

Meta-Cognitive Technologies in the Training of Students-Future Teachers

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Abstract

The relevance of the study is determined by the importance of solving the problem of training a future specialist, a subject teacher who has professional competences formed at a new level. The article is aimed at studying the innovations in modern teaching, techniques, technologies and methods for improving the quality of the didactic interaction of subjects of the educational process within the framework of higher professional pedagogical education by the way of the example of training future mathematics teachers. At present, the problems associated with the disclosure of the didactic capacities of modern educational meta-cognitive technologies of a reflexive nature in the context of the practice-oriented professional training of future specialists remain inadequate, and in particular, in the formation of highly developed subject-specific thinking as one of the form of professional thinking of the future specialist. The article reflects the results of the experimental work having been carried out to introduce a didactic model of forming subject-specific thinking of the students, future teachers of mathematics, by means of metacognitive reflexive technologies in the synthesis with information and communication technologies. The investigation used the following methods: theoretical (the analysis of psychological and educational literature on the research problem, the study of mass and the generalization of advanced pedagogical experience, the pedagogical modeling), empirical (pedagogical observation, conversation, questioning, interviewing, testing). The materials of the article can be useful for practical professional activities of the teachers of higher educational institutions, the trainees of the system of additional professional education of pedagogical personnel, and all those who are interested in the theory and practice of implementing modern educational technologies.

Keywords: Educational technologies; Metacognitive; Training; Future teachers.



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1. Introduction

At present, the priority task of modern higher school is the preparation of an active, creative and independent personality of the future specialist with thinking settings that form intellectual skills and strengthen reflexive mechanisms in both educational and future professional activities. This requires new approaches, new tendencies in improving the substantive, organizational and activity, evaluation and effective components of education, etc. (Bannert *et al.*, 2017; Gotoh, 2015; Zakirova and Koletvinova, 2014).

In this connection, the ways, forms and methods of work connected with meta-cognitive reflexive technologies acquire special significance in the practice of modern higher education, which, in a synthesis with the means of information and communication technologies, stimulate the independence and creativity of the students.

This article deals with the description of the stages of solving the indicated problem with reliance on the didactic model of the formation of subject-specific thinking of the students using the methods of metacognitive reflexive technologies in the synthesis with information and communication technologies (Razumova *et al.*, 2017).

2. Materials and Methods

The following approaches and methods were used in the course of the study: systematic approach for revealing the nature of the problem; classification, systematization, generalization of pedagogical experience on the problem under study; observation, comparison, questioning; analysis of the results obtained.

The study was carried out with the students of the pedagogical department of N. I. Lobachevsky Institute of Mathematics and Mechanics of Kazan (Volga) Federal University (Villalobos, 2013).

3. Results and Discussion

A significant number of works deal with different aspects of the introduction of educational technologies in the educational process and their influence on certain types of thinking (V.P. Bepalko, V.V. Davydov, N.V. Kuzmina, G.K. Selevko, V.A. Slastenin, V.F. Shatalov) (Andreev, 2012; Selevko, 1998; Slastenin, 2008; Vershlovsky and Sukhobskaya, 2007).

The opportunities to increase the effectiveness of the entire education system as a result of the use of information and communication technologies are revealed in the works by the following scholars: G.P. Andreeva, A.A. Kuznetsova, C. Preston, I.V. Robert, T. Eisenberg (Hu and Webb, 2009; Panyukova, 2010; Robert, 2010).

Currently, the technologies of meta-cognitive reflexive character which lie in emphasizing personal mechanisms of thinking, forming intellectual skills and reinforcing reflexive mechanisms in educational and professional activities are put forward (Yu. N. Kulyutkin, I.V. Mushtavinskaya, S.A. Terno, P. Huston) (Al-Hunaiyyan *et al.*, 2017; Hunaiyyan *et al.*, 2017; Mushtavinskaya, 2011;2014; Terno, 2013).

The conceptual-theoretical and concrete content model of the organization of students' educational activity developed by the authors is based on the updated educational technologies (reflexive metacognitive technologies, information and communication technologies) and includes the components, such as: motivational and target, axiological, activity and procedural and reflexive and evaluative (Razumova *et al.*, 2017).

Our experimental research is focused on the possibility of increasing the level of students' creative independence, as a form of manifestation of subject-specific thinking, through the synthesis of reflexive metacognitive technologies with the means of information technology. As a result of the experiment, a certain educational environment was created that actively engages the subjects of the educational process into creative work, into the improvement of professional competencies, personal qualities (Antúnez, 2018).

When carrying out the experimental work, we were guided by the basic principles of pedagogical research: objectivity, holistic approach to pedagogical research, consideration of the personal factor in pedagogical research, study of the phenomenon in its development and links with other phenomena of the process, etc.

At the first stage, the level of subject-specific thinking of future specialists was diagnosed, the students interpreted this kind of professional thinking, revealed the forms of presentation of this thinking, the importance of priority development of independent creative activity. The productivity of such work depended to a large extent on the additional efforts of the teachers, which aimed at analyzing the back action with subsequent discussion. The monitoring was also conducted by the cards of self-rating and expert evaluation of the teacher's competence.

Diagnostics revealed the following theses: the half knowledge by the students of the importance of subject-specific thinking in the process of forming personal and professional qualities of the future teacher; a low level of active independent search thinking activity in solving various types of problematic tasks of a professional orientation; a low level of flexibility and speed of switching of thinking, the ability to find the most exact solution from a number of approximate ones.

At the second stage of the experimental work, the developed model of the organization of student learning activities was introduced, based on the use of synthesis of metacognitive reflexive technologies with information and communication technologies. The model under consideration is based on personality-oriented, competent, reflexive approaches. The interaction between the subjects of the educational process - the teacher and the trainees, as well as between the trainees themselves - occurs in the context of reflective creative and technological environment, represented by instrumental and creative components, ensuring the achievement of the effectiveness of the process with the consideration of the individual traits of the trainees and developing the students' reflexion.

Within the bounds of this article, we confine ourselves to describing one of the stages of the activity-procedural level of the proposed model. In particular, let us dwell upon some parts of the work on the disciplines of subject series. An increase in the status of the subject-specific thinking as a whole and, in particular, the creative independence of the future teacher occurs in solving the problems that comprise certain problem situations, which are either specific-objective or methodical tasks in the subject area under study.

The model was realized during the classes on the method of teaching geometry, elementary mathematics, free electives ("Modern means of assessing the quality of education", "Psychological foundations of teaching mathematics", "Information technology in education").

In the proposed model, lectures were delivered using the method of "advanced lecture", based on active attending by the students and on partner relations between the teacher and the students, established according to a problem-dialogical type with the possibility of using dynamic and static cadres of computer software packages. The material of the lecture was divided into several logical parts, each of which was constructed as "Challenge – Comprehension of the Content (Listening to the Lecture) – Reflection". At the stage of challenge before listening to the lecture, the students answered questions that had both a motivational function and a function of actualizing the experience (What do I know?). Then, during the lecture, the trainees sought the correspondence of their initial assumption answers with the material of the lecture. The results obtained were discussed at the stage of reflection. The information received in this way was acquired by the students as a personal discovery of knowledge that they did not know.

Consolidation of the lecture material was carried out in practical and laboratory classes, built in the form of discussions, conferences, business games and trainings. The organization of these classes was based on the principles of presence of problems, the dominant information component and "negative experience". New teaching elements are included in the content of practical classes: the tasks of a problem nature aimed at studying, analyzing and estimating the errors made in concrete real situations; problem tasks that permit errors on the part of the student, that make it possible to discover the pattern of wrong reasoning and develop the appropriate tactics for further actions. Thus, the formation of new experience is carried out by creating problematic dialogical situations, which are formed on the basis of emerging contradictions, which require the decision of the full inclusion of a certain type of thinking.

We emphasize the peculiarities of the organization of practical and laboratory training courses "Teaching methodology for mathematics", "Methodology for teaching mathematics on a bilingual basis" (bachelor's degree program - 3, 4 courses) using gaming technologies.

In the sixth semester, within the framework of the above-mentioned academic discipline, the students master technologies and methods for studying the content lines of the school course of geometry. Several classroom sessions are devoted to the topic “Basics of building a school course in geometry”. The tasks of these classes include: the identification of didactic bases for constructing a lesson in geometry; the development of a lesson in geometry and the presentation of the results in the form of a lesson scenario; direct conducting a geometry lesson using modern educational technologies.

The students independently choose the topics from the course of geometry to develop a lesson scenario in accordance with all the legal and regulatory foundations of teaching this discipline in high school. At a later time the learning experiences happening within the classroom are in the form of role-playing games “The lesson of Mathematics”, where each student one after another gets either a teacher role (all the rest are his students) or a student (respectively, one of the students is a teacher). In addition to the fact that the students play the role of students within the classroom environment, they must simultaneously act as specialists, the teachers of mathematics, and perform a full analysis of the lesson taking place. Then a discussion is organized, where all the points of the lesson are discussed - the positive aspects of the student’s work, as well as weak points. In conclusion, the teacher states the achieved results, formulates the final result of the lesson.

The main goals of this role-playing game are: modeling the subject and social content of future professional activities; solution of professional problems, difficulties that are often encountered by young professionals during the course of the lesson using innovative techniques.

In the same semester the topic “Modern school textbook of geometry” is studied. The following tasks are being solved: identifying the features of textbooks on geometry included in the Federal component (considering the conceptions of each textbook); defining the role in the current structure of education, conditions of use; developing the logical-didactic analysis of the material of the school textbook of geometry.

The final class happens in the form of a conference lecture. The students are divided into the following groups: several groups (5 people each) – respectively, the representatives of composite author of textbooks on geometry; one group (2-3 people) – the representatives of the management of educational institutions of the city, one group – the representatives of the press (journalists) and one (2-3 people) – the teachers of mathematics. The questions that reveal the historical development of the textbook of geometry, starting with the period of the 18th century are discussed at the beginning of the lesson. At the next stage, each of the representatives of the composite author of school textbooks advertises and demonstrates the benefits of their manual with the help of the independently developed computer program “Modern Geometry Textbook” (considering the requirements for the analysis of geometry textbooks). In addition to this, the developers articulate the results of the conducted survey on the application of their textbook in schools. The representatives of schools, the journalists, in turn, ask questions related to the appropriateness of using a specific educational and methodological set in educational process in schools, the correspondence of these study aids to modern concepts of constructing a course of geometry. The result is the identification of a school book that best meets the modern requirements for school textbooks. It should be noted that as a result, after graduation of the students from university, most of the young specialists, the teachers of mathematics, choose the geometry textbook which was highly appreciated within the above classroom learning.

The main goal of the described game is the development of professional elementary competencies related to the collection and analysis of the information educational environment that realizes the principles of modern didactics, the ability to self-education, the willingness to use educational programs in academic subjects in accordance with the requirements of educational standards, and purposeful regulation and control of one’s own activities.

The results obtained in the course of the work have shown that the trainees form their professional competences at a new level, active independent search thinking activity leads to the formation of unique properties of the future specialist, and the level of subject-specific thinking increases. The answers of the students were well-reasoned, grounded, and logical. The development of technology lesson schemes was carried out in accordance with the requirements of FSES. Being immersed in a situational professional activity, the students demonstrated a fairly high level of proficiency in the basics of vocational and ethical culture.

The final, the third stage of the study is generalization. In order to draw conclusions about the effectiveness of the developed model of the organization of the students’ learning activities, in particular, to determine the quality of the students’ skills that characterize creative independence as an integral element of object-specific thinking, we have developed a package of final professional practical work consisting of creative tasks of a problem nature. In particular, the students were offered to develop mathematics programming tools used to develop the students’ mathematical thinking, intended primarily to help the student’s thinking process. Later in the course of pedagogical practice in the educational institutions of the Republic of Tatarstan, the students tested the developed computer programs and evaluated the efficiency of using computer products in the process of teaching mathematics, based on the assessments of the success of students and educational effect. The estimation of the quality of the created software was carried out in accordance with the criteria of the psychological, didactic, technical and ergonomic level.

Such a work supposed: the selection of school mathematical material of a problem nature; the identification of the level of knowledge, skills, the formation of the main universal educational activities of the students in mathematics; the setting of the purpose of the educational task of a problem nature, such as contradiction; the choice of the way to organize the process of solving the problem situation, the method and means of solving the educational task; the revelation of the importance of information obtained in the process of its solution. The future specialist should understand what methodological task he will solve with the aid of computer and information and communication tools during the lesson, how this idea has been realized at the program level, what tools were used to

create this program and how the program can be modified depending on educational purposes, level of preparation of the students, and also to think over, develop and make corresponding assignments for the organization of the educational process in class (pre-viewing activities, while-viewing activities, post-viewing activities). Thus, the future teacher needed to have both a structural-systemic, holistic view of the material of the academic discipline, and specialized means and technologies for constructing this content.

As a result of this experimental stage, the students have created specific products, namely: illustrative demonstration computer programs on school sections of mathematics with visualized and animated elements based on the latest tools of modern information and communication technologies (the universal modeling software tools such as GeoGebra, a package of symbolic mathematics Maple, KOMPAS 3D computer-aided design system, computer systems of Maxima algebra); training mathematical mini-games, developed as small applications, including Android OS, in the development of Gideros Studio using Lua programming language.

The obtained results are indicative of the formation of students' understanding of the permanent search for effective forms and ways to increase the productivity of the solution of professional subject problems, the manifestation of a high level of creative independence in the organization of methodological work.

In general, in the course of experimental research, the development of subject-specific thinking was determined by the following indicators: the student puts forward an educational and cognitive problem based on his pedagogical experience, a hypothesis for solving the problem; the student expresses his standpoint in solving this problem, and also critically approaches the possible alternatives; the student "sees" the effectiveness of using active learning tools in solving the problem, systematizes knowledge and creates its own basis for solving the problem (Demchenkov et al., 2018).

4. Summary

In the course of this study, we arrived at the following main conclusions:

1. It has been determined that the synthesis of metacognitive reflexive technologies with information and communication technologies influences the formation of the form of subject-specific thinking of the students, such as creative independence.

2. The application of a systematic, purposeful approach to the development of professional training of the students on the basis of the synthesis of metacognitive reflexive technologies with information and communication technologies ensures a high level of formation of the subject-specific thinking of future teachers on the whole.

3. For the university educational process, this synthesis brings about fundamentally new didactic opportunities for creating the prerequisites for intensifying the educational process.

5. Conclusion

The metacognitive reflexive technologies synthesized with information and communication technology increase the level of formation of subject-specific thinking of the future teacher, as one of the variety of professional thinking. It is especially important for the teacher, because, firstly, it is one of the most intellectually loaded professions, and secondly, only the teacher having a high level of professional thinking can successfully accomplish the task of forming the thinking of the students with whom he works.

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