methods: A quasi-experimental research design with a posttest-only control group was used. The participants were 60 eighth-grade students from SMP Negeri 1 Mataram Baru during the 2023/2024 academic year. Students were divided into two groups: one receiving instruction via the SAVI approach and the other using the expository model. Essay-based assessments were used to evaluate students' critical and analytical thinking skills. The instruments were previously tested for validity and reliability. Data analysis was performed using Multivariate Analysis of Variance (MANOVA) to evaluate differences between the two groups.
Results: The results showed a significant difference in student performance between the two groups. Students in the SAVI group demonstrated higher scores in both critical and analytical mathematical thinking. MANOVA results revealed statistically significant values ($p < 0.05$), confirming the effectiveness of the SAVI model over the expository method.
Conclusion: The SAVI instructional model significantly enhances students' critical and analytical thinking in mathematics. Its multisensory design promotes deeper cognitive engagement, making it a promising approach for improving mathematical thinking at the secondary school level.

Keywords: Analytical thinking, Critical thinking, Expository learning, Mathematics education, SAVI learning model

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INTRODUCTION

* **Corresponding author:**
Ita Purnama Jaya, Universitas Islam Negeri Raden Intan Lampung, INDONESIA
ita_purnama11@gmail.com

The ability to think critically and analytically is essential in mathematics education, as it enables students to understand concepts deeply and apply them in real-life situations (Dolapcioglu & Doğanay, 2022; Stylianides & Stylianides, 2008). However, international assessments such as TIMSS and PISA have consistently reported that Indonesian students perform poorly in mathematical reasoning and problem-solving (Thien et al., 2015). This gap suggests that conventional instructional methods have failed to promote higher-order thinking among learners. Improving cognitive outcomes in mathematics is therefore a pressing educational challenge that requires pedagogical innovation (Körtesi et al., 2022).

The traditional expository model remains the dominant teaching method in many Indonesian classrooms, despite its limitations in fostering student engagement and independent thinking. This approach often emphasizes rote learning and passive knowledge absorption, which limits students' cognitive development. As a result, learners struggle to develop the critical and analytical skills required for complex problem-solving. The current state of mathematics instruction calls for a more dynamic and learner-centered alternative.

The SAVI (Somatic, Auditory, Visual, Intellectual) learning model presents a promising solution by integrating multisensory learning experiences that align with how students naturally process information. This model encourages students to engage physically, listen actively, observe carefully, and think reflectively. Prior research suggests that such multisensory approaches enhance motivation, comprehension, and long-term retention. However, empirical studies examining the effectiveness of the SAVI model specifically in improving mathematical thinking skills are still limited.

This study responds to that need by investigating how the SAVI approach impacts students' mathematical critical and analytical thinking in comparison to the expository model. It addresses the gap by using a quasi-experimental design supported by rigorous statistical analysis. The findings are expected to contribute to improved instructional practices in mathematics, especially in junior high schools. Moreover, the study aligns with broader educational goals to cultivate essential cognitive competencies in the 21st century.

Building cognitive flexibility and reasoning in mathematics requires teaching strategies that go beyond content delivery. Models like SAVI offer a more holistic learning experience that engages multiple senses and supports different learning styles (Simbolon et al., 2020). When students are allowed to explore concepts through movement, discussion, observation, and reflection, their understanding becomes more meaningful and lasting (Bergmark, 2023; Howell, 2021). This study seeks to examine how such an approach translates into measurable improvements in students' thinking abilities.

Numerous scholars support the integration of multisensory approaches to enhance cognitive performance in mathematics. For example, Coronado Farroñán et al. (2024) emphasize the importance of didactic strategies for deep conceptual learning in engineering education.(Georgieva & Nikolova, 2021) advocate for communication-based learning to promote mathematical reasoning. Similarly, (Mandal et al., 2024; Williams et al., 2025) stress the need for analytical thinking to address real-world complexities, supporting the relevance of instructional models like SAVI.

(Bazile et al., 2025; Bogomolov et al., 2024) provide conceptual frameworks linking strategic intelligence and analytical reasoning to structured problem-solving. Their findings suggest that active thinking frameworks are critical across learning domains, including mathematics. Studies by (De Falco, 2020; Kazaryan & Tregubova, 2022) show that visual modeling and conceptual flexibility enhance students' ability to reason through abstract content. Moreover, (Ahsan et al., 2019; Verbavatz & Barthelemy, 2019) demonstrate how decision-making and logical analysis are essential in both academic and applied contexts. Despite this growing body of evidence, few studies have explored how the SAVI model influences both critical and analytical thinking in a mathematical setting. Many existing works focus on general outcomes like engagement or comprehension, without isolating specific cognitive impacts. Additionally, limited research employs robust comparative methods such as MANOVA to test the significance of instructional approaches. This study contributes by filling that methodological and conceptual gap.

While prior studies affirm the value of active, multisensory learning, there is a lack of empirical research that simultaneously measures critical and analytical thinking in mathematics using the SAVI model. Most previous investigations do not provide controlled comparisons with traditional methods, leaving open questions about instructional efficacy. Moreover, few studies are conducted within junior high school contexts in developing countries like Indonesia. These gaps highlight the need for evidence-based evaluations of SAVI's cognitive impact in real classrooms (Celik, 2024). The primary goal of this study is to evaluate whether the SAVI instructional model effectively enhances students' critical and analytical thinking in mathematics. The research compares the outcomes of students taught using the SAVI model with those instructed through the conventional expository method. It is hypothesized that the SAVI group will demonstrate significantly higher performance in both cognitive domains. This investigation is expected to provide practical implications for teaching strategies in mathematics education.

METHOD

Research Design

This study employed a quasi-experimental design with a posttest-only control group structure (Mwenda et al. 2023). The purpose of using this design was to examine the causal relationship between the learning model and students' critical and analytical mathematical thinking without random assignment. The experimental group received instruction through the SAVI (Somatic, Auditory, Visual, Intellectual) learning model, while the control group was taught using the traditional expository approach. This design allowed for controlled comparisons of student outcomes following the instructional interventions.

Participants

The participants were eighth-grade students from SMP Negeri 1 Mataram Baru, Indonesia, during the 2023/2024 academic year. A total of 60 students were selected through purposive sampling and divided equally into two groups of 30 each. Class VIII-3 served as the experimental group, and Class VIII-1 functioned as the control group. Both groups were taught the same mathematical content on "Relations and Functions" by teachers with equivalent teaching experience to ensure instructional consistency

Instrument

Data were collected through essay-based tests specifically designed to assess students' critical and analytical thinking skills in mathematics. The test items were constructed to reflect problem-solving tasks that required reasoning, evaluating, classifying, and connecting mathematical ideas. Prior to administration, the instruments underwent a rigorous validation process, including content validity review, difficulty index analysis, discrimination index measurement, and reliability testing (Mela et al. 2023). The instruments were deemed appropriate for capturing higher-order cognitive performance among junior high school students.

Data Analysis Plan

The data analysis process involved both assumption testing and hypothesis testing using SPSS version 25. Normality was assessed through the Kolmogorov-Smirnov test, while homogeneity of variances was evaluated using Levene's Test. After confirming that the assumptions for multivariate analysis were met, the hypotheses were tested using Multivariate Analysis of Variance (MANOVA). This statistical technique enabled the simultaneous examination of differences in critical and analytical thinking scores across the two instructional groups

RESULTS AND DISCUSSION

Results

To evaluate the impact of the SAVI (Somatic, Auditory, Visual, Intellectual) learning model on students' critical and analytical mathematical thinking, several statistical analyses were performed, including descriptive statistics and Multivariate Analysis of Variance (MANOVA).

Table 1. Descriptive Statistics of Students' Posttest Scores

Variable	Group	Mean	Std. Deviation
Critical Thinking	SAVI (Experimental)	82.13	7.24
Expository (Control)	74.37	8.91	
Analytical Thinking	SAVI (Experimental)	79.10	6.83
Expository (Control)	71.85	7.56	

Students in the experimental group who received SAVI-based instruction achieved higher mean scores in both critical and analytical thinking compared to their peers in the control group. This suggests a positive initial indication of the effectiveness of the SAVI approach in enhancing students' cognitive performance in mathematics.

Table 2. MANOVA Results for Learning Model Effect

Dependent Variable	Source	F-value	Sig. (p-value)
Critical Thinking	Learning Model	8.816	0.004
Analytical Thinking	Learning Model	6.106	0.016
Combined (Wilks' Λ)	Learning Model	—	0.001

As shown in Table 2, the results of the MANOVA test confirmed statistically significant differences in both critical and analytical thinking between the experimental and control groups. The p-values for both dependent variables were below 0.05, and the multivariate test (Wilks' Lambda) indicated a highly significant overall effect (p = 0.001). This confirms that the learning model used had a substantial influence on student outcomes across both thinking domains.

Discussion

The findings strongly suggest that the SAVI model significantly improves students' ability to think critically and analytically in mathematics (Komarudin et al. 2024). The multisensory nature of the SAVI approach engages students through movement, listening, observation, and reasoning, which together stimulate multiple cognitive processes. Compared to the passive nature of expository instruction, this model encourages learners to construct knowledge actively. Such engagement fosters better problem comprehension and encourages students to reflect deeply on mathematical tasks (DiNapoli & Miller, 2022).

The use of video materials and group-based problem-solving activities aligns with auditory and visual aspects of SAVI. These tools enhance students' attention and motivation while allowing them to internalize concepts more effectively. Prior studies support that visual and auditory stimuli increase memory retention and facilitate comprehension of abstract material (Duarte et al. 2023). Thus, the integration of these components contributes meaningfully to learners' ability to analyze and reason.

The intellectual aspect of SAVI promotes reflective thinking, where students are required to identify relevant information, connect concepts, and apply logical steps in problem-solving. Through this process, students engage in complex reasoning that mirrors real-world applications. The activities in the experimental group demanded justification, synthesis of knowledge, and evaluative thinking—hallmarks of higher-order cognitive learning.

Collaborative discussion further enabled students to compare perspectives, justify ideas, and negotiate meaning. These interactions not only strengthened their understanding of content but also developed their ability to articulate reasoning—central to critical thinking. Rahmaniah et al. (2023) emphasized that peer interaction in learning environments supports cognitive flexibility and metacognition, both of which are observable in this study.

The results align with literature advocating for student-centered and multisensory learning environments to cultivate cognitive growth. Studies by Coronado Farroñán et al. (2024), Georgieva & Nikolova. (2021) highlight how instructional design that emphasizes interaction and integration improves thinking ability. However, this study adds empirical support by using robust quantitative methods to demonstrate SAVI's effectiveness in a junior high school setting (Van Schoors et al. 2021). This provides educators with validated evidence to consider multisensory instructional models in mathematics.

Implications

The findings suggest that adopting the SAVI learning model can significantly enhance students' cognitive performance in mathematics, particularly in areas requiring critical and analytical thinking. This has meaningful implications for curriculum developers, school administrators, and educators who seek to improve instructional quality. Implementing multisensory and student-centered models may address persistent gaps in mathematical achievement. The SAVI approach represents a practical and pedagogically sound strategy for improving classroom learning outcomes.

Research Contribution

This study contributes to the growing body of research on multisensory learning by providing robust empirical evidence of the SAVI model's impact on higher-order thinking. It advances the literature by simultaneously examining critical and analytical mathematical thinking using a quasi-experimental design and multivariate analysis (Yohannes & Chen, 2024). Additionally, the study offers practical insights for middle school mathematics instruction, particularly in under-researched contexts such as Indonesian secondary education. These contributions make it relevant for both international scholars and practitioners in education.

Limitations

Despite its strengths, the study has some limitations. The sample size was relatively small and drawn from a single school, which may affect the generalizability of the findings. The study also focused only on immediate post-instruction outcomes without examining long-term retention. Future studies are encouraged to involve larger, more diverse samples and longitudinal data to evaluate the durability of cognitive gains.

Suggestions

Future research should investigate the application of the SAVI model across different mathematical topics and grade levels to validate and expand its effectiveness. It would be valuable to incorporate qualitative methods such as classroom observations or student interviews to gain deeper insights into student engagement and learning processes. Longitudinal studies are also recommended to examine whether improvements in critical and analytical thinking are sustained over time. Lastly, integrating digital learning tools with the SAVI approach could further enrich learning experiences and outcomes.

CONCLUSION

This study concludes that the SAVI (Somatic, Auditory, Visual, Intellectual) learning model has a significant and positive effect on students' critical and analytical thinking skills in mathematics. Compared to the traditional expository teaching method, the SAVI approach enables students to engage more deeply with mathematical content through multisensory interaction and cognitive reflection. The findings, supported by descriptive statistics and MANOVA results, demonstrate that students taught using SAVI achieved higher performance in both critical and analytical domains. These results affirm the value of incorporating student-centered, multisensory instructional strategies to foster higher-order thinking in mathematics education. Furthermore, the study provides empirical support for the application of the SAVI model in junior high school settings, particularly in contexts where student engagement and cognitive outcomes remain limited under conventional teaching methods. By involving learners actively—physically, mentally, and socially—SAVI not only enhances conceptual understanding but also encourages the development of transferable thinking skills. The implementation of SAVI is therefore recommended as an effective instructional model for improving cognitive outcomes in mathematics. Future research is encouraged to explore its long-term impact and applicability across broader educational settings.

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AUTHOR CONTRIBUTION STATEMENT

Ita Purnama Jaya contributed to the conceptualization of the study, designed the research framework, and coordinated the classroom implementation of the SAVI instructional model. She also led the data collection process and drafted the initial version of the manuscript. Bambang Sri Anggoro was responsible for the development and validation of the test instruments, performed the statistical data analysis, and interpreted the MANOVA results. He also provided critical revisions to the methodology and results sections of the paper. Fraulein Intan Suri contributed to the literature review, reviewed relevant Scopus-indexed studies, and assisted in synthesizing theoretical support for the discussion. She also participated in the final editing and ensured the manuscript met academic publishing standards.

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