



## A Study of Prospective Teachers' Metacognitive Abilities in Pedagogy of Science

Shah Nabi Khan<sup>1</sup> & Prof. Mehnaz Ansari<sup>2</sup>

Ph.D. Research Scholar<sup>1</sup> & Professor<sup>2</sup>, Department of Teacher Training & Non-Formal Education  
(IASE), Faculty of Education, Jamia Millia Islamia New Delhi, aligzaim@gmail.com &  
mansari@jmi.ac.in

DOI : <https://doi.org/10.5281/zenodo.17314568>

### ARTICLE DETAILS

**Research Paper**

**Accepted:** 17-09-2025

**Published:** 10-10-2025

**Keywords:**

*Prospective Teachers',  
Metacognitive Abilities,  
Pedagogy of Science*

### ABSTRACT

This study investigates the metacognitive abilities of prospective teachers in the pedagogy of science, focusing on how factors such as gender, institutional type, and science stream (Biology, Chemistry, Physics) influence these abilities. Metacognition defined as the awareness and regulation of one's own thinking is essential in effective science teaching, as it promotes critical thinking, problem-solving, and reflective practice. A quantitative descriptive survey was conducted with a sample of 53 prospective teachers from Jamia Millia Islamia (New Delhi) and Al-Falah University (Haryana), utilizing the Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ). The data were analysed using t-tests and ANOVA. Findings revealed no statistically significant differences in metacognitive abilities based on gender, type of institution, or science stream, indicating that these background variables do not significantly influence metacognitive development. These results align with existing literature, suggesting that metacognitive abilities are better enhanced through structured interventions rather than demographic or institutional factors. The study highlights the need for teacher education programs to integrate targeted strategies for developing metacognitive skills, which are crucial for improving teaching effectiveness in science education.



## Introduction

Metacognition is the awareness and control of one's own thinking processes while learning (Veenman, 2011). It has two main parts: metacognitive experiences and metacognitive knowledge, which is supported by cognitive neuroscience research (Fleur et al, 2021). This awareness and control are vital for creative thinking (Jia et al, 2019). Hasson-Ohayon et al. (2020) describe it as a higher-level idea that includes being aware of how we think. Key elements include metacognitive information, metacognitive experiences, goals, and tasks. Metacognition also means thinking about one's thought processes. This includes awareness, understanding, and control over personal and general human thinking (Peteranetz, 2018). John Flavell (1970), highlighting the awareness and understanding of one's own thoughts. Being aware of metacognitive processes is called metacognitive awareness. This means knowing how individual learns, thinks, and solves problems. It has two parts one metacognitive regulation and second metacognitive knowledge. This idea connects to self-regulated learning. Flavell (1979) noted that metacognition includes metacognitive experiences and metacognitive knowledge in his model. In contrast, Brown's model emphasizes the role of executive control in metacognition (Brown, 1987). Metacognitive awareness is especially important for future educators. It enables them to reflect on their teaching methods. The involvement of prospective teachers in education, particularly science education, is essential for fostering students' capacity for critical thinking, problem-solving, and conceptual understanding. In education, particularly science education, there is increased attention paid to teachers' use of metacognitive skills. The skills metacognitively are important for enhancing their effectiveness as teachers. Metacognition is often defined as thinking about one's own thinking. It is the awareness and regulation of cognitive processes, such as planning, monitoring, and evaluating the learning activity. This study will look at the metacognitive skills of prospective science teachers and the impact that metacognitive skills have on science teaching.

Science education needs the abilities to assess, and teaching methods change based on student needs. Improving metacognitive skills can help teachers be more aware of their own learning. This awareness can lead to better teaching choices. It can also help create a classroom environment that encourages student participation and learning improvement. While we know little about how pre-service teachers' metacognitive skills affect their science teaching, the role of metacognition in education is vital for meaningful learning. This encourages students to explore how various metacognitive processes impact teaching strategies and student learning opportunities.

## Review of literature



Ford, D. J. et al. (2023) researched the use of virtual simulations for practicing whole group discussions. They focused on preservice teachers' metacognitive awareness. The results showed that participating in virtual simulation experiences improved their metacognitive awareness of leading discussions. However, preservice teachers tended to be overconfident in judging their own metacognitive awareness.

Chumdari, C. et al. (2023) studied how metacognitive awareness affects the critical thinking skills of elementary school prospective teachers. They found that metacognitive interventions led to significant improvements in teaching skills, especially in self-regulation. This allowed students to better understand and present concepts. The researchers emphasized the significance of planning, monitoring, and evaluating as essential parts of improving teaching skills. They suggested that using metacognitive strategies is important for building future teachers' confidence and skills in classroom settings. This highlights the need for such interventions in teacher education.

Siyaya, M. C. et al. (2022) examine information literacy and metacognitive skills of pre-teachers in a rural school in South Africa. The finding that even with government initiatives to digitise education, many rural teachers expressed fears regarding using computer applications independently. The study also identified a lack of self-evaluation, goal setting, and help-seeking, as metacognitive skills that affect the useful use of technology in teaching. As a recommendation, the authors suggested training rural teachers in cognitive development, emotional intelligence, and computer skills that could enhance their teaching abilities. Maryani, I., Alhakim, M. A., and Gestiardi, R. (2021) studied the metacognitive skills of prospective primary school teachers at the Universitas Ahmad Dahlan by using a quantitative descriptive approach. Their study included a sample of 100 students recruited from students in semesters II, IV, and VI, data was collected using the Metacognitive Abilities Inventory (MAI). The results identified low to medium range metacognitive skills were evident, as indicated by the limited development of the prospective teachers. The highest scored metacognitive skills were recorded in declarative knowledge in relation to cognitive knowledge and planning in relation to cognitive regulation. Saputri, W., & Corebima, A. D. (2020) conducted research on the correlation between metacognitive skills and cognitive learning results of biology pre-service teachers across different learning models. The results indicated a significant correlation between metacognitive skills and cognitive learning outcomes, with the regression equations for all three learning models being parallel and consistent. This finding is valuable for lecturers to select the appropriate learning model that enhances pre-service teachers' metacognitive skills and cognitive learning results. Asyari, M., & Ikhsan, M. (2019) conducted research on the effectiveness of the inquiry learning model in improving prospective teachers' metacognition knowledge and awareness. The results showed significant variations in metacognition knowledge and awareness after the learning



intervention ( $p < 0.05$ ). While the inquiry learning model did not have a significant impact on all groups ( $p > 0.05$ ), it proved effective in enhancing metacognition knowledge and awareness in fluid learning, though its impact varied across the three experimental groups. Alam, M. A. (2017) conduct research on Metacognitive Abilities of Secondary School Biology Teachers. People's that revealed that there was no significant difference between Metacognitive Abilities Inventory (MAI) score of male and female, rural and urban biology teachers.

### **Need of the study:**

Metacognitive abilities are vital for Prospective teachers to help plan, monitor and evaluate their teaching practice particularly in science education, but little research exists on the development of these skills and use during the teacher preparatory program. This study will help us to understand how metacognitive abilities interact with a professional's readiness to teach. In science education, metacognitive skills help prospective teachers make connections for purpose, develop understanding of complex ideas, and promote critical thinking. This research will explore metacognition with a view towards improving teacher educator programs.

### **Objectives:**

1. To assess the metacognitive abilities of prospective teachers in the pedagogy of science.
2. To identify which metacognitive strategies are used in the pedagogy of science.

### **Hypotheses:**

**H<sub>01</sub>**. There is no significant difference in the metacognitive abilities of prospective teachers in the pedagogy of science with respect to gender.

**H<sub>02</sub>**. There is no significant difference in the metacognitive abilities of prospective teachers in the pedagogy of science with respect to the type of institution (government or private).

**H<sub>03</sub>**. There is no significant difference in the metacognitive abilities of prospective teachers in the pedagogy of science across different science streams (Biology, Chemistry, and Physics).

### **Research Design:**



In this study, a quantitative descriptive research design approach was employed to explore A Study of Prospective Teachers' Metacognitive Abilities in Pedagogy of Science. As its name suggests, descriptive research primarily describes and interprets a phenomenon; in fact, it focuses on existing events and their relationship with the present circumstances (W. Best et al., 2020).

**Methodology:**

The present study is of the descriptive-survey type because it deals with the present status of internet addiction of university students. The sample of this study consisted of 53 prospective teachers were selected from Jamia Millia Islamia New Delhi and Al Falah University Dhauj Haryana.

**TOOLS:** A Standard questionnaire was employed to collect data developed by Khurram, A. F. A. et.al The survey approach entails a well-defined problem and specific aims, utilized for gathering data from relatively large samples at a specific time, without regard for the features of individuals as distinct entities (W. Best et al., 2020). The tool comprises 14 items adopting a 5-point Likert scale.

**Measurement Tools:**

To measure the metacognitive abilities of prospective teachers, this study adopted the Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ) developed by Khurram, A. F. A., Islam, M. U., & Bilal, A. (2020).

**Data analysis and interpretation**

Data was analysed quantitatively to find out Prospective Teachers' Metacognitive Abilities in Pedagogy of Science.

**Table 1:** A comparison of Prospective Teachers' Metacognitive Abilities in Pedagogy of Science in terms of gender

To find out the Prospective Teachers' Metacognitive Abilities in Pedagogy of Science mean, standard deviation and t-test was used and the details are explained in the following table

Gender	Mean	S. D	df	N	t-value	Sig.
Male	51.28	13.199	52	32	-0.512	At 0.005
Female	53.23	14.438		22		Level

From the table 1, The comparison of mean metacognitive abilities scores between male and female prospective teachers shows that male participants had a mean score of 51.28 and a standard deviation of 13.199. Female participants had a slightly higher mean score of 53.23 and a standard deviation of 14.438. The calculated t-value for the difference between these means is -0.512 with degrees of freedom (df) equal to 52. At the 0.005 level of significance, the table t-value is 2.678. Since the absolute value of the observed t-value (0.512) is much smaller than the critical value, the difference is not statistically significant. The null hypothesis ( $H_0$ ) states that there is no significant difference in the mean metacognitive abilities of male and female prospective teachers. Therefore, we accept it. The alternative hypothesis ( $H_1$ ), suggesting a significant difference exists, is rejected. This result indicates that gender does not play a significant role in influencing the metacognitive abilities of prospective teachers within the sampled population. The slight difference in means may be attributed to random variation rather than a real gender-based effect. Hence, it can be concluded that both male and female prospective teachers exhibit comparable levels of metacognitive abilities.

**Table 2:** A comparison of Prospective Teachers' Metacognitive Abilities in Pedagogy of Science in terms of institutions

Institutions	Mean	S. D	df	N	t-value	Sig.
Govt.	52.56	12.78	52	27	0.258	At 0.005 Level
Private	51.59	14.62		27		

From the table 2, The comparison of prospective teachers' metacognitive abilities in the pedagogy of science based on the type of institution reveals that government institution participants had a mean score of 52.56 with a standard deviation of 12.78, while those from private institutions had a slightly lower mean score of 51.59 with a standard deviation of 14.62. The calculated t-value is -0.258 with 52 degrees of freedom. At the 0.005 level of significance, the table t-value is 2.678. Since the absolute value of the observed t-value (0.258) is far less than the critical value, the difference is not statistically significant. Therefore, the null hypothesis, which states that there is no significant difference in the metacognitive abilities of prospective teachers from government and private institutions, is accepted. The alternative hypothesis is rejected. This suggests that the type of institution does not significantly influence metacognitive abilities in the pedagogy of science among prospective teachers in the given sample.

Table 3: Summary of one-way ANOVA of Prospective Teachers' Metacognitive Abilities in terms of pedagogy of science stream

Source of variance	df	SS	MSS	F-value	Sig.
Science	2	578.48	289.24	1.595	At 0.005 Level
Stream Error	51	9249.22	181.35		
Total	53	9827.70			

From the table 3, The one-way ANOVA analysis comparing prospective teachers' metacognitive abilities across different pedagogy of science streams Biology, Chemistry, and Physics reveals differences in mean scores i.e Biology (Mean = 49.32), Chemistry (Mean = 57.73), and Physics (Mean = 53.07). The analysis shows a between-group sum of squares (SS) of 578.48 with 2 degrees of freedom, and a mean sum of squares (MSS) of 289.24. The within-group (error) SS is 9249.22 with 51 degrees of freedom, resulting in an error MSS of 181.35. The calculated F-value is 1.595. At the 0.005 level of significance, the critical F-value is considerably higher than the observed F-value, indicating that the difference in group means is not statistically significant. Therefore, the null hypothesis—which states that there is no significant difference in metacognitive abilities among prospective teachers of different science streams is accepted. The alternative hypothesis, suggesting a significant difference among the means, is rejected. Although Chemistry students showed a higher average metacognitive ability compared to Biology and Physics, this difference is not large enough to be considered statistically significant. Thus, it can be concluded that the specific science stream does not significantly affect the metacognitive abilities of prospective teachers in this sample.

### Discussion:

The findings of this study show that gender, type of institution, and science stream do not significantly affect the metacognitive abilities of prospective teachers. The slight differences in mean scores are due to random variation rather than real effects. This suggests that male and female prospective teachers, regardless of their institution or science stream, have similar levels of metacognitive abilities. These results are supported by Maryani et al. (2021), who found that prospective primary teachers in Indonesia had low-to-moderate metacognitive skills, without strong differences based on background factors. This study highlights elements such as learning involvement, academic performance, and the structure of the



learning environment particularly blended learning play a crucial role in enhancing metacognition. However, other studies emphasize the importance of structured support in improving metacognitive awareness. For example, Ford et al. (2023) showed that virtual simulations helped preservice teachers become more aware of their teaching abilities, although many overestimated themselves. Chumdari et al. (2023) found that self-regulation strategies helped improve critical thinking and teaching skills. Siyaya et al. (2022) highlighted that rural teachers lacked digital skills due to low self-reflection and planning.

Overall, this study agrees with recent research that metacognitive abilities is not strongly influenced by background characteristics. Instead, it supports the idea that focused training and support are needed to strengthen these skills in teacher education programs.

### References:

- Ford, D. J., Luke, S. E., Vaughn, S. M., & Fulchini-Scruggs, A. (2023). Virtual Simulations to Practice Whole Group Discussions: Preservice Teachers' Metacognitive Awareness. *Journal of Educational Technology Systems*, 52(1), 73–95. <https://doi.org/10.1177/00472395231184566>
- Chumdari, C., Atmojo, I. R. W., Ardiansyah, R., & Shintawati, A. (2023). The Effect of Metacognition Awareness on the Critical Thinking Skills of Elementary School Teacher Elementary School Prospective Teachers. *AL-ISHLAH: Jurnal Pendidikan*, 15(4). <https://doi.org/10.35445/alishlah.v15i4.4527>
- Siyaya, M. C. (2022). Information Literacy and Metacognitive Abilities of Teachers: Case of a South African Rural School. *International Journal of Education and Literacy Studies*, 10(1), 173. <https://doi.org/10.7575/aiac.ijels.v.10n.1p.173>
- Saputri, W., & Corebima, A. D. (2020). The correlation between metacognitive skills and cognitive learning results of biology pre-service teachers on different learnings. *Journal of Turkish Science Education*, 17(4), 487–503. <https://doi.org/10.36681/tused.2020.40>
- Khurram, A. F. A., Islam, M. U., & Bilal, A. (2020). Development and Validation of Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ). *Journal of Educational Sciences*, 7(2), 129-144.
- Hastuti, I. D. (2020). *Development Of Collaborative Inquiry-Based Learning Model To Improve Elementary School Students 'Metacognitive Ability*. 9(02).



- Md Afroz Alam. (2017). *Metacognitive Abilities of Secondary School Biology Teachers*. Unpublished. <https://doi.org/10.13140/RG.2.2.32634.98245>
- Cakici, D. (2018). Metacognitive Awareness and Critical Thinking Abilities of Pre- Service EFL Teachers. *Journal of Education and Learning*, 7(5), 116. <https://doi.org/10.5539/jel.v7n5p116>
- Moritz, S., & Lysaker, P. H. (2018). Metacognition – What did James H. Flavell really say and the implications for the conceptualization and design of metacognitive interventions. *Schizophrenia Research*, 201, 20–26. <https://doi.org/10.1016/j.schres.2018.06.001>
- Yıldız, H., & Akdağ, M. (2017). The Effect of Metacognitive Strategies on Prospective Teachers' Metacognitive Awareness and Self Efficacy Belief. *Journal of Education and Training Studies*, 5(12), 30. <https://doi.org/10.11114/jets.v5i12.2662>
- Kartal, M., Demir, Ö., & İbrahim Kaya, H. (2017). An Evaluation on the Regression Level of Prospective Teachers' Metacognitive Skills in terms of their Community Service Activities Perceptions. *Universal Journal of Educational Research*, 5(1), 1–10. <https://doi.org/10.13189/ujer.2017.050101>
- Salles, A., Ais, J., Semelman, M., Sigman, M., & Calero, C. I. (2016). The metacognitive abilities of children and adults. *Cognitive Development*, 40, 101–110. <https://doi.org/10.1016/j.cogdev.2016.08.009>
- Akturk, A. O., & Sahin, I. (2011). Literature Review on Metacognition and its Measurement. *Procedia - Social and Behavioral Sciences*, 15, 3731–3736. <https://doi.org/10.1016/j.sbspro.2011.04.364>
- Panaoura, A., & Philippou, G. (2007). The developmental change of young pupils' metacognitive ability in mathematics in relation to their cognitive abilities. *Cognitive Development*, 22(2), 149–164. <https://doi.org/10.1016/j.cogdev.2006.08.004>
- G., & Moshman, D. (1995). Metacognitive theories. *Educational Psychology Review*, 7(4), 351–371. <https://doi.org/10.1007/BF02212307>
- Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. *American psychologist*, 34(10), 906.