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Research Paper

A Qualitative Analysis of the Pre-Service Science Teachers Pedagogical Understandings of Metacognition

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ABSTRACT

Metacognitive learning enables the learner to take charge of their learning making them a reflective learner. A reflective learner is skillful, efficient, and possesses the quality of self-awareness and self-regulation. The knowledge of metacognition and metacognitive strategies are vital for the teachers who shape the cognitive and affective domains of the learner. The present study explored the awareness of pre-service science teachers about metacognition and identified the usage of metacognitive strategies as a teaching methodology. The findings of the study reflected the constructive outcomes exhibited by the pre-service teachers in their understanding of the concept of metacognition. However, the implementation strategies of the pre-service teachers reflected the challenges they faced and an imperative necessity of intervention in the form of pedagogical support. The result of the findings attempts to throw light on the need of revamping the teacher education curriculum where the focus is specified on achieving the mastery of the Metacognition and metacognition strategies. With the smooth instilling of metacognition, the vision of inculcating Higher Order Thinking skills amongst the learner may become a certainty in near future.

Keywords: *Metacognition, Metacognitive Strategies, Pre-service Science teachers*

Success in a 21st-century classroom entails developing learners who are active problem solvers, critical thinkers, and efficient decision-makers. The transforming global educational learners who can cognitively engage in the emerging problems and understand the thought process to effectively solve the problem. The learner's ability to take "active control over cognitive processes" (Gama, 2004) indicates the ability of the learner to exhibit the act of conscious decision-making. The act of conscious decision-making demands the student's awareness of their metacognition during the entire teaching-learning process.

According to Pressley (2002), metacognition is "thinking about thinking" or it is a mental state when an individual is aware of one's thought process and is effectively able to evaluate the efficiency of the decisions taken in any context or especially in a learning environment. Metacognition differs from cognition as the latter happens to be only an act of knowing whereas metacognition is the learner's reflection about what he or she already knows or is in the process of learning (Smith, 2004). Various researches have proved that when the learner

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can make the shift in their reasoning pattern from cognitive to metacognitive thinking there is a there is a significant enhancement in the retention and comprehension ability and to "think metacognitively is the critical distinction between low and high achieving students" (Pogrow, 2004).

Recent years have witnessed the growing consensus of researchers, academicians, policymakers, and teachers in advocating the usage of the metacognitive competencies and strategies in the teaching-learning process. Numerous researches have verified the encouraging affiliation between usage of metacognitive competencies with academic achievement of the learners in various areas of study. The ground-breaking work of Flavell (1974) in the concept of metacognition has provided an opportunity for the learners to autonomously guide and regulate their thought processes. The usage of metacognitive strategies has become more pertinent in the present time when the common goal of education at the global level is to promote lifelong learning and holistic development.

Illustrating the enormous role of teachers in the learning process Bowman et.al (2005) emphasized that, "for students to develop inquiring skills and to learn to reflect, teachers must learn how to guide the learning process. This can only occur when metacognitive strategies are modeled by the teacher" (p.336). Mastering metacognitive skills demand overhauling the teacher education curriculum, revamping the pedagogical practices, giving more emphasis to cognitive and metacognitive concepts in the teacher education curriculum. Veenman et al. (2006) argued that "many teachers lack sufficient knowledge about metacognition" (p.10), and Boulware-Gooden (2007) has starkly pointed out that "classroom teachers often fail to teach this [metacognitive] process" (p.72). Although, there are a good number of research on the significance of metacognition and metacognitive strategies the effective intervention and implementations of the same raise some doubt related to teachers' knowledge, skills, and teaching practices of metacognition (Oztruk2016). Implementing the metacognition strategies in the teaching-learning process may have advantages but it is equally as important to analyze a few queries like "Are the teachers prepared to make effective usage of metacognitive strategies in a teaching-learning process? Which metacognitive learning strategies should be employed in actual classroom situations? and Which metacognitive strategies are most effective concerning the academic performance of the learners? Besides that, the most important question is that are the students in the classroom are ready to take charge of their learning?

The present study attempts to explore the metacognitive knowledge gained and implemented by the pre-service science teachers in their teacher training process. Metacognition and metacognitive strategies are some of the important content areas covered in the pedagogy curriculum of the Teacher Education program in India.

LITERATURE REVIEW

Metacognition developed as the focus area of research in the field of education in 1970. The pioneer of this concept is John Flavell who defined Metacognition as "knowledge concerning one own cognitive process". This definition was later summarized as "cognition about cognition" or thinking about thinking". Metacognition is one of the significant concepts of cognitive psychology which bears the potential to enhance the learning outcomes of the learners in a exceedingly constructive manner as it prepares the learner to "focuses on his or her thinking process" (Stewart & Landine, 1995, p. 17). Flavell (1979, p. 906) categorized three important components relevant in the structure of metacognition such as "*knowledge of*

strategy, knowledge of the task, and knowledge of one's cognition". A teaching-learning process depends on these three related kinds of metacognitive knowledge directly or indirectly continue to be perceived as essential components of the learning process (Krathwohl, 2002; Pintrich, 2002). Awareness of one's metacognition demands the knowledge of the task, and understanding of Strategic knowledge which denotes the knowledge of strategies for learning and thinking (Pintrich, 2002). Besides mastering the content, it is also important for the students should acquire the knowledge of how, when, why, and where to apply these strategies (Veenman, Van Hout-Wolters, & Afflerbach, 2006). There are number of effective metacognitive strategies like KWL, think-aloud method, concept maps when implemented by teachers can enhance the learners' metacognitive skills (Pedone, 2014). The teachers and learners need to possess the understanding of "Metacognitive knowledge which involves knowledge about cognition in general, as well as awareness of and knowledge about one's cognition (Pintrich, 2002, p. 219). A teacher's understanding of metacognition enhances the probabilities of advancement of higher-order thinking skills (HOTS) among the learner as being the most sought-after learning outcomes across the globe.

Purpose of the Study

The most operative pedagogical understanding of metacognition is conceivable only when the teacher absorbs the skills to implement the metacognition strategies effectively and efficiently in the classroom. In general, pedagogical understanding of metacognition refers to the teaching strategies and instructional techniques that will be used in particular situations to achieve a teaching goal. Successful metacognitive instruction addresses student schema, knowledge of strategies, and knowledge of the conditions for implementing strategies. (Gourgey,1999). Considering the significant role, the Teacher Education curriculum plays in shaping the overall personality and skills of the Teachers this study aims to explore the Pre-service science teachers' awareness of metacognition. It also aims to understand the implementation of metacognition strategies in the science teaching-learning process in a simulated setup.

Research Design

This present study was conducted by implementing a qualitative research design to explore the awareness of pre-service science teachers about metacognition in science teaching. The present study also explored the implementation of metacognition strategies in science teaching by the pre-service science teachers. The sample of this study consisted of twelve pre-service science teachers who participated enthusiastically. The data thus obtained through the semi-structured interviews were later transcribed and analyzed to identify the relevant themes (Cresswell, 2008).

The participants of this study were selected through Purposive sampling. Twelve Pre-service science teachers who were pursuing a degree course in science education willing to take part in this study were selected through non-probability sampling. Purposive sampling method is adapted in this study as the nature of the study required participants with desired characteristics (Etikan et al. 2016). The significance of using purposive sampling is that it encourages the identification and selection of participants who possess the required knowledge to achieve the goal of the study. The present study aims to explore the awareness of pre-service science teachers understanding of metacognition and execution of metacognitive strategies in science teaching. The Data is collected through semi-structured interviews. The twelve pre-service science teachers who volunteered to participate in this

research are called S1-S12. The participants of the research do not possess any teaching experience. The participants of this research gained knowledge of the concept of metacognition through the pedagogy curriculum aimed for the degree course and also attended a few webinars on the various aspects of the concept of Metacognition organized by the Department. The researcher acted as an observant participant to gain a preview of the pre-service teacher's application of the metacognitive strategies in the simulated setup.

Data Collection and Analysis

Qualitative methodology was implemented for the analysis of the data obtained from the interview with the participants. One of the pre-requisites of qualitative research is that the researcher must obtain the maximum possible information with the help of research tools. Additionally, data triangulation is also an important characteristic of qualitative research. Data triangulation in the current study was done by conducting the interviews with the participants in an unvarying manner over different content areas covered in science teaching in a simulated classroom. While analyzing the interview data the researchers conferred subject experts for identifying the themes to ensure triangulation which confirms the data validity. The present study also incorporated the inter-rater reliability (IRR) test (McAlister et al.,2017) to ascertain the research reliability. Gradually, the interview data was inscribed and categorized into the themes which emerged as a result of the analysis. The researcher concluded into the following two major themes:

1. exploring the pre-service science teachers' awareness of metacognition.
2. implementation of metacognitive strategies in science teaching in a simulated class setup.

FINDINGS/RESULTS

The Data obtained through the Semi-structured interviews are summarized into four broad themes:

- Pre-service teachers' understanding of the term "Metacognition"
- Need and significance of Metacognition in Science Teaching
- Identifying the teaching strategies that promote the implementation of metacognition.
- Challenges faced during implementation of the metacognitive strategies in Science teaching.

  - *Exploring the pre-service science teachers' awareness of metacognition:* The information required for this section of the study was collected by taking a semi-structured interview with 12 pre-service science teachers with the purpose to explore their understanding of the concept of metacognition.
  - *Pre-service teachers' understanding of the term "Metacognition":* The responses of the students reflected their understanding of the term "cognition" and "metacognition" which is concerned about thinking. The pre-service teachers could very well differentiate between the terms "cognition" and "metacognition" as a result they could provide substantial information on the variables undertaken in the study. The response thus obtained was merely focussed on the development of thinking skills (For example *in-depth thinking, analytical ability, problem-solving and decision making*)

S10*: metacognition is "the ability to understand their thought process"*
S5 *metacognition refers to the ability to analyze their thinking skills.*

"……*The term metacognition refers to learners' ability to think at a higher level……."* S1.
"…… *metacognition is the student's ability to incorporate thought process where they learn to implement cognitive skills like decision making and creative thinking.* S4
The response obtained through the participants depicted that they have an extensive understanding of the term metacognition.

b. **Need and significance of Metacognition in Science Teaching:** To explore the awareness of the participants further about metacognition they were enquired about the need and significance of the term "Metacognition" in the science teaching-learning process. The data obtained from the interviews depicted that the participants consider it essential to acclimate the concept of metacognition in science teachings as it had significant positive outcomes. Usage of Metacognition in teaching-learning promotes:

- Understanding the scientific concepts in a meaningful manner.
- Enhances the overall effectiveness of the teaching and learning process
- provides an opportunity for the learners to develop the habit of Deep thinking on science concepts.

S2 "Makes it easier for students to understand any difficult concept of science
S9 *"Makes science teaching more effective and impactful.*
S3 *"The students learn to take charge of their thinking process which helps them to be a constructive thinker".*

The responses obtained from the participants depict that they consider the significance of metacognition is immense in the science teaching-learning process as it enhances the learner's ability to take charge of their thought process.

(2) Implementation of metacognitive strategies in science teaching in a simulated class setup: The second Theme of the study focussed on the teaching strategies implemented by the pre-service science teachers in a simulated class setup. It was the first-hand exposure of the pre-service science teachers to teach in a simulated setup and they were encouraged to implement the metacognitive strategies in their teaching methodologies.

c. Identifying the teaching strategies that promote the implementation of metacognition. The response obtained from the participants revealed that they implemented the following metacognitive strategies such as :

Active Reading*: Active reading incorporates the readiness of the learner to learn a new concept.*

Preview is done to preview the chapter by looking at headings, bolded terms, and any charts or graphs.

Question*:* Questioning Self "What do you want to learn?"

Dual Coding: Dual coding is about connecting images with words. The learners learn to compare the visuals to the words and further they explain the visuals in their own words. For Example: *Mind maps, infographics, diagrams, cartoon strips, timelines, etc.*

Elaboration: It can be done in various manners such as *explaining and describing concepts with many details, comparing two or more concepts and explaining how they are similar and different, relating ideas to your own experiences, explaining concepts to others.*

S7 "I prefer dual coding as the metacognitive strategy as I am a visual learner Graphics and Images help me to understand in a better manner.

S9 "Elaboration helps me to understand the concepts, I also gain self-confidence while I explain others."

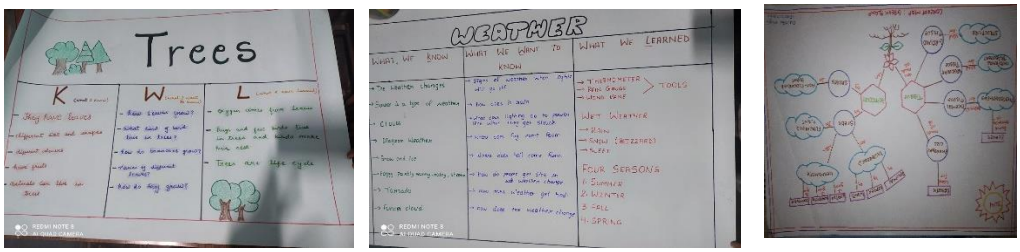

Image : Concept Maps used by Pre-service teachers during Science teaching learning process.

d. Challenges faced during Implementation of the metacognitive strategies in Science Teaching: This section explored the challenges faced by the pre-service teachers in adapting the metacognitive strategies in the teaching-learning process. The research findings concluded the following constraints faced by pre-service teachers during their teaching-learning process:

- difficulty in planning the lesson plans to adapt the metacognitive strategies
- more training is required to facilitate the implementation of the metacognitive strategies in the teaching-learning process.
- classroom management was a task.
- students finding it difficult to think ingeniously.

It took lots of time to plan the lesson plan based on the metacognitive strategies…. S11
The department should organize more webinars and sessions based on the metacognitive strategies so that, we can learn more ways to adapt the metacognitive strategies. S2
Some students in the simulated class did not want to do the task based on metacognitive strategies. S5

DISCUSSION

The data obtained from the pre-service teachers reflected on the constructive output of implementing the metacognitive strategies in science teaching. The pre-service science teachers resonated with the advantages of metacognitive strategies in shaping the learner to become a reflective thinker. The findings of the study also reflected the awareness of the pre-service teachers about cognition and metacognition. Metacognition is essential at each level of education because metacognition not only establishes a good foundation for students' cognitive thinking, such as understanding concepts and gaining a deeper understanding, but it can also assist students in realizing their learning strategies (Suleiman et.al.2020). There are limited challenges which the students faced during the implementation of the teaching-learning process which can be easily overcome by providing the essential support. Metacognition is a key skill for their survival and success in the 21st century (Thienngam et al., 2020). The curricular models based on metacognitive strategies would be a supportive step to promote a leaner becoming a reflective thinker.

CONCLUSION

The present study analyzed the awareness of metacognition in the pre-service science teachers and also explored the implementation strategies of metacognition in the teaching of science. The development of Higher-order Cognitive skills is one of the essential 21st-century skills. Therefore, it is essential to provide more scope of similar concepts in the

teacher education curriculum to empower the teachers with the necessary skills. Developing metacognition in the learner is only conceivable if the teachers are suitably competent in the metacognitive strategies. The present study utilised the qualitative method and the findings from this study authorize that the pre-service science teachers grasped the concept of metacognition as a part of their curriculum and also implemented the acquired metacognitive strategies such as *active reading, concept mapping, dual coding reflecting, planning, elaborating,* and *evaluating* in their teaching methodologies. The participants sensed that the implementation of the metacognitive strategies resulted in a positive impact on teaching and learning. They also shared the constraints and the challenges faced by them during the simulated sessions. The Teacher Education curriculum must emphasises strictly on the implementation of the metacognition and innovative metacognitive strategies in the pedagogy courses. As early implementation of metacognition will pave a smooth way for the learners to become reflective thinkers which is the necessity of the 21st Century.

Recommendations

The present study suggests that exposure of pre-service teachers with metacognition and metacognitive strategies had a constructive impact on the pre-service science teachers teaching methodologies. The response given by the students depicted the transition towards a reflective learner. The concept of metacognition should be adapted and given due weightage uniformly across the Teacher Education curriculum. The implementation of the metacognitive strategies should not be restricted to the science only. Moreover, future research may consider bigger sample size, across different subject areas. In addition, besides solely using the qualitative method, future research/es may incorporate quantitative techniques involving larger sample size. The findings of the research paves way similar research in other subjects like languages, mathematics and other branches of social sciences across all levels of education.

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