

Metacognitive Awareness And AI Readiness Among Pre-Service Teachers: Preparing Reflective Educators For The AI Era

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ABSTRACT

Artificial intelligence (AI) is rapidly changing the face of educational practices, and therefore the future teachers need to develop not only digital skills, but also high-level cognitive and reflective ones. Metacognitive awareness is one of those skills, which will help pre-service teachers to control their learning process and instructional decisions in AI-enhanced learning environments. The conceptual article will be devoted to the problem of the interrelation between metacognitive awareness and AI readiness of pre-service teachers, paying special attention to the role of reflective thinking in the responsible, ethical and pedagogically relevant integration of AI technologies in educational practices. Relying on such theories as metacognition, self-regulation, and technology integration, the article will reveal how the processes of metacognition influence AI literacy, adaptation in the new situation, critical evaluation of information generated by the computer, as well as pedagogical decision-making. It will also address the issue of recent frameworks of AI competency and teacher education reform in this regard. Finally, the article assumes that the concept of AI readiness includes not just technical skills, but also cognitive, ethical and reflective competencies that will enable teachers to implement AI technology in their professional activity making the right decisions.

Keywords: Metacognitive awareness, Artificial Intelligence, AI readiness, Pre-service teachers, Teacher education, Reflective practice.

INTRODUCTION

Artificial intelligence (AI) has become one of the most disruptive technologies of the current century, affecting educational systems, teaching techniques, assessment approaches, and learning processes globally. The growing popularity of generative AI applications, intelligent tutoring systems, adaptive learning systems, automated assessment technologies, and databased educational technologies has largely changed the roles of teachers. Instead of merely being providers of information, they need to take the role of learning facilitators, AI knowledge evaluators, ethical thinkers, and reflective practitioners able to integrate AI in various classroom settings (UNESCO, 2024).

Thus, for future teachers to prepare for this changing educational environment, it is not enough for them to gain relevant technical knowledge of the AI tools. They need to develop cognitive and metacognitive skills, which will allow them to realize when and why

AI can be applied in teaching and what its limitations and ethical issues are. AI readiness implies not only digital literacy and technology proficiency, but also reflective thinking, pedagogical reasoning, ethics, and professional development.

The concept of metacognitive awareness, or an individual's knowledge and regulation of his/her cognitive operations (Flavell, 1979), provides a solid basis for acquiring these skills. Individuals can use metacognition to plan their learning strategies, monitor their understanding, assess outcomes, and revise the approach if needed. In the context of teacher education, metacognitive awareness is crucial for allowing pre-service teachers to critically analyse their educational strategies, assess the efficiency of AI-aided educational practices, and regulate their own professional learning in the dynamically changing technological environment (Schraw & Dennison, 1994). In that way, metacognitive awareness becomes

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crucial in preparing competent teachers who will be able to make responsible pedagogical decisions.

The connection between metacognitive awareness and AI readiness is particularly important because, very often, the information provided by AI technology needs to be interpreted and verified by humans. Teachers with high levels of metacognitive awareness will be able to critically analyse AI-provided information, identify possible errors and bias, and evaluate the pedagogical suitability of the data. Additionally, these teachers will be able to teach their students to critically analyse AI information and use it responsibly. (Luckin, 2018).

More recent trends in teacher education add weight to the significance of combining metacognitive awareness with AI skills training. In particular, as the UNESCO AI Competency Framework for Teachers (2024) states, teachers should not only have AI technical skills, but also human-centered competencies, which include reflective practice, ethical reasoning, professional judgement, and lifelong learning. Furthermore, educational reforms such as NEP 2020 in India call for incorporating the use of digital technologies, critical thinking, creativity, problem solving, and reflective teaching practices into the training of teachers.

Although there has been increased attention to the issue of AI integration in education, much of the literature available in this sphere tends to focus on such areas as technological acceptance, digital competence, and/or AI literacy, while there has not been enough attention paid to the cognitive and metacognitive aspects involved in teachers' AI readiness. This is why it is vital to understand the role of metacognitive awareness in AI readiness of teachers.

Within this context, the current paper analyses the theoretical link between metacognitive awareness and readiness to work with artificial intelligence of pre-service teachers. Based on the theoretical concepts of metacognition, self-regulated learning, and educational technology, this paper offers a review of current literature to explain the role of reflective thinking and self-regulation in productive implementation of AI in teaching. In addition, this paper provides practical suggestions for teacher education institutions and approaches for integrating

metacognitive training together with the development of artificial intelligence skills into pre-service teacher education programs.

2. Theoretical Foundations:

Theory of Metacognition by Flavell

This paper is based mainly on Flavell's (1979) theory of metacognition that suggests that metacognition is a person's awareness and regulation of cognition. According to Flavell, metacognition includes two interconnected aspects of metacognitive knowledge and metacognitive regulation. While metacognitive knowledge is the person's awareness of one's own cognitive capabilities, demands of the task and learning strategies, metacognitive regulation implies the process of planning, monitoring and evaluating of one's thinking while solving the problem or making the decision.

Theoretical Background:

In the context of teacher education, these processes allow the pre-service teachers to critically examine instructional practices, judge the validity of AI-generated data, and make well-informed pedagogical decisions. As the use of AI technology impacts educational practice, the educators have to constantly track their awareness of AI technologies, reflect upon the instructional outcomes, and adapt their teaching techniques according to the needs of the learners. Thus, metacognition becomes an important cognitive tool for responsible use of AI in classrooms (Flavell, 1979; Schraw & Dennison, 1994).

3. Technological Pedagogical Content Knowledge (TPACK)

The TPACK model developed by Mishra and Koehler (2006) is another important theoretical approach. It claims that good technology integration presupposes the existence of the unified comprehension of knowledge about technological tools, pedagogical methods, and content. While AI is an advanced form of educational technology, its effective use implies teachers' understanding not just of AI technologies, but of their pedagogical aspects as well. Metacognition facilitates the process of reflection on technology, pedagogy, and content interactions. Hence, an AI-ready teacher needs to have both

technological knowledge and metacognitive skills to be able to evaluate the usefulness of the technology for learning outcomes.

4. AI Competency Framework for Teachers

UNESCO AI Competency Framework offers a modern theoretical approach to Teachers (2024). This document specifies the competencies necessary for using AI appropriately during teaching and learning processes. These competencies include:

- Human-centred mindset
- AI ethics
- AI fundamentals and uses
- AI pedagogy
- Professional learning

Unlike some other frameworks, which emphasize technical competencies only, UNESCO Framework for Teachers gives priority to reflection, ethical reasoning, critical thinking, and continuous professional development. It can be easily seen that such competencies are very similar to metacognitive awareness. Teachers who are able to monitor, regulate and evaluate their thinking processes will be able to use AI effectively.

5. Reflective Practice Theory

The reflective practice theory by Schön (1983) highlights the importance of experts engaging in reflective practices in the course of action and after action. Reflective action allows experts to address instant challenges, while reflective on action helps them learn professionally.

There is a great need for teachers to engage in reflective practices while using AI in the classroom because of many scenarios in which they need to assess the work done by AI, handle any ethical issues that arise, and adapt their teaching style on the spot.

6. Diffusion of Innovation Theory

According to the Diffusion of Innovation Theory by Rogers (2003), the diffusion of technology within social systems is explained. The acceptance of innovation depends on certain attributes such as

relative advantage, compatibility, complexity, trialability, and observability.

In the area of teacher education, the adoption of AI is an educational innovation that will require teachers to make an assessment of the advantages and disadvantages of the innovation and whether it is compatible with their objectives. This assessment process will be facilitated through metacognition, which will allow teachers to make rational judgments about AI innovation.

7. Metacognition as a Determinant of AI Readiness

Metacognitive awareness can be seen as a core mechanism that translates the information about AI technologies and possibilities into the proper, responsible teaching practice of pre-service teachers. In the proposed conceptual framework, the notion of AI readiness is understood as the product of some core inputs, such as AI literacy, digital citizenship, reflective dispositions, and ethical understanding. These inputs provide future teachers with the necessary knowledge and values needed for working with AI technologies in education. Through metacognitive processes, which include planning, monitoring, and evaluation, pre-service teachers learn to use AI technology strategically in their lesson planning, constantly monitor students' learning process and the reliability of results produced by AI, and evaluate the pedagogical effectiveness, fairness, and ethical aspects of AI-aided instruction. As a result, the use of these reflective processes helps pre-service teachers to make appropriate decisions concerning instructional practices and strategies and the ways of using AI technology as an aid to them. Hence, the proposed framework argues that successful reflection leads to the desired educational outputs in terms of development of students' higher order thinking skills, ethical and responsible use of AI technologies, instructional innovation, and increased.

8. Metacognition in Teaching Using Artificial Intelligence

Metacognition has a critical role in ensuring that pre-service teachers can utilize Artificial Intelligence in their teaching approaches successfully. Metacognitive individuals develop plans for instructional activities, monitor the effectiveness of teaching approaches using AI, and assess students' progress and the quality

of content provided by artificial intelligence. In other words, through the process of reflection, such individuals are able to identify any potential biases, errors, and weaknesses of AI, hence make better pedagogical choices. While some educators rely on AI as a reliable knowledge source, metacognitive individuals use AI as a thinking companion that helps in improving judgment and instructional innovation (Flavell, 1979; Schraw & Dennison, 1994). As a result, metacognition enables adaptive expertise in a changing technological environment.

9. Ethical Decision-Making of AI:

The growing integration of generative AI in education creates several ethical dilemmas connected with privacy, biases, transparency, academic integrity, and proper use of technologies. The ability of metacognitive awareness allows educators to critically analyse all ethical issues before the implementation of AI in teaching practice. Educators practicing reflective thinking tend to doubt the accuracy of information generated by AI, identify possible biases, and ensure that AI assists instead of interfering with the process of educating. Therefore, ethical decision-making involves the ability of educators to regulate their cognitive processes, understand the limitations of AI products, and remain professionally accountable for instructional decisions.

10. Reflective Teacher Education:

Educational institutions of teacher preparation bear significant responsibility in ensuring that the future teachers will be prepared to work with the new realities associated with AI-enhanced classrooms. In order to foster AI readiness in teachers, it is important to incorporate metacognitive training in the teacher education programs to develop reflective practice through reflective lesson planning, inquiry, digital problem solving and self-evaluation of professional competence. Reflective journal writing, AI-based microteaching, digital portfolios, case-based learning and peer evaluation activities will give pre-service teachers the opportunity to examine their instructional decisions and evaluate the pedagogical merits of AI technologies. This way, they will develop adaptive expertise and learn how to be lifelong learners and respond to future technological changes (Schön, 1983; Zimmerman, 2000).

11. Implications for Teacher Education Programs

Based on the results of this conceptual analysis, there are certain implications for teacher education institutions. First, AI literacy should be incorporated into teacher education curriculum rather than being delivered in a form of technology course. Secondly, instruction in metacognitive strategies should be a part of teacher education program in order to foster reflective practice, self-regulation and pedagogical reasoning. Third, teacher preparation programs should offer authentic opportunities to preservice teachers to use AI technologies and critically assess their value in an educational setting. Lastly, teacher educators should be trained continuously on AI pedagogical approaches to set good examples of how to integrate AI technologies responsibly. (Schön, 1983; Zimmerman, 2000).

12. Directions for Future Research:

While there have been numerous advances in the field of teachers' AI readiness research over the past few years, several areas require future investigation. Future empirical research might focus on determining the relationship between metacognitive awareness and AI readiness through structural equation modeling, mediation, and/or longitudinal approaches. Other possible topics of future study include whether variables such as digital literacy, teacher self-efficacy, AI anxiety, critical thinking, and reflective practice serve as mediators or moderators for the relationship in question. The comparative studies that involve various teacher education programs, cultures, and educational levels can help understand the influence of metacognitive awareness on AI readiness worldwide.

CONCLUSION

Incorporating metacognitive knowledge in AI-oriented teacher education programs holds the promise of revolutionizing teacher education programs for the future. Instead of simply preparing teachers to work with AI systems, teacher education programs need to train reflective individuals who can assess AI systems critically and make ethical decisions related to instruction in the new learning environment. Through embedding metacognition in AI literacy programs, future teachers can develop autonomy, innovation, and become lifelong learners

who can prepare their students for living in an AI world.

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