

Metacognitive Angle Method: Theoretical Foundations and Practical Application Algorithm

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Abstract: This article presents the theoretical foundations and algorithm for the practical implementation of an original methodological approach developed by the author — the metacognitive angle method (MAM). The metacognitive angle refers to the mental space where the student's cognitive processes (thinking, learning, problem-solving) intersect with metacognitive processes (observation, evaluation, and management of one's own thinking). The study, based on J. Dewey's experiential pedagogy, J. Flavell's theory of metacognition, L.S. Vygotsky's zone of proximal development, D. Kolb's experiential learning cycle, and B. Zimmerman's self-regulated learning model, forms the conceptual foundations of MAM. The article presents a seven-stage algorithm for the practical implementation of the method, its adapted version for university students, and criteria for evaluating effectiveness. The research results introduce a new methodological tool into scientific discourse for the development of metacognitive competencies of students in higher educational institutions.

Keywords: Metacognitive angle method, metacognition, cognitive space, thinking strategy, self-regulation, zone of proximal development, experiential learning cycle, students, higher education, reflective practice.

Introduction: One of the primary tasks facing higher education in the second quarter of the 21st century is the formation of students as independent, critically thinking, and reflective individuals. In the context of rapid growth in knowledge and constantly changing labor market requirements, a student's most important competence is their ability to consciously manage their own knowledge and thinking processes [3, 9]. This ability is known in psychological and pedagogical literature as metacognitive competence and is recognized as one of the central goals of modern education. The concept of metacognition, introduced into scientific discourse by J. Flavell (1979), represents a person's ability to understand, observe, and manage their own cognitive processes [7]. Nowadays, metacognition is considered not only a psychological but also a broad pedagogical category. According to research by the British Educational Foundation (EEF, 2024), the consistent and systematic implementation of metacognitive strategies increases students' academic performance to a seven-month academic achievement level [14].

The document "Development Strategy of New Uzbekistan for 2022-2026" of the Republic of Uzbekistan defines the development of students' critical and independent thinking skills as a priority task [1]. However, a holistic methodological approach to the effective implementation of metacognitive strategies in higher education practice has not been sufficiently developed. Existing methods often consist of separate techniques and are unable to transform the student's cognitive and metacognitive processes into a unified systematic activity. To solve this problem, the author developed the metacognitive angle method (MBM) within the framework of the conducted research. The concept of "angle" in the name of the method is understood not in a geometric sense, but in a metaphorical sense - as a mental space where the student's cognitive and metacognitive processes intersect. Just as a geometric angle connects two directions, the metacognitive angle represents a conceptual point connecting the thought process and the process of thinking about it. The relevance of the research is justified by the following contradictions:

first, although the development of metacognitive competencies of higher education students is an urgent task, holistic methodological approaches in this field are insufficient; second, existing metacognitive strategies are often not adapted to the local cultural and pedagogical context; third, theoretical developments on the conceptual space that unites the cognitive and metacognitive processes of students are rare. The aim of the research is to reveal the theoretical and conceptual foundations of the metacognitive angle method, develop an algorithm for its practical application, and present an adapted version for higher education students.

To form the theoretical basis of the metacognitive angle method, several classical and modern conceptual directions were analyzed.

The first theoretical direction is the classical foundations of metacognitive theory. The concept of metacognition, introduced by J. Flavell (1979), was later developed in the research of A. Brown (1987), J. Pintrich (2002), and others [7, 8]. The authors identified two main components of metacognition: metacognitive knowledge (knowledge of one's own cognitive abilities and strategies) and metacognitive regulation (processes of planning, observation, and evaluation). These classical concepts serve as the theoretical basis for the concept of the "cognitive-metacognitive angle" in the NMS.

The second theoretical direction is cultural-historical psychology. L.S. Vygotsky's theory of the zone of proximal development serves as an important methodological foundation for the MDB [15]. In this case, the metaphor of "corner" also means the intersection of the zone of tasks that the student can solve independently and the zone of tasks that he can solve with the help of adults. At this intersection point, the student has the opportunity to master new metacognitive strategies.

The third theoretical direction is the theory of experiential learning. D. Kolb's experimental learning cycle (1984) combines stages of concrete experience, reflective observation, abstract conceptualization, and active experimentation [4]. In MBM, the four stages of this circle are transformed into the main forms of activity carried out in the space of the metacognitive angle. The concept of reflective thinking [13], outlined in J. Dewey's work "How We Think" (1933), forms the philosophical and pedagogical basis of the method.

The fourth theoretical direction is the theory of self-regulated learning (SEL). B. Zimmerman (2000) distinguished three cyclical phases of learning in the SRL model: preliminary thinking, execution, and self-reflection [10]. A. Bandura (1986) recognized self-

control, self-esteem, and self-reaction as central mechanisms for learning in socio-cognitive theory [12]. In the MBM, these three processes constitute the internal dynamics of the "angle" space.

The fifth theoretical direction is modern reflexive educational research. The results of a study on metacognition and self-regulation published by EEF (2024) provide experimental confirmation of the effectiveness of metacognitive strategies [14]. D. Nicole and S. McCallum (2022) proposed the concept of internal feedback, revealing the mechanism for the internal evaluation of a student's performance results [11]. Developments in local research on the formation of students' reflexive abilities [9] and sanogenic reflection [6] play an important role in adapting the MES to the educational conditions of Uzbekistan.

The following scientific methods were used in the study: theoretical analysis and synthesis (integration of existing metacognitive theories); conceptual modeling (development of a conceptual model of the "metacognitive angle"); pedagogical design (creation of an algorithm for practical application); and comparative-pedagogical analysis. The principles of constructivist pedagogy, socio-cognitive theory, the activity-based approach, and the systematic approach were used as the methodological basis.

RESULTS AND DISCUSSION

1. The theoretical essence of the concept of metacognitive angle

The metacognitive angle is a conceptual category introduced by the author, representing a dynamic space where cognitive and metacognitive processes intersect in a student's mental activity. The term "angle" is based on a geometric metaphor: just as in a geometric angle, two directions meet at a single point, in a metacognitive angle, the student's mental activity in two directions - scientific (cognitive) and self-thinking (metacognitive) - is combined into a single space of interaction.

The metacognitive angle has the following characteristics: first, dynamism - its breadth and depth change throughout the student's development; second, multi-layeredness - it includes cognitive, metacognitive, affective, and motivational components; third, individuality - its configuration is unique for each student; fourth, didactic manageability - it can be formed and developed using special pedagogical tools.

The features that distinguish the metacognitive angle from traditional psychological and pedagogical concepts are manifested in the following. The close development zone (Vygotsky) represents a static space,

while the metacognitive angle represents a point of dynamic interaction. While metacognition is a general psychological process, the metacognitive angle is its didactically organized space. While reflection is a one-way process, the metacognitive angle encompasses activities oriented toward both science and self-reflection.

2. Conceptual model of the metacognitive angle method.

The metacognitive angle method is a methodological approach that systematically and consistently develops students' metacognitive competencies based on the metacognitive angle space. The method has three main dimensions: the vertical dimension (cognitive-metacognitive depth), the horizontal dimension (width of subject content), and the dynamic dimension (development over time).

The theoretical basis of the method consists of the following five principles:

The first principle is the principle of cognitive-metacognitive unity. In the MCC, knowledge of the subject and knowledge of one's own thinking are not studied separately, but are developed in interconnection within a single educational process. While solving a mathematical problem, the student simultaneously observes and evaluates their own problem-solving strategy.

The second principle is that of conscious reflection. Reflection is not accidental or spontaneous, but is carried out as a conscious activity organized using special pedagogical means. This directly relies on Dewey's concept of "reflective thinking" [13].

The third principle is the principle of gradual transition to autonomy. MBM is based on Vygotsky's close development zone and Brun and Wood's "scaffolding" concepts: a consistent transition from teacher assistance to the student's fully independent metacognitive activity is ensured [15].

The fourth principle is cyclicity. Metacognitive activity is organized as a cyclical process integrated with the Kolb cycle (concrete experience - reflexive observation - abstract conceptualization - active experimentation) and the Zimmerman SRL cycle (planning - execution - reflection) [4, 10].

The fifth principle is the principle of discursivity. In MCC, metacognitive processes are manifested in internal, oral, and written language. Students express their thinking verbally and maintain a written reflexive diary, which makes their metacognitive processes visible (visible thinking) [14].

3. Components of the metacognitive angle

The metacognitive angle space consists of four main components (Table 1). These components interact and ensure the student's holistic metacognitive activity.

Table 1. Components of the metacognitive angle space

No	Component	Content and function
1	Cognitive component	Subject knowledge and skills (on a specific topic): concepts, patterns, problem-solving algorithms, factual information. This forms the first direction of the angle.
2	Metacognitive component	Knowledge of one's own cognitive processes and strategies for managing them: planning, observation, assessment. This forms the second direction of the angle.
3	Affective-motivational component	Emotional and motivational states: self-confidence, interest, persistence, adaptation to frustration, academic motivation. It provides the "energetic" dimension of the angular space.
4	Diskursiv-kommunikativ komponent	Skills in expressing one's thoughts orally and in writing, conducting metacognitive dialogue with peers, and writing reflective texts.

4. Algorithm for the practical application of the metacognitive angle method

As a result of the conducted research, a seven-stage

algorithm for the practical implementation of the metacognitive angle method for higher education students was developed (Table 2).

2-jadval. MBM ning ettita bosqichli amaliy tatbiq algoritmi

Stage	Name	Content	Tools
I	Diagnostic stage	Determining the level of students' initial metacognitive competence	MAI (Metacognitive Awareness Inventory) scale, individual interview, task analysis
II	Conceptual introduction	Introducing the concept of metacognitive angle, explaining metaphor	Visual models, presentation, metaphorical analysis, real-life examples
III	Modeling	Demonstration of metacognitive strategies by the teacher using the "think-aloud" method	Thinking Aloud, Screen Demonstration, Video Recordings
IV	Collaborative training	Students working in pairs in the metacognitive angle (with teacher support)	Problem-solving in pairs, mutual Q&A, metacognitive dialogue
V	Independent practice	The student's independent application of metacognitive angle strategies	Reflective diary, independent assignments, self-assessment sections
VI	Integration	Transfer of the metacognitive angle to various academic disciplines and professional activities	Interdisciplinary projects, professional internships, portfolio
VII	Evaluation and improvement	Assessment of the dynamics of metacognitive competence development	Re-diagnosis, portfolio analysis, longitudinal follow-up

5. An adapted version of MBM for higher education students

When adapting the method for higher education students, the following specific features were taken into account.

Firstly, the age characteristics of students (18-23 years old) take into account their ability to think abstractly, plan independently, and manage their activities. At this age, the ability to deeply understand the conceptual model of the metacognitive angle and its conscious use is manifested to the maximum extent.

Secondly, the professional orientation required by higher education allows for the linking of the metacognitive angle with future professional activity.

For example, a future teacher learns to apply the metacognitive angle not only in their own learning but also in teaching their future students.

Thirdly, the credit-module system allows for the organic integration of the metacognitive angle into the process of independent work, term papers, and graduation theses. The student performs each independent task within the metacognitive angle space: plans, executes, observes, evaluates, and draws conclusions.

Fourth, the digital learning environment opens up new opportunities for the metacognitive angle method. Implementing the metacognitive angle module in LMS platforms (Moodle, Canvas), using artificial intelligence

tools (ChatGPT, Claude) for metacognitive dialogue - all of this can significantly increase the effectiveness of the method.

6. Performance evaluation criteria

To evaluate the effectiveness of the metacognitive angle method, the following four groups of criteria are proposed:

1) Cognitive criteria: level of mastery of subject knowledge, problem-solving effectiveness, academic performance indicators.

2) Metacognitive criteria: growth according to the MAI (Metacognitive Awareness Inventory), reflexive product quality, accuracy of self-assessment, and the repertoire of strategies.

3) Affective criteria: academic motivation, self-efficacy, attitude toward learning, and level of persistence.

4) Communicative-discursive criteria: metacognitive dialogue skills, quality of reflexive texts, level of adaptation to academic discourse.

Specific diagnostic tools are used for each criterion group: psychological tests, observation cards, product analysis methods, and expert evaluation. Evaluation is conducted at at least two points: at the beginning of the experiment (pre-test) and at the end (post-test); if possible, longitudinal observation is also conducted.

7. Problems and prospects for the practical implementation of the method.

A number of problems arise during the practical implementation of the MBM. Firstly, the metacognitive pedagogical competence of the teaching staff is often insufficient. Many teachers operate within the traditional model of knowledge transfer, and the transition to metacognitive pedagogy requires a significant professional shift for them. Secondly, an adaptation period is required for students to master metacognitive strategies - at least 2-3 months according to the experiments. Third, the traditional assessment system (focused on the acquisition of pure knowledge) cannot fully reflect metacognitive outcomes.

The prospects of the method are significant: firstly, the interdisciplinary nature of the MBM allows it to be used in teaching any subject; secondly, the possibilities of integration with digital educational environments and artificial intelligence tools are open; thirdly, its adaptation to the local cultural and pedagogical context allows it to be effectively implemented in the education system of Uzbekistan.

As a result of the conducted research, the following conclusions were drawn:

1. The Metacognitive Angle Method (MBM) is an original methodological approach developed by the author that serves the systematic development of students' metacognitive competencies based on the metacognitive angle space (a mental space where cognitive and metacognitive processes intersect). The method was formed based on the synthesis of J. Floull's metacognitive theory, L.S. Vygotsky's cultural-historical psychology, D. Kolb's experimental training cycle, and B. Zimmerman's SRL model [4, 7, 10, 15].

2. The conceptual basis of the MIC consists of five principles: cognitive-metacognitive unity, conscious reflection, transition to step-by-step autonomy, cyclicity, and discursivity. These principles provide the uniqueness of the method that distinguishes it from other metacognitive approaches.

3. The metacognitive angle space consists of four components: cognitive, metacognitive, affective-motivational, and discursive-communicative. These components interact and ensure the holistic metacognitive activity of the student.

4. The practical implementation of the MBM is carried out based on a seven-stage algorithm: diagnostic stage, conceptual introduction, modeling, joint exercises, independent practice, integration, assessment, and improvement. Each stage is provided with specific pedagogical tools and technologies.

5. The evaluation of the method's effectiveness is carried out according to four group criteria: cognitive, metacognitive, affective, and communicative-discursive. This comprehensive approach allows for the objective recording of the multifaceted impact of the method.

6. The uniqueness of the adapted variant for higher education students is manifested in its integration with age characteristics, professional orientation, the credit-module system, and the digital educational environment.

In future research, we consider it necessary to conduct experimental testing of the method in various higher educational institutions and fields of study, to study the possibilities of its integration with artificial intelligence tools, and to compare the effectiveness of the method in various cultural and pedagogical conditions.

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