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Опрос на лекции как фактор развития метакогнитивных навыков студентов вуза

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Аннотация. Цель исследования - установить влияние регулярного опроса во время лекции в университете на развитие метакогнитивных навыков студентов. В статье раскрывается методика трехэтапного опроса, состоящего из метакогнитивного контроля (самоанализа и самооценки), регистрации результатов и проверки фактического уровня усвоения обучающимися учебного материала. Научная новизна исследования заключается в том, что предлагаемая методика открывает возможности для развития таких метакогнитивных навыков студентов, как самоанализ (отражение качества своего познавательного процесса и эмоционального состояния) и самооценка (фиксация результатов этого отражения). В результате было установлено, что проведение регулярного трехэтапного опроса во время лекции развивает навыки самоанализа и самооценки у студентов и повышает академическую успеваемость студентов.

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In-Lecture Survey as a Factor of Developing University Students' Metacognitive Skills

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Abstract. The aim of the study is to determine the impact of a regular in-lecture survey on the development of university students' metacognitive skills. The article reveals the methodology of a three-stage survey consisting of metacognitive control (self-analysis and self-assessment), registration of results and verification of the actual level of students' assimilation of educational material. The scientific novelty of the research lies in the fact that the proposed methodology opens opportunities for the development of such students' metacognitive skills as self-analysis (reflection of the quality of their cognitive process and emotional state) and self-assessment (fixation of the results of this reflection). As a result, it has been found that conducting a regular three-stage in-lecture survey develops students' self-analysis and self-assessment skills and increases the academic performance.

Introduction

The relevance of the study. There is a demand for specialists capable of continuous professional self-improvement, ready to learn throughout their lives in modern society. So, today the university community faces the challenge of not only giving a student subject knowledge, but also helping to develop the ability to self-educate to become a self-regulating learner. Empirical studies have shown that the more self-regulating students are, the more effective and successful they are (Pintrich, 1995; Zimmerman, Schunk, 2001; Ишков, 2013).

One way to evolve students' self-learning and self-regulation skills is the development of metacognitive skills (Дарханчимэг, 2020; Карпов, 2018; Протас, 2022). O. Protas (Протас, 2022) notes that "metacognitive skills provide a solid foundation for self-development" (p. 11).

Metacognitivism is a broad and diverse concept which is characterized by a variety of approaches and a large empirical base of the results obtained (Бызова, Перикова, Ловягина, 2019). According to the psychologists D. Chartier and E. Loarer (Шартье, Лоарер, 1997), metacognitive skills are formed and developed as a result of the regulation of cognitive processes.

The importance of developing metacognitive skills is beyond doubt in the scientific community. There is a number of metacognitive strategies that have shown their effectiveness in higher professional education (Беленкова, 2022). However, the practical implementation of research recommendations is slow.

The pedagogical content of metacognitive strategies and their implementation in real practice have become the subject of this study. A methodology of a three-stage survey as an additional structural element of a university lecture has been developed. The purpose of introducing the survey into the lecture is to create pedagogical conditions for the development of students' metacognitive skills (self-analysis and self-assessment). The three-stage survey (TSS) consists of metacognitive control (self-analysis and self-assessment), registration of its results and assessment of the actual level of students' understanding of educational material. The choice of the TSS methodology is due to the fact that the functions of metacognitive regulation are carried out through the strategies that are expressed in planning one's activities, using the information received, monitoring the cognition process, detecting and correcting errors and evaluating them (Кислякова, 2010). TSS, playing the role of feedback, allows educators to monitor the learning process (the level of assimilation of educational material), developing the self-analysis and self-assessment skills among students.

To achieve the goal of the study, the following tasks were set:

- 1) to characterize the sense of the concept of "metacognitive control of university students" in pedagogy;
- 2) to describe the methodology of a three-stage survey introduced into the structure of a traditional university lecture;
- 3) to conduct an empirical study to identify the impact of a regular in-lecture survey on the development of students' metacognitive skills.

The following methods were used to conduct the research: analysis and synthesis of scientific-pedagogical and scientific-psychological sources of literature; pedagogical experiment; comparison and evaluation of the data obtained.

The theoretical basis of the study was the research of A. Fomin and E. Bogomolova (Фомин, Богомолова, 2019; Фомин, 2019) on the problem of finding psychological and pedagogical conditions for obtaining meta-subject results. Authors solve this problem through the development of the ability to track accurately the process and results of cognition in learning (Фомин, 2019, p. 10). The work of O. Protas (Протас, 2022) allowed us to make sure that metacognitive skills form the basis for future professional activity and are evolved in the process of applying metacognitive strategies. The studies of A. Ishkov (Ишков, 2013), A. Zobkov, A. Turchin (Зобков, Турчин, 2013) were used to comprehend the role of metacognitive skills and ways of creating pedagogical conditions for their development in educational activities. The research of V. Byzova, E. Perikova, A. Lovyagina (Бызова, Перикова, Ловягина, 2019), A. Karпов (Карпов, 2018), A. Litvinov, T. Ivolina (Литвинов, Иволина, 2013) helped us to study the psychological mechanisms of the formation of metaskills and their role in the development of self-regulation skills. The work of N. Shestak (Шестак, 2018) allowed us to discover the problems of improving the academic lecture.

The practical significance of the study was expressed in the formation of the experience of metacognition among the students of the experimental group, as well as in obtaining the results confirming the possibility of developing students' metacognitive skills using the survey methodology in university lectures.

Results and Discussion

Metacognitive control of university students

In psychology, metacognition is understood as "the psychological activity during which the study, control and management of cognitive processes is carried out" (Бызова, Перикова, Ловягина, 2019, p. 126). The concept of metacognitive control is included in the concept of metacognitive monitoring, which has an extension to the concept of metacognition and is considered as "a special cognitive process aimed at understanding cognitive activity, or understanding and having control over thought process and learning activity" (Литвинов, Иволина, 2013, p. 59).

A. Fomin and E. Bogomolova (Фомин, Богомолова, 2019) found a relationship between the accuracy of students' judgments about the results of their educational activities and academic performance. Moreover, "students who evaluate their competence in learning more precisely show a significantly higher success in learning; low-performing students are characterized by excessive confidence in the correctness of their solution of educational problems" (Фомин, Богомолова, 2019, p. 127). The psychological impact of metacognitive control on the academic performance of students is such that it requires continuous use in the educational process (Фомин, Богомолова, 2019, p. 134).

Metacognitive skills are developed during motivated learning activities. One of the methodologies for studying metacognition in psychological and pedagogical research is the assessment of metacognitive functioning through observation of academic work (Фомин, 2019). The pedagogical conditions for the successful implementation of this methodology are the setting of an educational task for the student, monitoring the implementation of this task and the results of its implementation (Фомин, 2019, p. 71-72).

Summarizing the above, it can be concluded that the pedagogical conditions for the development of metacognitive skills in the educational process should include setting a clear learning task for students; tracking the process of its solution; fixing the results of its implementation. A special requirement for these conditions is the constancy of the application of these conditions in the educational process.

The methodology of a three-stage survey (TSS)

TSS takes place in every lecture and consists of three stages. At the first stage, which lasted throughout the lecture, the presentation of the educational material was accompanied by questions from the teacher about understanding and comprehending what was being discussed at the lecture. The questions were asked in order to direct

students' attention to their own state of understanding or misunderstanding of the educational material. Thus, during the lecture, the students focused on their state of understanding the material being studied.

At the second stage of the TSS, metacognitive monitoring (students' self-assessment) was carried out (Survey #1). At the end of the lecture, the students were asked to answer the question: "How long, according to your feelings, you were in a state of understanding of the educational material that was studied today?". Each student assessed their own state of understanding the educational material and expressed it in numbers. To simplify their task, we have developed a table of correspondences between quantitative and qualitative levels of understanding (Table 1).

Table 1. *Quantitative and qualitative levels of students' understanding of the educational material during lectures for self-assessment*

Qualitative description of the state of understanding the educational material	Percentage of total lecture time, %	Quantitative level of students' comprehension
I did not comprehend anything during the lesson.	0-20	1
I understood a few things during the lesson.	21-40	2
During the lesson, sometimes I comprehended and sometimes I did not comprehend the educational material.	41-60	3
During the lesson, I most often comprehended rather than did not comprehend the educational material.	61-80	4
I comprehended the educational material throughout or most of the lesson.	81-100	5

At the third stage of the TSS, which took ~5 minutes right after Survey #1, an assessment of the students' understanding of the educational material was carried out (Survey #2). One of the features of Survey #2 is that it is conducted immediately after the presentation of new educational material to students. The other feature is its structure and content. It consists of first-level closed multiple-choice questions (Беспалько, 2018, p. 190-195). This means that Survey #2 tests knowledge at the level of understanding of the educational material. The sequence of questions followed the logic of the material presentation during the lecture. This was done so that the students could rethink the content of the educational material at the end of the lecture and, in a situation of choice, repeat the course of reasoning again. The questions had 3-5 answer options. It was necessary for the students to choose one or more correct answers. The answer options were chosen in such a way that it could lead the students to the right idea. Another purpose of the survey was to "involve" the students in an active learning process. The students used their notes made during the lecture to answer the questions. An example of Survey #2 is in the Appendix.

After such a survey, each student had two grades: self-assessment and assessment of their understanding of the educational material. The teacher had aggregate information about the levels of the students' understanding.

To analyze the dynamics of changes in the students' self-assessment (Survey #1) and an objective assessment of the students' understanding of the educational material (Survey #2), we used the correspondence table (Table 2).

Table 2. *Matching scores for Survey #1 (students' self-assessment) and Survey #2 (students' understanding of the educational material)*

Survey #1		Survey #2	
Quantitative level	Percentage of the total lecture time, %	Grade	Number of correct answers, %
1	0-20	1	0-20
2	21-40	2	21-60
3	41-60	3	61-73
4	61-80	4	74-86
5	81-100	5	87-100

The accuracy of metacognitive judgments (i.e. how close self-assessment is to an objective assessment) is usually measured by checking the calibration of students' judgments. Calibration, also known as absolute accuracy, shows the ability to make judgments that precisely reflect an objective assessment of knowledge (Rhodes, 2015). In an educational context, calibration is related to students' ability to judge when their knowledge is sufficient to achieve their goals (Shraw, 2009). We defined calibration as subtracting Survey #2 scores from Survey #1 scores. This indicator also allows exploring students' excessive confidence and self-distrust. In the study, if the calibration bias is positive, it indicates students' overconfidence, and a negative bias indicates a lack of students' confidence.

Empirical study results regarding the impact of a regular in-lecture survey on the development of students' metacognitive skills

The study was conducted at Primorsky Institute of Railway Transport in spring semester 2021/2022. The methodology of a three-stage survey was used at lectures in calculus for first-year engineering students for eight weeks (1 lecture, 2 academic hours per week). The total number of students was 63.

The average values of the results for Surveys #1 and #2 are shown in Table 3 and in Figure 1a. The scores for both surveys demonstrate growth dynamics throughout the experiment. Figure 1b shows how the calibration of metacognitive judgments has changed for the average value of two types of assessments during the experiment. The calibration of the students' judgments is maximal and positive, which indicates the students' excessive self-confidence at the beginning of the experiment. These data mean a low level of the students' awareness about the understanding or misunderstanding of the educational material. Then the calibration decreases, remaining positive, it denotes an increase in the accuracy of metacognitive judgments. In the seventh week of the experiment, the calibration of judgments became negative, it indicates a lack of the students' confidence. In the eighth week, it became a little higher.

Table 3. Average values for Survey #1 (students' self-assessment) and Survey #2 (students' understanding of the educational material)

Week	1	2	3	4	5	6	7	8
Survey #1	2.58	2.83	2.83	3.13	3.29	3.38	3.50	3.83
Survey #2	1.79	1.88	2.42	2.79	3.08	3.29	3.58	3.63

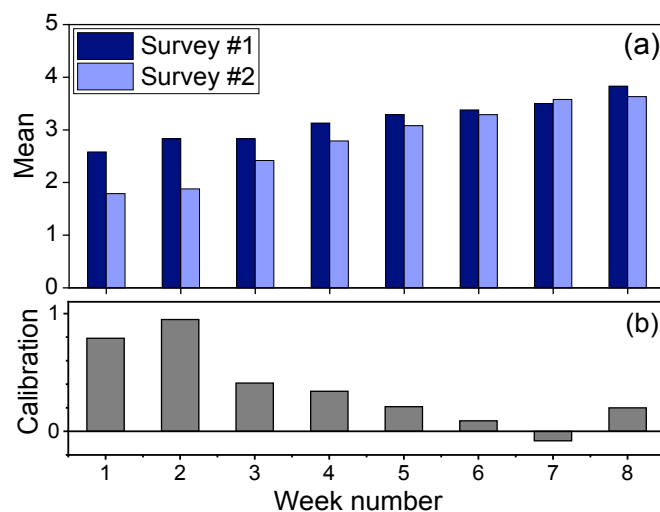


Figure 1. (a) The average value for Survey #1 and Survey #2
(b) The dynamics of calibration of the students' metacognitive judgments

At the end of the experiment, we conducted an anonymous survey (Final Survey) of the students to get feedback about the used methodology of a three-stage survey. The following survey was proposed: "Dear student! For eight weeks, you were asked to independently assess your subjective state of understanding of the teaching material at the lecture. Please answer the following questions and express your opinion in a free form: 1) What did you like and what did you not like about the methodology of a three-stage survey? 2) Has your self-assessment ability changed? If so, do you associate these changes with the survey conducted at the lecture? 3) Has it become easier or harder for you to study during these 8 weeks? What do you think the reasons for these changes are? Thanks! We wish you success in your further studies". This Final Survey allowed the students to express themselves freely, and the teacher received feedback about the experiment.

The results of the Final Survey showed that the majority of the students (81%) positively assessed the used methodology of a three-stage survey. The remaining 19% could not decide on their assessment. There were no negative ratings. To the second question of the Final Survey, 68% of the students answered that they noticed an improvement in the ability to objectively assess their understanding or misunderstanding of the educational material by the end of the experiment. They linked these changes to the methodology used. 64% of the students said that it became easier for them to study. The students noted that the results of Survey #2, received immediately after the lecture, indicated gaps in understanding, so this allowed them to regulate the process of self-learning.

Thus, a regular in-lecture survey creates conditions for the students to realize their own knowledge. An analysis of the calibration of the accuracy of metacognitive judgments by the average score shows that the accuracy of the students' metacognitive judgments increased throughout the experiment. The gap between self-assessment and an objective assessment of understanding of the educational material is narrowing. This means that the students begin to monitor their current state of understanding of the educational material. Control over one's understanding influences students' learning behavior and allows them to make effective decisions and choose effective learning strategies. As a result, the real level of understanding of the educational material in the classroom increases.

It is interesting to note that the students' self-assessment remained slightly revalued by the end of the study. Probably this will create a gradient towards the students' self-development, personal growth, and the pursuit of knowledge.

Since many students participate in lectures at the university, the teacher works for the entire audience simultaneously and equally for everyone. The inclusion of the presented survey in the lecture allows teachers to direct

a disparate flow of information addressed to everyone at once, activate individual mechanisms of self-regulation, personal aspirations of each student. These two oppositely directed energetically filled streams of information (from a teacher to a student, and vice versa) form a closed information space, thereby changing the quality of the educational process. The educational process is becoming more individualized, focused on the cognitive needs of students.

Conclusion

The analysis of the literature showed that metacognitive control is essentially related to metacognition and has an impact on learning outcomes. The psychological impact of metacognitive control on students' academic performance is such that it requires continuous use in the educational process. The authors have developed a methodology of a regular in-lecture survey as a factor contributing to the development of metacognitive skills of university students. The survey consists of metacognitive monitoring and students' understanding of educational material.

The results of the study showed a positive effect of using the three-stage in-lecture survey methodology to strengthen students' metacognitive skills (self-analysis and self-assessment). The accuracy of the students' metacognitive judgments (i.e. how close self-assessment is to an objective assessment of knowledge) increased throughout the experiment.

Based on the Survey #2 results, it can be argued that the proposed methodology has a positive effect on the assimilation of the material by the students. So, the students' progress increases. Using the methodology of a regular three-stage in-lecture survey contributed to a more active involvement of the students in the educational process.

During the experiment, the students developed not only motivation to study, but also self-confidence and a desire to study at the university. Based on the Final Survey results, 64% of the students said that it became easier for them to study. The majority of the students noted an improvement in self-assessment skills and attributed these changes to the methodology of a three-stage survey.

Thus, metacognitive monitoring and testing of learning material comprehension conducted together develop students' ability to think holistically, forming adequate self-assessment.

Further research perspectives are in the direction of using computer technology to speed up a regular in-lecture survey.

Appendix

An example of Survey #2

Dear student! Answer the following test questions by choosing the correct answer in your opinion. There may be more than one correct answer among the given answers.

1. What are the names of the equations whose solution is a function?
 - a) linear;
 - b) transcendent;
 - c) functional;
 - d) differential.
2. What is the distinguishing feature of differential equations from other types of equations?
 - a) the presence of only the differential of the function;
 - b) the presence of only a derivative function;
 - c) the presence of a derivative of a function and/or its differential;
 - d) the presence of an independent variable x , a function y of one or more variables, its derivatives or differentials.
3. What is the solution to a differential equation?
 - a) any real number;
 - b) y function;
 - c) any real number or y function;
 - d) derivative of the function y' .
4. What differential equations are called ordinary?
 - a) whose solution is any function;
 - b) for which the solution is a function of one variable;
 - c) for which the solution is a function of several variables;
 - d) whose solution is the derivative of the function y' .
5. How to check if a certain function is a solution of a given differential equation?
 - a) there is no way to do it;
 - b) you can substitute this function into the equation and get the correct number;
 - c) you can substitute the given function and its derivatives into the equation and get an identity;
 - d) you can find the derivative of this function and substitute it into this equation.
6. What is the order of a differential equation?
 - a) the number of terms in the equation;
 - b) a number reflecting the exponent of the y function;
 - c) a number reflecting the exponent of the independent variable x ;
 - d) a number that reflects the highest order of the derivative of the y function.

7. What is the process of solving a differential equation called?
 - a) integration;
 - b) differentiation;
 - c) logarithm;
 - d) potentiation.
8. What is the general solution of the n th order differential equation?
 - a) a function of the form $y=f(x, C_1, \dots, C_n)$;
 - b) all possible functions y_1, y_2, \dots, y_n ;
 - c) a function of the variable x and n arbitrary independent constants C_1, \dots, C_n ;
 - d) all independent constants C_1, \dots, C_n .
9. What is a particular solution of the n -th order differential equation?
 - a) a solution obtained from the general one for specific numerical values of the constants C_1, \dots, C_n ;
 - b) a solution that is under certain initial conditions;
 - c) one of the general solutions;
 - d) some of the general solutions.
10. What is the Cauchy problem?
 - a) the problem of finding a general solution of differential equations;
 - b) the problem of finding a general and a particular solution of differential equations;
 - c) the problem of finding a particular solution of differential equations according to the initial conditions;
 - d) the task of checking the initial conditions.

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