OPEN ACCESS

Manuscript ID:
EDU-2026-140311124

Volume: 14

Issue: 3

Month: June

Year: 2026

P-ISSN: 2320-2653

E-ISSN: 2582-1334

Received: 06.04.2026

Accepted: 29.05.2026

Published Online: 01.06.2026

Citation:
Manikandan, R., & Benjamin, A.E.W (2026). A Study on Problem-Solving Ability as a Predictor of Academic Achievement in Mathematics amoung Higher Secondary Students. *Shanlax International Journal of Education, 14*(3), 126–134.

DOI:
https://doi.org/10.34293/education.v14i3.11124

A Study on Problem-Solving Ability as a Predictor of Academic Achievement in Mathematics among Higher Secondary Students

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Abstract
The present study is based on the problem-solving ability as predictor of mathematics achievement of the higher secondary students. Problem-solving ability is regarded as one of the most important variables that affect students' success in mathematics education in the modern era, in which emphasis is laid on higher-order thinking skills. This study used descriptive survey design and employed stratified random sampling technique to achieve a sample of 285 higher secondary students. A standardized problem-solving ability test and mathematics scores from academic records were used to collect data. The findings from the study show moderate problem-solving skill and mathematics achievement level of students. A strong positive and statistically significant relationship was found between problem-solving ability and academic achievement. Further analysis with regression revealed problem solving ability to be a significant predictor, explaining a significant amount of variance in students' mathematics performance. The results show that students who have higher analytical reasoning, logical thinking and strategic problem solving abilities have better academic results. The study highlights the need for problem-solving approach in teaching and learning in Mathematics. It highlights the importance of changing the way mathematics is taught and taught with a focus on the students, encouraging them to think and apply mathematical concepts to real-life situations. The implications of the findings for teachers, curriculum developers and policy makers in improving mathematics performance at the higher secondary level are important. Problem-solving ability can be further studied as a predictor for students' mathematical development in future research within the following methodological approaches: longitudinal method and mixed method, this to find out more holistic picture of problem-solving ability in the mathematics learning process in various educational levels, subjects and geographical areas.

Keywords: Problem-solving Ability, Mathematics Education, Higher Secondary Students, Predictive Analysis, Higher Order Thinking Skills, Mathematics Achievement

Introduction

Mathematics is universally recognized as a fundamental discipline that contributes significantly to the development of logical reasoning, analytical thinking, and decision-making abilities among learners. Today, the focus of education has slowly been shifting from how to do the procedures and memorizing facts to developing higher order thinking skills, especially problem solving skills. This change has been prompted by the growing need for learners to be able to use mathematical knowledge in real-life situations and complex problem contexts.

Problem-solving ability in mathematics is the ability of learners to comprehend a situation, make sense of information that has been provided, develop strategies to solve a problem, carry out strategies, and assess results. It is a multi-faceted term that includes cognitive aspects like reasoning,

critical thinking and metacognition. Schoenfeld (2020) argues that problem-solving requires conceptual understanding as well as strategic skills, and reflective thinking. In this context, the students who actively participate in problem solving will be able to understand mathematical concepts and get good grades in mathematics.

The mathematics curriculum at the higher secondary level is more abstract and conceptually complex, where students need to draw on previous experience to combine with abstract thinking. This is a place where a lot of students may have trouble as a result of poor problem solving skills which is negatively influencing their overall performance. Studies reveal that students with sound problem-solving ability have better understanding, retention and application of mathematical concepts (OECD, 2023). This underscores the importance of problem-solving skills to mathematics achievement.

In addition, problem-solving is closely related to cognitive theories of learning, including constructivism, which focuses on active construction of knowledge by engaging in meaningful activities. In problem solving, the learners become self-regulated, are persistent and flexible, which will lead to better learning outcomes (Hattie, 2021). Moreover, executive functions like working memory, cognitive flexibility and planning have been identified as significantly impacting students' mathematical problem-solving abilities.

The success in mathematics is frequently regarded as an important measure of students' intellectual progress and potential career paths. But, content knowledge is not the only thing that impacts achievement, it is also affected by the ability to apply that content to a problem solving situation. Hence, the importance of studying problem-solving ability in the context of its predictive function to enhance the education practice and student outcomes.

In the current educational scenario, where competency-based learning is gaining prominence, the development of problem-solving ability has become a key objective of mathematics education. This emphasis is consistent with the Principles and Standards for School Mathematics, which identify problem-solving as a fundamental process standard in mathematics learning. National and international educational frameworks advocate for instructional strategies that promote inquiry, exploration, and application rather than passive learning. Despite these efforts, a gap still exists between students' conceptual understanding and their ability to solve problems effectively (Lester, 2007).

Against this background, the present study aims to examine problem-solving ability as a predictor of academic achievement in mathematics among higher secondary students. By exploring this relationship, the study seeks to provide empirical evidence that can inform teaching practices, curriculum development, and assessment strategies in mathematics education.

Need and Significance of the Study

Mathematics continues to be a core subject in the higher secondary curriculum, yet a substantial proportion of students experience difficulty in achieving satisfactory performance. One of the primary reasons identified in recent educational research is the limited development of problem-solving ability among learners. While students may acquire procedural knowledge, many struggle to apply concepts in unfamiliar or complex situations. This gap between knowledge acquisition and application underscores the need to examine problem-solving ability as a crucial factor influencing academic achievement in mathematics.

In the context of rapidly evolving educational demands, learners are expected to possess competencies that go beyond memorization, including critical thinking, analytical reasoning, and adaptability. Problem-solving ability integrates these competencies and serves as a key indicator of meaningful learning. According to OECD (2023), students who are proficient in problem-solving are better equipped to transfer their knowledge across domains and perform effectively in academic assessments. Therefore, strengthening problem-solving ability is essential not only for improving mathematics achievement but also for preparing students for real-world challenges.

At the higher secondary level, mathematics becomes increasingly abstract, requiring students to engage in complex reasoning and multi-step problem-solving processes. However, traditional teaching practices often emphasize routine exercises

and algorithmic procedures, which do not adequately foster higher-order thinking skills. Research by Hattie (2021) highlights that instructional strategies focusing on active learning and cognitive engagement have a significantly higher impact on student achievement compared to passive learning approaches. This indicates a pressing need to reorient teaching methods toward problem-solving-centered pedagogy.

Another important aspect that justifies the need for the present study is the growing emphasis on competency-based education frameworks, such as those promoted by national education policies and international assessment programs. These frameworks prioritize the development of problem-solving skills as a core learning outcome. However, there remains a lack of empirical studies, particularly at the higher secondary level, that examine the predictive relationship between problem-solving ability and academic achievement in mathematics within specific educational contexts.

The significance of this study lies in its potential contributions at multiple levels:

- Pedagogical Significance: The findings can guide teachers in adopting instructional strategies that enhance students' problem-solving abilities, there by improving learning outcomes in mathematics.
- Curricular Significance: The study can inform curriculum developers to integrate problem-solving tasks, real-life applications, and inquiry-based activities into mathematics syllabi.
- Assessment Significance: Insights from the study can help in designing assessment tools that evaluate not only factual knowledge but also analytical and problem-solving skills.
- Theoretical Significance: The study contributes to the existing body of knowledge by reinforcing the role of cognitive skills, particularly problem-solving, in academic achievement.
- Practical Significance: Educational institutions and policymakers can utilize the findings to design interventions aimed at improving mathematics performance among higher secondary students.

Moreover, in the Indian educational context, where board examinations play a crucial role in shaping students' academic trajectories, enhancing problem-solving ability can significantly influence performance outcomes. Students who develop strong problem-solving skills are more likely to approach examinations with confidence and competence.

Review of Related Literature

Poor teaching pedagogies and inadequate procedural approaches impact students' mathematics achievement, limiting their ability to build proficiency with basic mathematics skills. Taking curriculum revision into consideration to emphasize real-life problem solving can improve students' skills in mathematics (Bahtiti et al., 2025).

The reading ability in math is closely related to the value-added academic achievement in math. The results demonstrate a positive relationship between students' mathematics reading ability and their academic performance, suggesting that reading ability plays a crucial role in mathematics problem-solving and student achievement (Zhu & Wu, 2023).

The use of assessment strategies like performance, dynamic and authentic assessments, along with active learning approaches like problem-based learning, has been proven to enhance students' mathematical problem-solving skills, at different educational levels (Ukobizaba et al., 2021).

The quality and effectiveness of teachers' teaching has been reported to have a significant influence on students' academic performance in secondary schools, and this is a result of the use of highly motivated, problem-solving skilled teachers. The teacher's motivation and problem solving ability has a positive influence on the fertile learning environment needed for student achievement (Deepak Nandan & Sulaipher, 2025).

Students who have high mathematical ability and are good at identifying and analyzing problems, especially spatial problems (shape and space) are able to solve problems well, which means they have good academic performance (Putra & Novita, 2015).

Collaborative problem-solving learning environments have been shown to positively affect mathematical achievement for children in primary and secondary school; collaborative problem solving is one of the interventions identified to be effective in boosting mathematics achievement for primary and secondary students (Alegre et al., 2020).

Academic achievement in secondary students is significantly related to the emotional regulation skills. The ability to regulate emotions enhances problem-solving skills, resilience, and a focus on tasks, thereby positively impacting academic performance in mathematics (Khan & Jameel, 2024).

Higher education students' perceived stress is associated with their academic achievement through the mediating effects of mindfulness and problem-solving skills. Mindfulness-based problem solving skills can help alleviate stress and boost academic achievement, showing that there is a psychological aspect to academic success (Dikmen, 2022).

The use of systematic problem-solving strategies like the five-step structured problem-solving strategy in physics education enhances secondary school students' problem-solving skills and academic performance, highlighting the effectiveness of explicit problem-solving instruction (Musengimana et al., 2025).

Junior secondary students' achievement in mathematics can be predicted by interest and motivation. The findings showed that students' motivation and interest in learning are factors that influence their academic performance, as students with high motivation and interest levels tend to perform better in problem solving learning in mathematics (Asanre et al., 2024).

Research Gap

Recent reviews also indicate growing scholarly interest in mathematical problem-solving research across diverse educational contexts. Many existing studies primarily examine correlation rather than predictive relationships. Furthermore, there is limited research that integrates problem-solving ability as a key predictor variable in the context of mathematics achievement among higher secondary students.

Objectives of the Study

- To assess the level of problem-solving ability among higher secondary students.
- To analyze the level of academic achievement in mathematics among higher secondary students.
- To examine the relationship between problem-solving ability and academic achievement in mathematics.
- To determine the predictive value of problem-solving ability on academic achievement in mathematics.
- To identify the extent to which problem-solving ability influences academic achievement in mathematics.

Hypotheses of the Study

The following null hypotheses were formulated to guide the investigation:

- There is no significant relationship between problem-solving ability and academic achievement in mathematics among higher secondary students.
- Problem-solving ability does not significantly predict academic achievement in mathematics among higher secondary students.
- There is no significant influence of problem-solving ability on academic achievement in mathematics among higher secondary students.

Methodology

Research Design

The present study employed a descriptive survey method with a correlational research design. This design was considered appropriate as it enables the researcher to systematically examine the relationship between problem-solving ability and academic achievement in mathematics among higher secondary students. Furthermore, the correlational approach facilitates the identification of the predictive influence of problem-solving ability on academic performance without manipulating any variables. The design ensures that the study reflects real classroom conditions and provides meaningful insights into naturally occurring relationships among variables.

Variables of the Study

The study involves two primary variables. Problem-solving ability is treated as the independent variable, as it is assumed to influence students' academic outcomes. Academic achievement in mathematics is considered the dependent variable, as it represents the outcome that may be affected by variations in problem-solving ability. The clear identification of variables helps in conducting precise statistical analysis and interpretation.

Population of the Study

The population of the study comprises higher secondary students enrolled in recognized schools. These students are at a critical stage of education where mathematical concepts become more abstract and require advanced reasoning skills. The population includes students from diverse educational backgrounds, there by ensuring variability and representativeness in the study.

Sample and Sampling Technique

A sample of 285 higher secondary students was selected for the study using the stratified randoms sampling technique. This method was adopted to ensure that different subgroups within the population, such as gender, type of school, and locality, were adequately represented. The selection of 285 students provided a sufficiently large and balanced sample to enhance the reliability and generalizability of the findings. Care was taken to ensure that the sample reflected the characteristics of the population as closely as possible.

Tools Used for Data Collection

Data for the study were collected using two main instruments. The first instrument was a standardized problem-solving ability test designed to measure students' capacity to understand, analyze, and solve mathematical problems. The test included items that assessed logical reasoning, analytical thinking, and application of mathematical concepts. The second instrument was a mathematics achievement test, which measured students' academic performance. This was based on either standardized test scores or official academic records obtained from schools. Both tools were selected to ensure that they accurately captured the variables under investigation.

Validity and Reliability of Tools

Content validity of the Problem-Solving Ability Test was established through expert review by three specialists in mathematics education, yielding a Content Validity Index (CVI) of 0.92. Reliability was determined using Cronbach's alpha and the split-half method. The Problem-Solving Ability Test obtained a Cronbach's alpha coefficient of 0.88, indicating high internal consistency. The Mathematics Achievement scores demonstrated a split-half reliability coefficient of 0.84, corrected using the Spearman–Brown prophecy formula. These indices confirm that the instruments were reliable and appropriate for the present investigation.

Data Collection Procedure

The data collection process was carried out systematically with prior permission from the school authorities. The problem-solving ability test was administered to the selected students in a controlled classroom environment to ensure uniform testing conditions. Clear instructions were provided to the students to avoid any ambiguity during the test Academic achievement data were collected from official school records to maintain accuracy and authenticity. The entire process was conducted with careful supervision to ensure the reliability of the collected data.

Statistical Techniques Used

The collected data were analyzed using appropriate statistical techniques to address the objectives of the study. Measures such as mean and standard deviation were used to determine the levels of problem-solving ability and academic achievement. Pearson's correlation coefficient was employed to examine the relationship between the two variables. In addition, regression analysis was conducted to determine the predictive role of problem-solving ability on academic achievement in mathematics. These statistical methods provided a comprehensive understanding of both the relationship and the influence of the variables.

Assumptions of Statistical Procedures

The statistical analyses employed in the present study were based on several assumptions. Pearson's correlation analysis assumes linearity, normal distribution of variables, independence of observations, and homoscedasticity. Similarly, simple linear regression assumes a linear relationship between the predictor and outcome variables, normal distribution of residuals, absence of significant outliers, independence of errors, and homogeneity of variance. Preliminary data screening indicated that these assumptions were reasonably satisfied, thereby

supporting the appropriateness of the statistical procedures used in the study. However, minor violations may influence the interpretation of the findings and should be considered when generalizing the results.

Ethical Considerations

Ethical standards were strictly maintained throughout the study. Participation of students was entirely voluntary, and informed consent was obtained from the concerned authorities. The confidentiality of the participants' data was ensured, and no personal information was disclosed. The study was conducted with fairness, transparency, and respect for the participants, ensuring that no harm or bias affected the research process.

Data Analysis and Interpretation

The collected data were analyzed using appropriate statistical techniques to examine the levels of problem-solving ability and academic achievement in mathematics, as well as to determine the relationship and predictive influence between the variables. The results are presented with tables followed by detailed interpretations.

Level of Problem-Solving Ability

Table 1 Mean and Standard Deviation of Problem -Solving Ability Scores (N = 285)

Variable	Mean	Standard Deviation
Problem-Solving Ability	68.42	10.35

The mean score of problem-solving ability among higher secondary students is 68.42, with a standard deviation of 10.35. This indicates that the overall level of problem-solving ability is moderate. The moderate standard deviation suggests that there is a reasonable spread of scores around the mean, reflecting variability in students' problem-solving skills. This finding implies that while some students possess strong problem-solving abilities, a considerable number of students still require improvement in analytical and reasoning skills.

Level of Academic Achievement in Mathematics

Table 2 Mean and Standard Deviation of Academic Achievement Scores (N = 285)

Variable	Mean	Standard Deviation
Academic Achievement (Mathematics)	72.18	9.27

The mean academic achievement score in mathematics is 72.18, with a standard deviation of 9.27. This suggests that students, on average, demonstrate a satisfactory level of performance in mathematics. However, the presence of variation in scores indicates differences in students' understanding and application of mathematical concepts. The findings highlight the need for instructional strategies that cater to diverse learning needs and enhance overall achievement levels.

Relationship between Problem-Solving Ability and Academic Achievement

Table 3 Correlation between Problem-Solving Ability and Academic Achievement (N = 285)

Variable	Mean	Standard Deviation
Problem-Solving Ability & Academic Achievement	0.71	Significant at 0.01 level

The correlation coefficient (r = 0.71) indicates a strong positive relationship between problem-solving ability and academic achievement in mathematics. The relationship is statistically significant at the 0.01 level, which means that the probability of this result occurring by chance is very low. This finding suggests that students with higher problem-solving ability tend to achieve better academic performance in mathematics. The result supports the assumption that problem-solving ability plays a crucial role in enhancing students' understanding and application of mathematical concepts.

Table 4 Predictive Role of Problem-Solving Ability on Academic Achievement

Statistic	Value
Pearson's r	0.71
Coefficient of Determination (r^2)	0.50
95% Confidence Interval	[0.65, 0.76]
Effect Size Interpretation	Large

The correlation coefficient (r = .71) indicates a strong positive relationship between problem-solving ability and academic achievement. The coefficient of determination (r^2 = .50) suggests that approximately 50% of the variance in academic achievement is associated with problem-solving ability. The 95% confidence interval [0.65, 0.76] confirms the stability and precision of the estimated relationship.

Table 4 Regression Analysis of Problem-Solving Ability on Academic Achievement (N = 285)

Predictor Variable	R	R^2	Beta (β)	t-value	Significance	95% CI	Effect Size
Problem-Solving Ability	0.71	0.50	0.68	16.25	Significant at 0.01 level	[0.60, 0.76]	Large

Regression analysis revealed that problem-solving ability significantly predicted academic achievement in mathematics, β = .68, t(283) = 16.25, p < .001. The model explained 50% of the variance in academic achievement (R^2 = .50), indicating a substantial predictive influence. The 95% confidence interval [0.60, 0.76] further confirms the robustness of the estimated effect. According to Cohen's criteria, the observed relationship represents a large effect size. This implies that improvements in students' problem-solving skills are likely to result in significant gains in their mathematics achievement.

Discussion

The findings of the present study clearly establish that problem-solving ability has a strong and significant relationship with academic achievement in mathematics among higher secondary students. The observed positive correlation indicates that students who demonstrate higher levels of analytical thinking, reasoning, and strategic problem-solving tend to perform better academically. This result is consistent with recent empirical studies which empha size that problem-solving ability enhances conceptual understanding and facilitates the application of mathematical knowledge in diverse contexts. Furthermore, the regression analysis confirms that problem-solving ability is a significant predictor of academic achievement, suggesting that it plays a direct and influential role in determining students' performance outcomes. This aligns with contemporary cognitive perspectives, which highlight that higher-order thinking skills, including problem-solving, are essential for meaningful learning and academic success.

The moderate levels of both problem-solving ability and academic achievement observed in the study indicate that there is considerable scope for improvement through effective instructional interventions. Traditional teaching approaches that emphasize rote learning may not sufficiently develop students' problem-solving skills, thereby limiting their academic potential. In contrast, student-centered pedagogical approaches such as inquiry-based learning, problem-based learning, and collaborative learning have been shown to significantly enhance both problem-solving ability and academic performance (Hattie, 2021; Engelbrecht & Borba, 2024). The findings of the study underscore the need for educators to integrate problem-solving-oriented strategies into mathematics instruction, thereby promoting deeper understanding, critical thinking, and improved academic outcomes. Overall, the study reinforces the view that strengthening problem-solving ability is essential for enhancing students' achievement in mathematics and preparing them for complex real-world challenges.

Educational Implications

Mathematics instruction should prioritize problem-based and inquiry-oriented teaching strategies, enabling students to actively engage in analyzing, reasoning, and solving real-world mathematical problems rather than relying on rote memorization.

Curriculum planners should integrate structured problem-solving tasks and application-based learning activities that promote higher-order thinking skills and bridge the gap between theoretical knowledge and practical application.

Assessment practices need to be redesigned to include analytical, reasoning, and problem-solving components, ensuring that evaluation reflects students' conceptual understanding and cognitive abilities rather than mere procedural proficiency.

Teachers should be provided with professional development and training programs focused on innovative pedagogical approaches, such as collaborative learning and metacognitive strategy instruction, to effectively enhance students' problem-solving abilities.

Educational institutions should foster a supportive learning environment that encourages critical thinking, exploration, and independent learning, thereby strengthening students' confidence and competence in mathematics and improving overall academic achievement.

Limitations of the Study

The present study has certain limitations that should be acknowledged. First, the study was confined to a sample of 285 higher secondary students from a specific educational context, which may limit the generalizability of the findings. Second, the study employed a cross-sectional correlational design and therefore does not establish causal relationships between problem-solving ability and academic achievement. Third, academic achievement was measured using existing school records, which may be influenced by factors beyond problem-solving ability. Fourth, the study focused exclusively on mathematics achievement and did not consider other academic disciplines. Finally, variables such as motivation, self-efficacy, socio-economic status, and classroom environment were not included in the analysis, although they may also influence academic performance.

Suggestions for Future Research

Future studies may investigate the relationship between problem-solving ability and academic achievement among students at primary, secondary, undergraduate, and postgraduate levels. Comparative studies across different geographical regions, including rural and urban contexts, may provide deeper insights into contextual influences on problem-solving development. Longitudinal research designs may be employed to examine how problem-solving ability evolves over time and contributes to academic growth. Researchers may also explore the influence of mediating variables such as motivation, metacognitive awareness, mathematical anxiety, self-regulated learning, and digital literacy. Furthermore, experimental studies evaluating the effectiveness of problem-solving-based instructional interventions may contribute to the development of evidence-based educational practices.

Conclusion

The present study investigated problem-solving ability as a predictor of academic achievement in mathematics among higher secondary students. The findings clearly demonstrate that problem-solving ability has a strong and significant influence on students' academic performance. A positive and statistically significant relationship was observed between problem-solving ability and academic achievement, indicating that students who possess higher levels of analytical reasoning and strategic thinking tend to achieve better results in mathematics. Furthermore, the regression analysis confirmed that problem-solving ability is a significant predictor, explaining a substantial portion of the variance in academic achievement.

The study highlights that while students exhibit a moderate level of both problem-solving ability and academic achievement, there is considerable scope for improvement through targeted instructional interventions. The results emphasize the importance of shifting from traditional, procedure-oriented teaching methods to more student-centered approaches that foster critical thinking and problem-solving skills. By integrating problem-solving-focused pedagogy, curriculum design, and assessment practices, educators can enhance students' conceptual understanding and academic performance in mathematics. Ultimately, strengthening problem-solving ability not only improves academic outcomes but also equips students with essential cognitive skills required for lifelong learning and real-world problem-solving, which are fundamental components of mathematical proficiency (Kilpatrick et al., 2001). Although the findings demonstrate the significant predictive role of problem-solving ability in mathematics achievement, the results should be interpreted within the limitations of the study. Future investigations involving diverse educational levels, broader geographical contexts, and additional cognitive and motivational variables may further

strengthen understanding of the mechanisms through which problem-solving ability contributes to academic success.

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