



## Predictive role of metacognitive skills in the problem-solving ability of secondary school students

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### Abstract

This study aims to analyse the role of metacognitive skills in the problem-solving ability of secondary school students. Descriptive survey method was used to conduct the study and was administered on 200 secondary school students. The instruments used were Metacognitive Skills Scale by Madhu Gupta and Suman; and Problem-Solving Ability Test by Dubey and Mathur. After the collection of data, suitable statistical techniques were used to analyse the data. The research findings indicated that gender did not have a significant impact on the metacognitive skills of secondary school students. However, the findings also showed that problem-solving ability increases with higher levels of metacognitive skills. Students with high levels of metacognitive skills performed considerably better on problem-solving tasks compared to those with low or medium levels. These findings indicate that metacognitive skills are a significant predictor of problem-solving ability in secondary school students.

**Keywords:** Metacognitive Skills, Problem-solving Ability, Predictor

### Introduction

Problem-solving is a crucial part of a person as it reflects his intellectual behaviour. Studies conducted on metacognition shows that there is an intense connection between problem solving and metacognition. According to many psychologists such as Sternberg (1985), the learner needs metacognition skills, in addition to cognitive components, to regulate and monitor the problem-solving process.

### Metacognitive Skills

Metacognition pertains to advanced cognitive processes that require actively managing and overseeing the mental activities involved in the learning process. The term Metacognition was introduced by John Flavell in the early 1970s based on the term 'metamemory' which was previously formulated by the same author (John Flavell 1971). Flavell (1979) viewed metacognition as a learners' knowledge of their own cognition, defining it as 'knowledge and cognition about cognitive phenomena'. Metacognition may be defined as 'thinking about one's own thinking' or 'Cognitions about cognitions. According to him metacognition consist both metacognitive knowledge and metacognitive experiences or regulation. He further divides metacognitive knowledge into three parts: Knowledge of person variables, task variables and strategy variables. The term "metacognition" has been used to describe a wide range of epistemic processes.

Metacognitive skills encompass task orientation, planning, monitoring, evaluation and recapitulation. According to Veneman & Cleef (2019) <sup>[11]</sup>, metacognitive skills are manifested as a set of internalized self-instructions that guide pupils on what actions to take as well as when, why, and how to complete tasks. Metacognitive skills govern

cognitive processes, encompassing activities such as planning, monitoring, evaluation, and prediction (Desoete, 2009b; Veneman, Van Hout-Wolters, & Afflerbach, 2006) <sup>[12]</sup>.

### Problem-Solving Ability

Problem-solving ability refers to the capacity to effectively navigate and overcome challenges, puzzles, or issues encountered in various situations. It is a critical skill that involves analysing a problem, identifying potential solutions, and selecting the most appropriate course of action to reach a resolution. Effective problem solvers often exhibit qualities such as critical thinking, creativity, analytical reasoning, and the ability to make informed decisions. Problem-solving ability is a fundamental skill that plays a pivotal role in personal and professional success. Problem-solving involves a systematic approach to understanding, analysing, and resolving issues, drawing upon critical thinking, creativity, and decision-making skills. Cultivating this ability not only enhances one's effectiveness in addressing complex situations but also fosters adaptability and resilience in the face of ever-changing circumstances.

Problem-solving skills enable individuals to make informed decisions and ensure effective solutions by addressing the issues (Jordan and Troth, 2021) <sup>[4]</sup>. Moreover, it includes identifying, analysing and resolving the problems. So, critical thinking, adaptability, creativity, analysis skills, communication skills, etc., are the supporting factors of effective problem-solving.

Problem-solving skills have a multitude of real-life applications and are critical for students to face academic challenges and life beyond the classroom. Effective

problem-solving skills equip students to approach situations logically and make effective decisions. While considering academics, students use problem-solving skills to excel academically, strategically completing their assignments and analysing literature. Moreover, also helps in exams and the successful completion of projects by defining the research problem, analysing data, and drawing meaningful conclusions (Lamb *et al.* 2017) [6]

At the same time, Voica *et al.* (2020) [13] state that students or individuals with effective problem-solving skills can also ensure personal development by making constant decisions about their educations and extracurricular activities. Effective problem-solving supports them in weighing options and consequences and making informed decisions. In addition to that, it also helps the students for developing their interpersonal relationships. By conflict resolution and effective communication. Problem-solving skills assist an individual in understanding various perspectives and solving disagreements, whether it is with friends, family, or peers.

**Metacognitive skills in problem-solving**

Several researchers who have tackled this topic have emphasized relationships between metacognition and problem solving. Metacognitive cognitive abilities equate to problem-solving steps, and students use these abilities to identify variables in a problem and determine which strategies to use (Ramadhan *et al.*, 2019; Sevgi & Karakaya, 2020) [9]. Fauziana & Fazila, 2022 [3] concluded that there is a significant effect of metacognition on the ability to solve science problems. The implications of the results of this study are expected to be used as evaluation material and input for teachers in choosing and using appropriate learning strategies so as to improve problem-solving skills in science learning at the elementary school level. Safari & Meskini (2015) [8] concluded that metacognitive instruction has positive effects on students’ problem-solving skills and is required to enhance academic achievement, metacognitive strategies are recommended to be taught to the students.

Krishnakumar & Balasubramanian (2024) [5] found that the gender and type of school management emerged as significant factors influencing both metacognition and problem-solving skills. The findings suggest that enhancing metacognitive strategies could improve students' problem-solving abilities. Tasnim & Kumar (2023) also found that there was significant difference between the metacognition of male and female students, further locality had a significant influence on student’s metacognition. It was found that metacognition and problem-solving ability were significantly correlated.

**Research Questions**

1. Are there differences in the metacognitive skills of secondary school students on the basis of gender?
2. How do metacognitive skills predict and influence the problem-solving ability of secondary school students?

**Operational Terms**

**Metacognitive Skills:** Metacognitive skills are conceptualized as an interrelated set of competencies for learning and thinking and include many of the skills required for active learning, critical thinking, reflective

judgment, problem solving and decision making. The various dimensions of metacognitive skills in the current study are: Planning skill, Implementation skill, Monitoring skill and Evaluation skill.

**Problem solving ability:** It is the act of defining a problem; determining the cause of the problem; identifying, prioritizing, and selecting alternatives for a solution; and implementing a solution.

**Methodology**

This study employed a descriptive-survey research approach to comprehensively investigate the metacognitive skills of secondary school students and their predictive role in problem-solving ability. The study included a total of 200 students from two secondary schools located in Varanasi, U.P., India. This study employed a stratified random sampling to pick the necessary number of participants the students were directed to complete the Metacognitive skills and Problem-Solving Ability Tests.

**Instruments**

The researcher employed the following standardised tools: Metacognitive Skills Scale by Madhu Gupta and Suman (2017). The coefficient of correlation through the test-retest method was 0.763. The scale demonstrates a very high level of reliability according to the Split-Half method (0.949), indicating strong internal consistency. The validation process for the MCS scale involved experts' opinions to assess face validity and content validity, and the obtained correlation coefficients among different dimensions indicate that the scale has high construct validity, meaning it effectively measures the intended construct of Meta-Cognitive Skills. Problem Solving Ability Test by Dubey and Mathur was used. The Reliability of the Problem-solving Test was calculated by split-half (odd-even) method was 0.78 and by Kuder-Richardson Formula (Rational Equivalence Method) was 0.76. Its validity was tested by way of correlation its scores on a parallel form or test, and it was tested against two tests, *viz.*, R. K. Tandon's Group Intelligence Test, and Test of Reasoning Ability and was found to be 0.68 and 0.85 respectively.

**Result and Discussion**

The collected data from students was analysed through independent t-tests, ANOVA and Post hoc Tukey HSD.

**Test of Normality**

Before the Application of Independent Sample t-test and ANOVA, Test of Normality (NT) was made for checking the nature of collected data. Shapiro-Wilk test was performed to test the normality.

**Table 1:** The result of the Shapiro-Wilk test

Metacognitive Skills	Shapiro-Wilk		
	Statistics	df	Sig.
	0.986	200	0.054

3In table 1. the Shapiro-Wilk test ( $p>0.05$ ) did not show a significant departure from normality,  $SW(200) = 0.99, p = 0.054$ . It means that the scores for metacognitive skills were

approximately normally distributed. Furthermore, the *Sk* of -0.3367 and a *Ku* of 0.5887 for Metacognitive Skills shows normal distribution of the data. As the data are normally distributed, therefore, an independent t-test was applied.

1. Are there differences in the metacognitive skills of secondary school students on the basis of gender? To answer this question, mean, standard deviation and t value were calculated and result is shown in table 2.

**Table 2:** Mean, SD and t-value of Metacognitive Skills – Boys and Girls

Dimensions	Boys (N=100)		Girls (N=100)		t	df	P
	Mean	SD	Mean	SD			
Planning Skill	43.9	4.64	42.79	5.58	1.598	198	0.11
Implementation Skill	36.32	2.46	35.65	2.59	1.586	198	0.12
Monitoring Skill	39.48	5.06	38.4	4.18	1.645	198	0.1
Evaluation Skill	35.49	3.64	35.1	3.33	0.814	198	0.41
Overall Metacognitive Skills	159.3	13.23	156.13	12.2	1.775	198	0.08

\*Significant at 0.05 level

According to table 2, boys and girls overall t-value for metacognition skills is 0.1.775, which is lower than the table value of 1.96 at the 0.05 level of significance. The t-values for the various metacognitive skill dimensions are 1.598 for planning, 1.586 for implementation, 1.645 for monitoring, and 0.814 for evaluation. So, there is no significant distinction in metacognitive skills of boys and girls secondary school students which is consistent with the findings of and (David and Qasim, 2024) [2] which also showed that there is no significant differences based on gender in the four dimensions of metacognitive skills; however, these results oppose the findings of (Tasmin & Kumar, 2023; Krishnakumar & Balasubramanian, 2024) [5, 10] which showed that some differences exist based on gender. They showed that female students have a higher level of metacognitive skills compared to male students.

2. How do metacognitive skills predict and influence the problem-solving ability of secondary school students? To answer this question, the scores of Metacognitive skills derived from secondary school students were divided into three groups on the basis of percentile. Students having low metacognitive skills ( $\leq 33$ rd percentile), medium metacognitive skills (34th–66th percentile) high

metacognitive skills ( $\geq 67$ th percentile). The problem-solving ability scores of these groups were compared using a one-way analysis of variance (ANOVA).

**Table 3:** Summary of Data

Groups	Count	Sum	Mean	Variance
Low Metacognitive skills	72	347	4.82	7.70
Medium Metacognitive skills	69	338	4.90	6.18
High Metacognitive skills	59	450	7.63	22.27

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	319.14	2	159.57	13.92	2.22E-06	3.04
Within Groups	2258.74	197	11.47			
Total	2577.88	199				

The results in table 3. showed a statistically significant difference among the three groups,  $F(2, 197) = 13.917, p < .00001$ , indicating that students’ problem-solving ability differed across the three metacognitive skill levels. To identify the specific group differences, Tukey’s Honestly Significant Difference (HSD) post-hoc test was applied. The Tukey's HSD (honestly significant difference) procedure facilitates pairwise comparisons within ANOVA data.

**Table 4:** Post Hoc Tukey HSD

Pairwise Comparisons		HSD <sub>.05</sub> = 1.3901 HSD <sub>.01</sub> = 1.7351	Q <sub>.05</sub> = 3.3398 Q <sub>.01</sub> = 4.1685
Low: Medium	M <sub>1</sub> = 4.82 M <sub>2</sub> = 4.90	0.08	Q = 0.19 ( $p = .99007$ )
Low: High	M <sub>1</sub> = 4.82 M <sub>3</sub> = 7.63	2.81	Q = 6.75 ( $p = .00001$ )
Medium: High	M <sub>2</sub> = 4.90 M <sub>3</sub> = 7.63	2.73	Q = 6.56 ( $p = .00002$ )

The results in table 4. shows that students with high metacognitive skills ( $M = 7.63$ ) scored significantly higher on problem-solving ability than those with low metacognitive skills ( $M = 4.82$ ) ( $p < 0.001$ ) and those with medium metacognitive skills ( $M = 4.90$ ) ( $p < 0.001$ ). However, there was no significant difference between the low and medium groups ( $p = 0.99$ ).

The findings demonstrate that problem-solving ability increases with higher levels of metacognitive skills. Students with high levels of metacognitive skills performed considerably better on problem-solving tasks compared to those with low or medium levels. These findings indicate that metacognitive skills are a significant predictor of problem-solving ability in secondary school students, suggesting that enhancing metacognitive skills may play a

crucial role in improving students’ problem-solving performance. Similar studies were found by Fauziana & Fazila, 2022 [3] which concluded that there is a significant effect of metacognition on the ability to solve science problems. Safari & Meskini (2015) [8] also concluded that metacognitive instruction has positive effects on students’ problem-solving skills.

**Conclusion**

The findings of this study clearly indicate that metacognitive skills are a significant predictor of problem-solving ability among secondary school students. The students who have higher levels of metacognitive skills, planning, implementation, monitoring and evaluation have better problem-solving abilities. The development of

cognitive skills in students at the secondary school level is expected to help students solve various difficulties in understanding problems by choosing the right strategy, through the ability to check, detect, and correct errors so that later it will help them to improve the quality of learning. Therefore, developing metacognitive skills through instructional strategies and classroom interventions may play a crucial role in enhancing students' overall problem-solving performance and academic success.

## References

1. Aljaberi NM, Gheith E. University students' level of metacognitive thinking and their ability to solve problems. *American International Journal of Contemporary Research*, 2015;5(3):121-134.
2. David H, Qasim S H. Metacognitive Skills and Achievement in Mathematics: Nature of Relationship. *Adhigam*,2024;30:162-170.
3. Fauziana F, Fazila S. The impact of metacognition on elementary school students' problem-solving skills in science learning. *Jurnal Ilmiah Sekolah Dasar*,2022;6(2):278-286.
4. Jordan, P.J. and Troth, A.C. Managing emotions during team problem solving. Emotional intelligence and conflict resolution. In *Emotion and Performance*. United States CRC Press, 2021, 195-218.
5. Krishnakumar M, Balasubramanian K. Metacognition as a predictor of problem-solving performance in higher secondary school students. *International Journal of Novel Research and Development*,2024;9(7):2456-4184.
6. Lamb S, Maire Q and Doecke E. Key skills for the 21st century: An evidence-based review, 2017, 65-72.
7. Ramadhanti D, Ghazali AS, Hasanah M, Harsiati T. Students' metacognitive weaknesses in academic writing. A preliminary research. *International Journal of Emerging Technologies in Learning*,2019;14(11):41–57. <https://doi.org/10.3991/IJET.V14I11.10213>.
8. Safari Y, Meskini H. The effect of metacognitive instruction on problem solving skills in Iranian students of health sciences. *Global journal of health science*,2015;8(1):150.
9. Sevgi S, Karakaya M. Investigation of Metacognition Awareness Levels and Problem-Solving Skills of Middle School Students. *International Online Journal of Primary Education*,2020;9(2):260–270. <https://dergipark.org.tr/en/pub/iojpe/issue/69665/1110850>
10. Tasmin S, Kumar A. Metacognition among Senior Secondary School Students and its Relationship with Problem Solving Ability. *The Research Dialogue*,2023;02(03):2583-438.
11. Veneman M V J, Cleef D Van. Measuring Metacognitive Skills for Mathematics: Students' Self-Reports Versus On-Line Assessment Methods. *ZDM Mathematics Education*, 2019;51(4):691–701. <https://doi.org/10.1007/s11858-018-1006-5>
12. Veneman M V J, Van Hout-Wolters, B H A M, Afflerbach P. Metacognition and learning: Conceptual and methodological considerations. *Metacognition and Learning*,2006;1(1);3–14. <https://doi.org/10.1007/s11409-006-6893-00>
13. Voica C, Singer F M and Stan E. How are motivation and self-efficacy interacting in problem-solving and problem-posing. *Educational Studies in Mathematics*,2020;105:487-517.