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PEDAGOGICAL CONDITIONS FOR DEVELOPING METACOGNITIVE COMPETENCE IN A DIGITAL LEARNING ENVIRONMENT

Mamatmurotova Muhlisa Kamol qizi

Master of Termez State Pedagogical Institute

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ABSTRACT. This research paper analyzes the pedagogical conditions for the development of metacognitive competence in digital learning environments. Metacognitive activity encompasses the processes associated with the learner's understanding of his or her own cognitive processes, planning, monitoring, and evaluating learning activities. The possibilities of digital learning environments to support these processes are analyzed, as well as pedagogical conditions such as direct teaching of metacognitive strategies, the use of metacognitive prompts, the organization of feedback and scaffolding, and the establishment of self-assessment and reflection. The analysis of scientific research shows that the effectiveness of digital tools is associated with pedagogical design that purposefully supports metacognitive activity, rather than their presence.

Keywords: digital learning environment, metacognitive competence, metacognitive strategies, metacognitive monitoring, metacognitive regulation, feedback, scaffolding, reflection, self-assessment, self-regulated learning.

INTRODUCTION.

The widespread introduction of digital technologies into the educational process is increasing the requirements for the learner to independently organize and manage his/her educational activities. The expansion of the possibilities of using various information sources in the digital environment, independently completing tasks, and organizing the educational process at an individual pace requires the learner to develop skills related to understanding and managing his/her own activities. From this point of view, metacognitive competence can be considered one of the important pedagogical areas of the modern educational process.

Metacognitive processes are manifested in a way that is interconnected with the cognitive, metacognitive, motivational, and behavioral aspects of learning. In Panadero's review of self-regulated learning models, self-regulated learning is described as a broad construct that encompasses cognitive and metacognitive processes as well as motivational, affective, and behavioral aspects [1]. Therefore, the development of metacognitive competence should not be limited to the formation of theoretical knowledge alone, but should be linked to the development of the learner's ability to plan, monitor, and evaluate his or her own activities.

Meta-analytic studies examining the effectiveness of targeted metacognitive strategy training also show positive effects on learning outcomes. In particular, Donker et al. conducted a meta-analysis of 58 studies, 95 interventions, and 180 effect sizes to examine the effects of strategy training on academic outcomes [2]. Thus, the pedagogically targeted organization of technological opportunities for developing metacognitive competence in digital learning environments is of particular importance.

MAIN PART.

Purposeful organization of the development of metacognitive competence. The first condition for the development of metacognitive competence in a digital learning environment is to transform metacognitive activity into a conscious and purposeful task of the educational process. This requires the learner not only to complete the learning task, but also to think about how he plans it, which strategy he chooses, and how he determines the effectiveness of his activities.

Scottish International Conference on Multidisciplinary Research and Innovation – SICMRI 2026

A meta-analysis by Donker et al. showed that metacognitive knowledge is important in increasing the effectiveness of teaching strategies [2]. This result indicates the need to view metacognitive activity not as a random phenomenon in the learning process, but as a pedagogically planned process. Accordingly, in the design of digital courses and assignments, the question “what is learned?” should be answered, as well as the question “how does the learner manage the learning process?”

Directly teaching metacognitive strategies. The second condition for developing metacognitive competence is the direct and systematic teaching of metacognitive strategies. It is not enough to require the learner to independently plan, monitor, or evaluate; he or she must also learn how to carry out such activities.

In a meta-analysis by Donker et al., planning and metacognitive training were associated with significant outcomes among the strategies studied [2]. A subsequent meta-analysis by de Boer et al. examined the long-term effects of 48 metacognitive strategy interventions and found that the effect size was maintained and slightly increased from post-test to follow-up [3].

Therefore, developing metacognitive competence in a digital learning environment requires that strategies not only be recommended, but also be organized around **demonstrating, practicing, and analyzing the results of their application**.

Use of metacognitive prompts. One of the important opportunities of the digital environment for metacognitive development is the use of metacognitive prompts. Prompts can be organized in the form of specific questions or instructions that encourage the learner to plan, monitor, and evaluate.

Guo's meta-analysis, published in the Journal of Computer Assisted Learning in 2022, specifically examined the effectiveness of metacognitive prompts in computer-based learning environments. The study found that metacognitive prompts had a positive effect on self-regulated learning activities ($g = 0.50$) and on learning outcomes ($g = 0.40$). The effect also varied depending on the presence of feedback, specificity, and adaptability in the prompts [4].

This result suggests the need to design metacognitive prompts in digital environments not simply as question-and-answer elements, but as pedagogical tools that serve to guide learning activities. In particular, prompts that are task-relevant and tailored to the needs of the learner can enhance their pedagogical effectiveness [4].

Providing feedback and scaffolding. In developing metacognitive competence, it is important for learners to be able to learn about their own performance and to be able to change their actions based on this information. Therefore, feedback and scaffolding are considered to be important pedagogical conditions for digital learning environments.

Guo's study identified feedback as an important factor modifying the effects of metacognitive prompts on self-regulated learning and learning outcomes [4]. A systematic review and meta-analysis published by Thomann and Deutscher in 2025 analyzed 68 experimental studies on prompts in digital learning. The authors noted a positive effect of prompts on learning outcomes, but the magnitude of the effect varied depending on the study design and some prompt characteristics [5].

In this regard, scaffolding should not be organized as a tool that replaces the learner's independence, but as a temporary pedagogical support that gradually leads to independent activity. Therefore, in a digital environment, feedback and prompts should help the learner to realize his mistakes, reconsider his strategy, and determine his next move, rather than giving a ready-made answer.

Supporting self-assessment and reflection. Another important condition for the development of metacognitive competence is the ability of the learner to assess his/her own performance and to reorganize his/her further activities based on the results. This process can be organized in a digital environment through tools such as electronic portfolios, reflective diaries, self-assessment, and monitoring of learning outcomes.

Scottish International Conference on Multidisciplinary Research and Innovation – SICMRI 2026

A meta-analysis by Panadero, Jonsson, and Botella examined the relationship between self-assessment and self-regulated learning and self-efficacy. The study included 19 studies and 2305 participants across four meta-analyses; the effect sizes for SRL in the three meta-analyses were 0.23, 0.65, and 0.43 [6].

These results suggest that self-assessment can be linked to the development of metacognitive competence. However, pedagogically, self-assessment should not be limited to scoring results. The learner should analyze their performance by asking questions such as “what results did I achieve?”, “what strategies did I use?”, “how effective was the strategy?” and “what would I change in my next activity?”

Selecting digital tools according to pedagogical objectives. In a digital learning environment, the abundance of technological tools does not automatically mean high pedagogical efficiency. The main issue is what pedagogical task a particular technological tool performs.

Guo's study found that the effectiveness of metacognitive prompts depends on features such as feedback, specificity, and adaptability [4]. Thomann and Deutscher's 2025 meta-analysis found that the effects of prompts vary depending on their form and organization; for example, action-based and group-based prompts were more effective than standardized prompts [5].

Therefore, the main criterion for choosing a digital tool should not be its technical novelty, but rather the mechanism by which it supports the metacognitive activity of the learner. This approach allows us to interpret digital technology not as an independent pedagogical goal, but as a tool for purposeful didactic design.

Interdependence of pedagogical conditions. The above analysis shows that the presence of several separate tools for the development of metacognitive competence in a digital learning environment is not enough. It is important that they are organized as a pedagogically interconnected system.

This system can be expressed in the following logical sequence: **clear metacognitive goal, teaching the metacognitive strategy, applying the strategy in practical activities, monitoring and feedback, scaffolding and prompts, self-assessment and reflection, strategy re-selection or adaptation.**

In this case, the digital environment supports these processes technologically. However, the pedagogical effectiveness of this environment is determined not by its technical capabilities, but by **how it is integrated with metacognitive goals, tasks, feedback, and reflective activities**. This conclusion is particularly consistent with the results of meta-analyses on metacognitive prompts in digital environments [4; 5].

Conclusion. In conclusion, the development of metacognitive competence in a digital learning environment is ensured not by the use of technologies themselves, but by combining them with metacognitive goals, strategic activities, monitoring, feedback and reflection. In this process, one of the most important conditions is the systematic organization of targeted training of metacognitive strategies, self-assessment and pedagogical support.

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**Scottish International Conference on Multidisciplinary Research and
Innovation – SICMRI 2026**

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