THEORY AND INSTITUTIONS OF EDUCATION

DOI https://doi.org/10.30525/2592-8813-2023-3-11

DEVELOPMENT OF METACOGNITIVE SKILLS OF COLLEGE STUDENTS IN THE PROCESS OF LEARNING MATHEMATICS, TAKING INTO ACCOUNT NATURAL POSSIBILITIES

Valeriia Diachkova,
Senior Lecturer, Economics-Law College
of Zaporizhzhya National University (Zaporizhzhya, Ukraine)
ORCID ID: 0000-0003-0156-1400
valeria880220@gmail.com

Abstract. This article examines the assessment of metacognition, which allows the teacher to consider the learning process, and helps to identify a lack of knowledge and inaccuracies in understanding the material. The general theory of metacognition and its assessment is analyzed, which allows to find practical approaches to metacognitive strategies using reflective methods. Metacognition enables the teacher to consider the learning process, identify the lack of knowledge and inaccuracies in understanding the material, and understand which metacognitive strategies should be used at one time or another. The theory of metacognition and evaluation allows finding practical approaches to metacognitive strategies. By monitoring the logical thinking of students, a metacognitive strategy for conducting classes with college students is selected. And also in this article we will also consider two components of a complex synthesis – the metacognitive concept and B. Bloom's taxonomy.

Key words: metacognitive strategies, metacognitive processes, reflective metacognitive interview (RMI), metacognitive assessment, educational activity, taxonomy, affectivity, psycho-observation, metacognition.

Ukrainian society is concerned about the drop in the level of mathematics education. In fact, the reality of today is that every year we have a worse and worse level of preparation of basic skills in technical subjects, not everyone can be a professional engineer, but everyone needs to be able to use mathematical skills in real life every day.

The conditions of the war very quickly revealed the shortcomings of our education. The humanization of education in recent years did not provide an opportunity for the development of the technical field. And it is very expensive for us now. The development of mathematics education in the structure of secondary and higher schools will bear fruit in increasing the intellectual and technical capital of the state in the coming years.

The need to modernize mathematics education in FVNZ I-II levels of accreditation is determined by the development of mathematics as a science in the world, the growth of its role in the development of related sciences, as well as the need in mathematics education to create interest in students for the next educational activity, in this way we will come to a successful mastering the basics of life and professional skills. In this regard, a special place is occupied by problems related to the low level of mathematics education in Ukraine.

The research methodology is based on modern approaches to reforming education as a component of pedagogy. Modern pedagogical science in Ukraine is characterized by two interconnected and at the same time oppositely directed vectors: tradition and innovation. In both cases, scientists use postulates in the form of terms in the complex meta-linguistic element of conceptual certainties of this science. The scale and complexity of challenges and tasks, which are concentrated by the dynamism and innovative type of progress, the information explosion, bring to the fore the awareness of the role and self-sufficiency of an individual, increasing the requirements for his competence in all spheres of life, in particular, the pedagogical.

Education is the process of training a pupil or student for the purpose of training, optimization and development of metacognitive processes, metacognitive skills, and affective abilities. Education is the most important element for learning different skills and creating a common context, because it is a necessary condition for adaptation to the environment. Getting an education in high school and institutions of professional preliminary education is based on the dynamic assimilation of new knowledge, skills, and gaining experience in a certain field. Studying in educational institutions coincides with the period of transition from childhood to youth, which is sensitive for the development of metacognitive abilities. Youth is characterized by internal personal conflict and potential opportunities for effective intellectual and personal development, this period is characterized by the highest indicators of memory, attention and intelligence in general. Therefore, in addition to acquiring new knowledge, skills, and abilities in high school and vocational pre-university, the education system should focus on the development of the main intellectual resource of the individual - metacognitive abilities.

Currently, manufacturability is becoming the main feature of human activity. This provides a completely new transition to the efficiency and quality of the educational process. The distance learning system is now one of the components of the education system. Such an educational system consists of methodical, informational, organizational, programmatic and technical components. They are interconnected by various complex links, with the help of which we have the opportunity to conduct effective classes and obtain decent results.

At present, manufacturability is becoming the main feature of human activity. This provides a completely new transition to the efficiency and quality of the educational process. The distance learning system is now one of the components of the education system. Such an educational system consists of methodical, informational, organizational, programmatic and technical components. They are interconnected by various complex links, with the help of which we have the opportunity to conduct effective classes and obtain decent results.

As we all know, learning, like any other process, involves motor exercises. The movement in the learning process goes from the performance of one educational task to the performance of another task, which allows students to advance along the path of knowledge: from ignorance to knowledge, from incomplete knowledge to more complete and accurate learning. Learning should not be reduced to a mechanical "transfer" of knowledge, from teacher to student, because learning is a two-way process in which teachers and students must interact closely.

After several years of work, I came to the conclusion that one of the main conditions for achieving motor activity is that the achievement of certain goals is motivation. Motivation is based on personal needs and interests. Therefore, to achieve any academic success, it is necessary to make this process desirable. The French writer Anatole France said: "Knowledge absorbed with appetite is better assimilated".

Each teacher has his own view of modern students. My vision of the teaching process is as follows:

1. Each lesson should be carefully thought out in order to transfer one stage of the course to another and give students an opportunity to understand what they have done in the course and why it is necessary to do it that way.

2. Students should be ready to perceive new materials and to understand the topic of the mathematics course.

3. It is very useful to follow the principle "seeing it once is better than hearing it a hundred times". Everything the teacher says can be clearly reflected not only in an explanatory way, but also as a way to help discover the connection between concepts in the reasoning process.

4. This couple must be very interesting. The teacher should charge his emotions and transfer his positive impulses to students, which will help stimulate students' thinking towards activity.

5. The task of every teacher is not only to teach, but also to develop the student's thinking abilities through the subject of mathematics (that is, the speed of the reaction of development, the type of memory, imagination, etc.).

6. Each student should be given the opportunity to solve each problem several times during the study of the topic (provide constant "feedback" so that you can correct mistakes or misunderstandings).

7. It is necessary to evaluate not one solution, but the course of the solution, errors in the methodology of considering tasks, in order to introduce the concept of evaluation at different stages of the course.

An integral stage in the study of mathematics is the motivation of educational activities. It is necessary to convince students of the importance of studying this material, draw attention to mathematics, stimulate their interest, desire to learn, understand and apply knowledge to practice. In order for students to be interested, it is possible to use the following materials:

1. Historical tasks, legends, historical information about the subject.
2. Use interdisciplinary references to address relevant content issues.
3. Use models, drawings, tables, reference signals and practical works.
4. Solve problems that require knowledge of the subject.
5. I am developing math skills.
6. I create interesting questions for repetition and systematization of knowledge.
7. I use various techniques to form educational motivation.
8. In order to develop mathematical knowledge and skills, I use smartphones, mobile phones, tablets and other smart devices in my work to obtain information from Internet encyclopedias, to search for necessary information, to visualize information, to watch video lectures, to test or take questionnaires in the mode online, for constructing graphs, finding areas and volumes using integrals, conducting various experiments and calculations.

Not all students have natural technical data, so their path to knowledge in mathematics is more difficult, thus stress prevention is necessary. Working in pairs and groups of different levels, it is possible to achieve good results when weaker students feel supported by their friends and the teacher. The counterpoint to this pair is to encourage students to use different solutions without worrying about making mistakes or worrying about wrong answers. (Solberg Nes L., Evans D. R., Segerstrom S. C., (2009):1892)

Teaching students to work and think is the main task of the college; the teacher must be able to create creative and pragmatic emotions on a pair. The skillful use of visual aids and technical means meets the requirements of the modern educational process. Each educational toolkit has its own educational function and its own possibilities of use, therefore, all types of visualizations can and should be widely used. If the teacher's word is supported by well-thought-out visual images and if various means are used to save the student, then the pairs will become lively and more interesting. For this, we will get students to want to learn mathematics, because it is interesting.

An experienced teacher of mathematics can relatively easily track metacognitive processes. For example, a student is faced with the task of solving an economic or practical problem, and if at the end he did not receive a logical answer, then it is obvious that the mental operation was not correct, the result of which is not difficult to correct, since the teacher knows the exact position of the logical or computational error of the that competent mathematical thinking requires practical and analytical skills. But for some mathematics teachers, the metacognitive reasoning of some students is less clear. Then it is useful to analyse the mistakes made by the student himself.

Therefore, today a teacher of mathematics needs a comprehensive understanding of metacognitive processes, and without this, purposeful teaching is impossible.

Assessment of metacognition allows the teacher to examine the learning process as if under a microscope. But it helps to reveal a lack of knowledge and inaccuracies in understanding the material, so the teacher can change the directions of the learning process, making it easier or making it more difficult to find the right solution.

Understanding which metacognitive strategies a teacher needs to use at one time or another is not such a simple matter. By monitoring logical thinking during various types of activities: learning new material, consolidation, repetition, we can get valuable information about the student's thinking process, about his strengths and weaknesses, and this allows us to make changes and appropriate corrections in the learning process.

Metacognitive strategy – according to which clarifying the understanding of the task conditions can be done in three ways:

1) paraphrase while preserving the meaning,

2) paraphrase with a change of meaning;

3) replaced by "deliberately not true" (that is, the condition is similar in structure and topic, but, in fact, not true, according to mathematics);

4) the initial condition is unchanged.

Students read the condition, and then on the sheet where the options described above are marked as true or false, checking whether what they read corresponds to the condition. With a meaningful perception of the condition, the original and paraphrased with preservation of meaning are marked as true, and other cases are marked as false.

If the student asked is why he gave this or that answer, then his reasoning will acquire a metacognitive character. The answer to the question "Why?" generates a larger amount of data, on the basis of which it is possible to evaluate the student's thinking and determine the further course of mathematics education. The general theory of metacognition and its evaluation allows finding practical approaches to metacognitive strategies. Using reflective methods, the student reflects on what he has done. Practical metacognitive strategies include reflective metacognitive interviews, clarification using the questions "Why?", "How?" or "What purpose did we pursue?", in this way, we metacognitively adapt an informal knowledge test, and also carry out metacognitive visualization.

One of the key strategies for determining the metacognitive mental process is the metacognitive interview developed in 1993 (Rhodes and Shanklin). The purpose of the interview is to feel the student's thoughts from the inside, thus to understand why he answers this way and not otherwise. At the same time, it is not important for the teacher whether the answer to any of the questions is correct or incorrect, but why the student made this or that mistake. And the method of reflective metacognitive interview gives such information. This method is called reflective because the evaluation of actions takes place after the learning process. The interview procedure can be as follows: the student is asked to consider what actions he will perform to solve the task and then explain aloud why he performed the task in this particular way, and it is also rational.

To identify knowledge gaps, it is important that the teacher and student use the same terms. The student must be able to tell about his thoughts in such a way that it is clear to the teacher. For this purpose, it is important to introduce a terminologically unified language to improve mathematical literacy skills, thus conducting a reflective metacognitive interview (RMI) becomes an urgent need. If the participants of the learning process speak a mathematical language they understand, then the RMI results will be unfounded and understandable. Therefore, an effective interview can give a lot to determine the metacognitive abilities of a student. The teacher needs to reasonably think through the questions, since factual, simple ones are not suitable in this case. (Hibbing A. N., 2003: 762).

Bloom's taxonomy is not just a classification scheme. This is the request of the organi-call different thought processes as a hierarchy. In this hierarchy, every one level depends on the learner's ability to work at this level or nyah, lower ego. For example, in order for the learner to apply knowledge (level 3), he must have the necessary information (level 1) and have an understanding of it (level 2). (Murzagaliyeva A.E., Otegenova B.M., 2015: 8).

L. Anderson, after reviewing the taxonomy, made changes in emphasis. It became a kind of work on different forms of thinking. The latest version of the taxonomy began to reflect different forms of thinking, emphasizing the nature of thinking. How was it implemented in practice? The category of "knowledge" was called "recall" precisely because knowledge is a product of thinking. The category "understanding" acquired a new meaning, turning into the category "awareness", and the category "synthesis" was transformed into "creation". So, we finally have the following levels in B. Bloom's taxonomy (we start from the bottom): Remembering, Understanding, Applying, Analyzing, Evaluating, Creating.(Anderson L., Krathwohl D., 2001: 54)

Taxonomy of mental skills of higher order (table 1). The table I developed, the basis of which is Bloom's taxonomy, helps in creating effective questions that will give students the opportunity to think about their actions in solving a mathematical problem from the standpoint of metacognition.

Table 1

A Guide to Using Taxonomy to Improve Reading Comprehension in Mathematics

Level of thinking	Example of questions / tasks
Knowledge	What does this concept mean? (Give the definition.) Describe the condition of the problem. What formulas must be applied? List the main concepts. Tell me what the signs or properties are you will apply
Understanding	What happened to get at the end? (Result.) Explain why exactly these signs or properties you will apply Explain your next steps. Assume what needs to be done next. Give a brief outline of your thoughts.
Application	Where is it used? What would it look like to go the other way? Illustrate it in a diagram or drawing. Analyze your knowledge. You need to write down the course of your thoughts.
Analysis	Analyze the flow of mathematical thought. Compare the rationality of your actions during the period solving the task. Schematically depict the result of solving the problem. Correlations of the obtained result with assigned task. Investigate the reality of the obtained result.
Synthesis	Find a rational solution method. Organize a brainstorm. Make a solution plan. What would you change in the solution method? How should I change the drawing? Was there a mistake? (Imagine what's wrong.) Rewrite, change the decision. Correct the error.
Rating	Rational or the course of the decision? (Assessment.) Rate your work. Evaluate another student's work. Explain why you chose this solution method. Prove that the obtained result is correct. Determine the importance of the obtained result, also – its plausibility.

Consider examples of such questions: How can you evaluate your mathematical activities? What techniques did you use to solve the math problem? What picture did you imagine when you read the condition of the problem?

Metacognitive adaptation of informal checks (Why do you think so? or If you explain in more detail, you will help me understand you.) Leads to the fact that the teacher gathers enough information to assess metacognition: in this way, we find out what the problem is, where is the root mistakes, we find ineffective solution methods or a problematic link in knowledge, in the process of thinking or telling, we check the level of logical, abstract or spatial thinking and whether the student copies the solution methods obtained as a result of previously acquired knowledge too much. (Bloom, B.S., 1956: 12).

Metacognitive visualization (visual image) is the key to understanding the task, used by many teachers. Visualization is often used in geometry, solving practical problems, but it can also work no less effectively - especially in relation to lagging students. Hibbing and Rankin-Erickson advise those who do not have time to ask to draw pictures that arise in the process of reading in order to more clearly imagine the visual image of what they read. This technique can be made metacognitive by asking what is behind his graphic representation, how the drawing reflects the understanding of the condition, and whether he sees the course of the subsequent solution. Therefore, visualization helps to tie together the understanding of what has been read, the construction of a further solution and metacognition.

Therefore, metacognitive strategies are able to create such a context of new information that it is stored in memory, since the form of its integration with previously acquired knowledge facilitates the assimilation of related data. This strategy includes a number of techniques – from active repetition for memorizing the simplest, to integral schemes of organization and task development using systematization and unification of information, as well as reproduction and application of it in arbitrary, meaningfully different forms.

We can see that all these strategies make it possible to understand how the simplest assessment becomes a metacognitive assessment, thanks to the addition of several reflective questions that allow to determine the structure of the student's thinking. And it is the metacognitive assessment that makes it possible to achieve good results.

Thus, we can conclude that the purposeful development of metacognitive skills of college students in the process of learning mathematics using various tasks will contribute to the development of critical thinking, increased self-awareness, increased productivity, and the growth of the individual uniqueness of the students' mindset. The integral use of technological elements will allow to obtain reliably guaranteed learning results in the conditions of cognitive and creative activity of high school and college students, while optimizing the cost of study time. The use of computer technologies ensures a closed and directed educational process, and will also increase the interest of schoolchildren and students in mathematics.

When every citizen changes the approach to mathematics education, then the country will be able to get specialists in technical fields, and will have technical and economic development during the next decade. And then, all of us together, we will change these results to better ones, each of us by virtue, of our.

References:

1. Anderson L., Krathwohl D. (2001) A taxonomy for learning, teaching and assessing: a revision of Blooms taxonomy of educational objectives. Addison Wesley Longman, Ink. / Anderson L., Krathwohl D. – New York : NY, 154 s.
2. Bloom, B.S. (1956). Taxonomy of educational goals: classification of educational goals: Handbook I, cognitive subject. New York; Toronto: Longmans, Green. (in English)

3. Heathfield D. Rhythm, rhyme, repetition, reasoning and response in oral storytelling [D. Heathfield. Rhythm, rhyme, rehearsal, reasoning and response in oral storytelling], http://www.teachingenglish.org.uk/articles/rhythm-rhyme-repetition-reasoning-response-oral-storytelling
4. Hibbing A. N. (2003) A picture is worth a thousand words: Using visual images to improve comprehension for middle school struggling readers. [A. N. Hibbing, J. L. Rankin-Erikson A picture is worth a thousand words: Using visual images to improve comprehension for middle school struggling readers], The Reading Teacher. № 56(8). – pp. 758–770.
5. Murzagaliyeva A.E., Otegenova B.M. (2015) Tapsyrmalar men zhattygular zhinagy. Bloom taxonomies boyinsha oku maqsattary. [Collection of assignments and exercises. Learning objectives according to Bloom's taxonomy]. Astana: "Nazarbayev Ziyatkerlik mektepteri". Pedagogykalyk sheberlik ortalygy. (in Kazakh)
6. Solberg Nes L., Evans D. R., Segerstrom S. C. (2009). Optimism and college retention: mediation by motivation, performance, and adjustment. *J. Appl. Soc. Psychol.* 39, 1887–1912.