Exploring How Analytical Thinking Skills Influence Algebra 1 Performance Among Grade 8 Learners

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Abstract: This study examined the relationship between analytical thinking skills and Algebra 1 performance among Grade 8 students. Using a correlational research design, 135 students from a public middle school participated. Analytical thinking was measured through a validated assessment, and academic performance was determined from students' Algebra 1 grades. Results indicated that students generally demonstrated basic analytical thinking skills and that stronger analytical thinking was associated with higher Algebra 1 performance. These findings underscore the importance of developing problem-solving, logical reasoning, and pattern recognition skills in mathematics instruction. The study recommends implementing strategies such as problem-based learning, scaffolded reasoning exercises, and collaborative problem-solving tasks to enhance analytical thinking and improve mathematical achievement.

Keywords: Analytical thinking, Algebra 1, Grade 8 students, Mathematics achievement, Problem-solving

INTRODUCTION

Algebra 1 serves as a pivotal component in middle school mathematics curricula, laying the groundwork for higher-level mathematical concepts and critical thinking skills (National Council of Teachers of Mathematics [NCTM], 2014; Van de Walle et al., 2019). Grade 8 students, in particular, are at a developmental stage where abstract reasoning and problem-solving abilities are crucial for mastering algebraic concepts (Battista, 2007). Analytical thinking—characterized by logical reasoning, pattern recognition, and systematic problem-solving—is hypothesized to significantly influence students' performance in Algebra 1 (Facione, 2015; Schoenfeld, 2016). This study aims to explore how analytical thinking skills impact Algebra 1 achievement among Grade 8 learners, providing insights into potential instructional strategies that could enhance mathematical proficiency.

Existing literature underscores the importance of analytical thinking in academic performance, particularly in mathematics. Wang et al. (2025) conducted a systematic literature review highlighting that students who engage in analytical thinking tend to perform better in mathematics, possibly due to the higher emphasis on analytical mathematical thinking in the evaluation process. Similarly, Theabthueng et al. (2022) found that integrating problem-based learning with collaborative techniques like Think-Pair-Share significantly enhanced Grade 8 students' analytical thinking and learning achievement in science, suggesting potential applicability to mathematics education. Furthermore, Yurt (2022) emphasized that analytical thinking skills are essential in mathematics teaching, as they enable students to understand mathematical problems, plan steps, and verify answers effectively. Additionally, Farhi et al. (2024) examined cognitive control among primary and middle school students, finding associations between cognitive control mechanisms and math achievements, indicating that analytical thinking may play a role in mathematical success. Moreover, Hariri (2025) conducted a systematic review on learning styles and mathematics achievement, identifying critical analysis and logical reasoning as key components influencing students' mathematical performance. Collectively, these studies suggest a positive correlation between analytical thinking skills and academic performance in mathematics.

Despite the recognized importance of analytical thinking, there is a paucity of research specifically examining its impact on Algebra 1 performance among Grade 8 students. Most studies focus on general mathematical reasoning or problem-solving skills without isolating analytical thinking as a distinct factor. Additionally, existing research often overlooks the role of instructional strategies in developing analytical thinking within the context of Algebra 1.

This study aims to fill the identified gap by exploring how analytical thinking skills influence Algebra 1 performance among Grade 8 students. Through a combination of assessments measuring analytical thinking and academic achievement, the research will provide insights into the specific contributions of analytical thinking to students' success in Algebra 1. The findings are expected to inform

instructional practices and curriculum design, emphasizing the development of analytical thinking skills to enhance mathematical achievement.

RESEARCH OBJECTIVE

The objective of this study is to investigate the relationship between analytical thinking skills and Algebra 1 performance among Grade 8 students in a selected public Junior High school during the School Year 2024-2025.
Specifically, the study aims to:

1. Assess the level of analytical thinking skills among Grade 8 learners.
2. Determine the academic performance of Grade 8 students in Algebra 1.
3. Examine the correlation between analytical thinking skills and Algebra 1 achievement.

METHODS

Design. This study employed a correlational research design to examine the relationship between analytical thinking skills and Algebra 1 performance among Grade 8 students. Conceptually, a correlational research design is defined as a non-experimental approach that investigates the degree and direction of the relationship between two or more naturally occurring variables without manipulating them (Creswell, 2014; Gravetter & Wallnau, 2017). This design allows researchers to determine whether higher levels of one variable (analytical thinking skills) are associated with higher or lower levels of another variable (Algebra 1 performance) while maintaining the natural educational context of the participants.

Environment. The study was conducted in a public middle school in the United States where Algebra 1 is taught as part of the Grade 8 mathematics curriculum. The school follows the state's standard mathematics curriculum aligned with the Texas Essential Knowledge and Skills (TEKS) for Algebra 1, ensuring uniformity in the instruction received by students.

Participants. The study involved 135 Grade 8 students enrolled in Algebra 1 classes at the selected school, including both male and female students aged 13–14 years. Participants were included if they were actively enrolled in Algebra 1 and had completed at least one semester of instruction, ensuring adequate exposure to the curriculum. Students with learning disabilities or those requiring individualized instruction were excluded to maintain comparability in analytical thinking assessment outcomes and Algebra 1 performance, resulting in a homogeneous sample suitable for examining the relationship between the two variables.

Sampling Design. This study employed universal sampling, a type of non-probability sampling in which all members of the defined population who meet the inclusion criteria are selected as participants (Etikan, Musa, & Alkassim, 2016). In this study, all 135 Grade 8 students enrolled in Algebra 1 who had completed at least one semester of instruction were included. Universal sampling was chosen to ensure that the entire accessible population contributed to the analysis, maximizing the comprehensiveness of the data and allowing for a more accurate examination of the relationship between analytical thinking skills and Algebra 1 performance. Students who did not meet the inclusion criteria, such as those requiring individualized instruction due to learning disabilities, were excluded.

Instruments. Two primary instruments were employed in this study to measure the variables of interest. The first was an Analytical Thinking Skills Assessment, a validated multiple-choice and problem-solving test designed to evaluate logical reasoning, pattern recognition, and systematic problem-solving abilities among middle school students, adapted from Facione (2015) and Wang et al. (2025). Conceptually, analytical thinking is defined as the cognitive process of systematically analyzing information, identifying patterns, and drawing reasoned conclusions (Facione, 2015). The second instrument was the Algebra 1 Academic Performance measure, which consisted of students' most recent Algebra 1 grades obtained from school records. Academic performance in this context is understood as the demonstrated mastery of algebraic concepts and problem-solving skills as reflected in formal assessments (Wang et al., 2025).

Data Collection Procedure. Data collection in this study involved two main procedures designed to ensure accuracy, consistency, and ethical compliance over a period of two weeks. First, the Analytical Thinking Skills Assessment was administered during regular class hours under standardized conditions, with uniform instructions and a fixed time limit of 60 minutes for all participants. Second, students' Algebra 1 academic performance data were obtained from official school records with permission from administrators. All collected data were coded to maintain participant anonymity and confidentiality, ensuring that individual identities were protected while providing reliable measures of academic achievement.

Data Analysis. Data analysis in this study utilized both descriptive and inferential statistical techniques to examine the relationship between analytical thinking skills and Algebra 1 performance. Descriptive statistics, including the mean and standard deviation, were calculated to summarize participants' analytical thinking scores and academic achievement. To determine the strength and direction of the relationship between the two variables, the Pearson correlation coefficient was employed. Conceptually, data analysis is defined as the systematic application of statistical or logical techniques to organize, summarize, and interpret data (Gravetter & Wallnau, 2017). All analyses were performed using Microsoft Excel, and statistical significance was set at $p < 0.05$, ensuring rigor and objectivity in examining the hypothesized relationship.

Ethical Considerations. Ethical considerations were strictly observed throughout this study to ensure the protection of participants' rights. Approval was obtained from the school administrator prior to data collection. Informed consent was secured from parents or guardians, and student assent was obtained to confirm voluntary participation. Participants were informed of their right to withdraw from the study at any time without penalty. All data were treated with strict confidentiality, and identifiers were coded to protect individual privacy.

RESULTS AND DISCUSSION

This section presents the findings of the study on the relationship between analytical thinking skills and Algebra 1 performance among Grade 8 students.

Table 1. Descriptive Statistics and Pearson Correlation of Analytical Thinking Scores and Algebra 1 Grades (n = 135)

Variables	Mean	SD	r	p-value	Interpretation
Analytical Thinking Skills	69.13	9.40	0.35*	< 0.05	Significant
Algebra 1 Performance	65.15	10.86			

Note. 0–49 – Poor, 50-59 – Needs Improvement, 60-69 – Satisfactory, 70-79 – Good, 80-89 – Very Good, 90-100 – Excellent.

The descriptive analysis revealed that the analytical thinking scores of the participants ranged from 43.80 to 94.63, with a mean of 69.13 and a standard deviation of 9.40. According to the parametric scoring rubric for analytical thinking, a mean score of 69.13 falls within the "Satisfactory" range (60–69). This suggests that, on average, Grade 8 students demonstrate basic analytical thinking skills, able to solve simple problems but having trouble with multi-step or abstract tasks. The Algebra 1 grades ranged from 40.00 to 94.97, with a mean of 65.15 and a standard deviation of 10.86, indicating moderate variability in academic performance.

The Pearson correlation coefficient between analytical thinking skills and Algebra 1 performance was $r = 0.35$, $p < 0.05$, indicating a moderate positive relationship. Students with stronger analytical thinking skills tended to achieve higher grades in Algebra 1, highlighting the importance of logical reasoning, pattern recognition, and systematic problem-solving in mathematical success. The results of this study support the growing body of research highlighting the critical role of analytical thinking in mathematics achievement. Analytical thinking enables students to approach problems systematically, identify patterns, and apply logical reasoning, which are essential for understanding algebraic concepts (Facione, 2015; Wang et al., 2025). Middle school students who develop these cognitive skills are better equipped to solve complex problems, retain mathematical concepts, and transfer knowledge to new contexts (Battista, 2007; Öz, 2024).

The moderate positive correlation between analytical thinking skills and Algebra 1 performance suggests that while analytical thinking contributes significantly to mathematics achievement, it is not the sole determinant of success. Other variables, such as prior knowledge, study habits, motivation, and instructional quality, likely interact to influence academic outcomes (Hariri, 2025; Syaiful, Rahman, & Hidayat, 2021). This aligns with research by Clements and Sarama (2011), who emphasized that conceptual understanding in mathematics requires both cognitive skills and effective instructional support.

Instructional strategies that explicitly foster analytical thinking have been shown to improve learning outcomes in mathematics. Theabthueng, Thongthammachat, and Tansakul (2022) found that integrating problem-based learning with collaborative techniques such as Think-Pair-Share enhanced Grade 8 students' analytical thinking and achievement. Similarly, Yurt (2022) reported that teaching methods that promote critical reasoning, pattern recognition, and stepwise problem-solving help students develop higher-order thinking skills, which directly impact performance in algebra and other mathematics domains.

Given that the mean analytical thinking score of the participants fell within the "Satisfactory" range, there is a clear need for targeted interventions to strengthen these skills. Teachers can employ scaffolded reasoning exercises, collaborative problem-solving tasks, and real-world applications to challenge students' thinking and improve both analytical skills and subject-specific knowledge. By focusing on cognitive development alongside curriculum content, educators can enhance students' readiness for higher-level mathematics and support overall academic achievement (Farhi, Marzouk, & Alghamdi, 2024; Wang et al., 2025).

CONCLUSION

The study concludes that students with stronger analytical thinking skills perform better in Algebra 1. Students currently demonstrate only basic analytical thinking, indicating a need to strengthen higher-order thinking abilities. Teachers should incorporate instructional strategies that actively develop analytical thinking—such as problem-based learning, scaffolded reasoning tasks, and collaborative problem-solving activities—into their lessons. Doing so will improve students' understanding and performance in Algebra 1 and equip them with critical thinking skills essential for success in future academic and real-world challenges.

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