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Study on Willingness of Future Math Teachers to Enhance the Learning and Cognitive Activity of Students

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ABSTRACT

The urgency of the problem stated in this paper results from the fact that willingness of students to organize future professional activities requires the correction of contents, forms and methods of practical classes on techniques of teaching mathematics, as well as the improvement of programs of all types learning and teaching practices. The leading methods to the problem of the study were: theoretical analysis and familiarization of studies, questionnaire surveys, overt observations, design methods, analysis of creative activity products. The study involved about 1,000 students, 50 young teachers, and 15 university teachers. The main purposes of the study are to identify the means of training future math teachers to enhance learning and cognitive activities of students, to identify the main difficulties of students and young teachers in the organization and in enhancement of learning and cognitive activities of students, and to determine the level of willingness of students to enhance learning and cognitive activities (reproductive, functional, creative).

KEYWORDS
Learning cognitive activity; teaching methods; teaching practices; future math teachers

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Introduction

Urgency of the problem

A modern expert in any field of professional activity should have a solid grounding, he or she should be able to make their own decisions, choose and process necessary information, and should be able to take a creative approach to solving problems. The basis of this creative independence is laid in the education and professionalism of a teacher, his or her competence determines not only the successful education of students, but also their success in life, and in their future professions.

Preparation of future teachers in KFU is carried out in two ways: traditionally (based on Yelabuga Institute of KFU) and distributively (based on research and teaching departments in KFU specialized institutions, which possess modern teaching and laboratory facilities).

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Alongside "ekoneft" (ecological oil), "astrochallenge" and "translational 7P medicine ", "teacher of the XXI century" is one of the priority projects implemented recently by Kazan University.

As part of the new "Teacher of the XXI century" project, the integrative type of organizational structure will be implemented.

Subjective training of future teachers is carried out by specialized institutions (Institute of Fundamental Medicine and Biology, Institute of Mathematics and Mechanics named after Lobachevsky, and others), offering scientific and educational facilities, human and material resources for training purposes. Psychological and educational components of future teachers training are implemented by the Institute of Psychology and Education. Practical training of teachers takes place in KFU's lyceums and schools, through the school-university partnership.

We are interested in training modern math teachers at the Institute of Mathematics and Mechanics named after N.I. Lobachevsky.

Problem statement

The federal state educational standards of basic education are aimed at facilitating pupils to possess knowledge on subject and meta-subject levels as well as personal developments. The latter implies the willingness towards cultivating the habits of self-development, personal self-determination, motivation to learn and purposeful cognitive activities. Achievement of personal outcomes by pupils is possible first of all through the organization of learning and cognitive activities both within and outside the classroom. In the proceedings of Professor M.A. Tchoshanov (2011); the principles of a constructive and didactic thinking are provided, one of which is - "the process is more important than the result". That is to say, the way mathematical knowledge is obtained, facilitates the pupil's thinking, his ability to analyze, compare, generalize, and prove.

A teacher should master the competencies that contribute to enhancing the learning and cognitive activities of students. In this regard, it is necessary to become familiar with the ever-changing scopes of information, to create innovative approaches to educational solutions to problems, to design and plan the general learning process, to design it at different levels and stages, to use modern efficient methods and forms of education, and finally, to predict and analyze the results through periodical reflections and corrections of their educational activities. This determines the relevance of our research.

Basics of the professional work of future math teachers are formed in the course of studying the methods of teaching mathematics during pedagogical internships, which also includes term papers and final qualifying work implementation.

The methodical preparation of a future teacher is inextricably connected with the analysis of the three main interacting components of an educational process: syllabus and content, teaching process – the educative activity of a teacher, and the process of learning - cognitive activities of students (Lerner & Skatkin, 1980).

Research questions

In this regard, our work aims at studying the willingness of future math teachers to organize learning and cognitive activities of school students at a new level. First, we need to define the concept of "learning and cognitive activity." Let us consider how it is understood by some scientists.

O.B. Dautova (2011) determines the learning and cognitive activity as "the activity of a person, who is carrying out goal-setting on the basis of subject and coordination of personal problems; sourcing out solutions to these problems through the universal methods of activity; focusing on the system of significant value relations "I - the world" in order to obtain a supportive syllabus.".

E.Yu. Fedotova (2009) understands it as "a motivated and purposeful acquisition of educational contents by pupils, through actualizations of cognitive mental processes, aimed at skills and personal qualities development, ensuring the success of educational activities.

E.B. Korobiy (2014) notes that "cognitive activity in a general sense - is the unity of sensorial perception, theoretical thinking, and practice. It is carried out in every life stage of human development, in a variety of activities and social relations. However, only learning through education can be clearly shaped in a specific learning and cognitive activity, that is peculiar only to a person; this activity involves, for example, execution of such subject-practical activities in educational process such as; experimentation, design, projection, research and problems solving.

G.I. Shchukina (1979) characterizes cognitive activity as the integration of research teaching orientations, cognitive interests, and satisfaction, with the use of various sources of knowledge and favorable conditions for activity implementation.

V.A. Slastyonin & E.N. Isaev (2002) sees learning and cognitive activity as a "learning process, purposely organized by a student or externally, with the aim of acquirement of cultural wealth accumulated by humanity", at the same time the author notes that "its objective results are scientific knowledge, skills, behavior patterns and types of activities that can be mastered by a learner".

E.P. Tarasova (2006) comprehends learning and cognitive activity as a "holistic activity in the unity of its components (learning and cognitive tasks solving, self-control, and self-evaluation) aimed at learning about the world, and having, as a result an all-round personality development of students through the acquisition of new knowledge and skills, i.e. obtaining cultural experience. This definition reflects our point of view to a greater extent.

The education is impossible without the simultaneous dynamic activities of teachers and students, without their active cooperation. No matter how actively a teacher aspires to give knowledge, there is no educational process unless students themselves learn actively and a teacher motivates and provides the organization of their learning and cognitive activities.

V.A. Krutetskiy (1972) noted in his researches that "the maximal enhancement of cognitive activities of students and the development of their active and independent creative thinking, stands as an important task in education".

A.S. Raimkulova (2016) defines the enhancement of cognitive activities of students as a special system of a teacher's educational actions, through the

arrangement of learning and cognitive activities that meets the goals and objectives of active learning and flows in a certain mode.

In our study when explaining the concept of "enhancement of learning and cognitive activity" we focus on the definition of S.N. Yaroshenko (2004) who understands it as an inspiration to transfer a student from a reproducing level of learning and cognitive activity to a creative level, where student-reality interactions are characterized by his mastery of the system of scientific knowledge and methods of activity at a creative level.

The Scientific theory of educational processes involves the development of methods and ways of organizing learning, cognitive and research activities of students, which provides effective knowledge acquisition, skill exercising and formation of thinking and activity paradigm. The work of a teacher can be effective only when it is based on knowledge of the internal mechanisms of teaching, the understanding of how students reflect and the interpretation of the acquired information in the educational process. Thus, the interaction between teachers and students cannot be reduced to a ratio of "transmitter - receiver." There is a need for active cooperation of all participants in the educational process. French physicist Pascal stated that "a pupil is not a vessel that needs to be filled, but a torch which needs to be ignited". Thus, education can be defined as a purposeful process of active interactions between teachers and students, through which the students obtain knowledge, skills, ways of thinking and acting on the basis of their own activity.

One of the main structural parts of this interaction is the operational activity component that is implemented by specific methods, techniques and instruments of teaching and learning.

Purpose of the study

The purpose of the study is to prepare future teachers of mathematics to enhance the learning and cognitive activity of students. Aims are seen in the adjustment of the content, forms and methods of practical classes on techniques of teaching mathematics and in the improvement of programs of all types of learning and teaching practices.

Materials and Methods

To identify students' perception of active techniques of teaching mathematics, and ways of students' cognitive activity enhancements, the second and third-year students of the pedagogical department (Institute of Mathematics and Mechanics, Kazan Federal University) were surveyed with questionnaires. It was carried out both before and after the pedagogical internship, and both before and after studying the methodological course "mathematics teaching methods".

Since methodological disciplines are not studied in the first two years, it is clear that the second year students' responses can be explained by intuitive choices and personal experience.

When asked about the methods and techniques that can be used to enhance learning and cognitive activity of students in school, student-respondents gave a lot of interesting answers, showing that the topic is relevant to them.

Some student-respondents preferred playful teaching methods, pointing to the necessity to understand students' needs, awareness of their peculiarities,

provision of discipline in a classroom and reward of achievements in order to guarantee motivation to develop one's self personally, for the future.

Some students suggested using discussions, which can enable school students to actively share their ideas and opinions as well as talk and listen carefully to speakers. Some respondents pointed out to the need to create situations where a child would be able to show independence. Following the discussion, students proposed to allow each child to express his or her opinion and to say whether he agrees with the views of other children; that is believed to aid them to analyze and evaluate their own answers and answers of their classmates.

Students also offered to use the method of competition, which, in their opinion, stimulates efficiency of goal-achievement and the use initiative. However, it is necessary to strictly control the course of the lesson, keeping the children from turning a competition into a conflict; it should be carried out friendly and amicably.

One of the students offered a method, which she studied at the university, - a compilation of case studies on the subjects passed by the students. This practice, in her opinion, teaches children to look at the problem in a new way, get to know the "inside part".

It is obvious that students limit the understanding of the organization of learning and cognitive activities by a teacher to mean disciplining students. Third-year students, who have studied the methodological course "mathematics teaching methods", in their responses to the question of methods and techniques of facilitating mental activities of pupils emphasize the following: productive teaching methods (problem, algorithmic, heuristic, research, error method), creative tasks performance, entertaining tasks solution, use of interdisciplinary connections, didactic gaming, organization of work in smaller groups, debating and discussions, analysis and self-reflection of activity, collaboration (assistance of classmates on specific issues), organization of best projects exhibitions, praise and encouragement of pupils. Students pay attention to the fact that while engaging pupils in a process, a teacher should not forget about the use of visual methods, clear issue statements, stimulations, and motivations.

Thus, it can be seen that the second-year students used only intuitive ideas about methods and techniques of enhancing the learning and cognitive activities of students, while the third-year students have already been familiarized with them theoretically, but at the same time lack a systematic knowledge of methods, techniques and means of teaching.

Over the years, we have studied teaching activities of students of 4^{th} and 5^{th} courses during their pedagogical internship. At the beginning of their independent teaching practice, the task for students was to organize the learning and cognitive activities of students. In order to ascertain the abilities of students to organize this activity, we carried out analysis of the lessons given and "Diaries of pedagogical internship" of 940 students of the department of Mathematics of TSUHE and the department of teacher education of the Institute of Mathematics and Mechanics in Kazan Federal University, between 2002 and 2015.

Students were made to answer the question: "What difficulties did you meet in the organization of learning and cognitive activities of students?"; also their supervising teachers analyzed their activities during the practice.

Results and Discussions

We have identified the educational, personal, subject, and psychological reasons for the difficulties (see Table 1).

Table 1. Main faults and difficulties of trainee teachers in organizing learning and cognitive activities of students

Student's point of view (external performance)	Teacher's point of view (internal performance)
1. Pedagogical reasons	
1.1. Preparation for the lesson	
- Lesson goal setting;	- formal goal settings; - correct timing of the lesson; - choice of optimal pace of the lesson;
- Selection of teaching methods; - Differentiated selection of educational material;	- choice of effective teaching methods; - selection of tasks that engage students; - foreseeing difficulties students can meet while mastering the subject;
1.2. Organizing and carrying out the lesson	
- Resolution of problematic situations;	- resolution of controversial issues; - choice of the elaborative questions method, allowing students to see and correct their own mistakes; - imposing their own solutions when performing complex tasks, making students unable to personally get the desired result;
- Control of the whole class work;	- allowance of unified responses; - control of the whole class work; - focusing only on the student who answers at the blackboard; - working only with excellent students;
- Assessment of students' knowledge;	- assessment of oral and written responses; - full and clear conclusions and generalizations when summing up the lesson outcomes;
2. Personal reasons	
- Lack of experience; - Anxiety during the lessons;	- illiterate mathematical speech; - poor knowledge of educational material; - failure in presenting material intelligibly;
3. Subject reasons	
- Lack of knowledge of some math topics;	- difficulties in teaching geometry: in drawing, in formulation of geometrical propositions, in statement and evidence tasks, lack of spatial awareness, etc.; - difficulties in teaching trigonometry; - difficulties in teaching the elements of mathematical analysis; - difficulties in dealing with non-traditional tasks;
4. Psychological causes	
- Keeping the discipline.	- poor knowledge of methods, motivation, and stimulation of students; - failure to take into account psychological and age peculiarities of students; - inability to carry out an individual approach; - inability to choose the right style of communication; - inability to actualize educational possibilities of the lesson in terms of independent thinking of pupils formation; - problems with keeping the discipline.

The students themselves quite objectively and critically assess their own weaknesses, but at the same time, they saw only the external side of their actions, without feeling the internal mechanisms in the process of learning and cognitive construction of activities. There is a prevailing desire to impose their own lesson scenario, without taking into account intrinsic features of a class. Students were unable to lead pupils to an independent "discovery" of new knowledge and ways of activity, they could not use vivid "problem points", they tried to explain everything themselves, they were quick to point out errors, and it was hard for them to see "someone else's" method of solving a problem. They generally used the reproductive learning methods, requiring only the simple copying of their actions, and demonstration of weak abilities as active teaching methods.

Having studied the professional activities of young teachers - graduates of departments of education and mathematics, Institute of Mathematics and Mechanics, whose teaching experience were less than three years, and having observed the lessons of young professionals (50 lessons), we have identified the following weaknesses in enhancing the learning and cognitive activities of students. Young teachers:

- tend to present a new topic themselves;
- use mostly rhetorical questions;
- do not implement other ways of solving the problem;
- do not sort out ways to organize a new activity, a new algorithm, etc.

Observations of young professionals show that in their work with pupils, they, the same as students, use mostly explanatory, illustrative and reproductive teaching methods.

Conclusion

Thus, there is a contradiction between the knowledge of students in enhancing learning and cognitive activities and their abilities to apply them during teaching internships, as well as at the beginning of an independent professional activity.

Based on the empirical research and theoretical material analysis, in order to form competencies that contribute to the solution of problems on enhancing students, we have identified three levels of willingness of future math teachers to enhancing learning and cognitive activities of students:

- low level (to know - reproductive knowledge) implies the ability to analyze and use prepared syllabus of lessons.
- average level (to be able – functional ability) implies the ability to organize learning and cognitive activity of students at separate stages of the lesson;
- high level (to master- creative mastership) implies willingness to enhance learning and cognitive activity of students.

On the first level, it is supposed to give the algorithms of different stages of the lesson, teach lessons using syllabus, and imply case technologies.

On the second level it is suggested to use recommendations, similar to the ones developed by authors on enhancing learning and cognitive activity of students, related to some structural elements of mathematical content (see Table 2).

The third level provides the future teacher an independent mastery of the system of scientific knowledge and the methods of enhancing learning and cognitive activities of students.

In the future, it is expected to develop and test a didactic model of willingness of future math teachers towards enhancing the learning and cognitive activities of students.

Table 2. Recommendations to enhance learning and cognitive activity of students

Structural elements of the mathematical content	Examples
Concepts. Term. Definition	Motivation of introducing a new term with a support on the essential characteristics of the studied concepts. The term "log" → $2^x = 5$ "Name the new term for the degree indicator to which you want involute 2 to get 5". The term "module" → The essential characteristic of the numbers 3 and -3. "To be at the same distance from the origin of coordinates".
Algorithms	Division of a whole number by a fraction, recorded using the numbers 0 and 1 (0.1, 0.01, 0.001, etc.) Number 12 is divided by those numbers using a known method (long division). $12:0{,}1 = 120$ $12:0{,}01 = 1200$ $12:0{,}001 = 12000$ Noted here: - the number increase; - shows how a result is recorded.
A new way of action	Solution of the quadratic equation by releasing a perfect square extraction. $x^2 - 4 = 0;\ (x-2)(x+2) = 0$ $x^2 - 6x + 5 = 0;$ $x^2 - 6x + 9 - 4 = 0;\ (x-3)^2 - 2^2 = 0.$ Formula derivation of the solution of the quadratic equation.
Tasks	A passenger of a train moving at a speed of 79.2 km/h, noticed that an oncoming train moved pass during 12 seconds. Determine the speed of the oncoming train, if its length is 480 m. We make a mathematical model of the problem, which is the difference between the speed rates of these trains.
Exercises	Solution of non-standard inequalities. Compare: a) $x^2 \geq 0;\ x^2 > 0;\ x^2 \leq 0;\ x^2 \leq 0;$ б) $x^2 + 3x + 5 \geq 0;\ x^2 + 3x + 5 > 0;\ x^2 + 3x + 5 \leq 0;\ x^2 + 3x + 5 \leq 0;$ c) $(2x+1)^2 \geq 0;\ (2x+1)^2 > 0;\ (2x+1)^2 \leq 0;\ (2x+1)^2 \leq 0.$ Conclusions: 1) "solution depends on the sense of inequality"; 2) is based on the knowledge of students "what it means to solve inequality".

Disclosure statement

No potential conflict of interest was reported by the authors.

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References

Dautova, O. B. (2011) Changing learning and cognitive activity of students in modern education. : PhD Thesis. St. Petersburg, 232p.

Fedotova, E. Yu. (2009) Formation of informational and communicative competence of students in the process of effective learning and cognitive activity: PhD Thesis. St. Petersburg, 195p.

Korobiy, E. B. (2014) Enhancement of learning and cognitive activity of students as a pedagogical problem. *Theory and practice of social development*, *3*, 141-143.

Krutetskiy, V. A. (1972) Fundamentals of educational psychology. Moscow: Prosveschenie. 224p.

Lerner, I. Ya. & Skatkin, M. N. (1980) Process of education and its principles. Moscow: Znaniye. 311p.

Raimkulova, A. S. (2016) Methods of enhancement school students' cognitive activity by future teachers. *International journal of experimental education*, *2-1*, 78-81.

Shchukina, G. I. (1979) Enhancement of cognitive activity of students in the learning process. Moscow: Prosveschenie.145p.

Slastyonin, V. A. & Isaev, E. N. (2002) Pedagogics: manual for graduate students in education. Moscow: Academiya. 98p.

Tarasova, E. P. (2006) Challenges in learning and cognitive activities as a means of personal development of students: PhD Thesis. Smolensk: Mist. 245p.

Tchoshanov, M. (2011) Engineering of training technologies. Moscow: BINOM. Knowledge Laboratory. 279p.

Yaroshenko, S. N. (2004) The concept of "enhancement of learning and cognitive activity" of students in scientific and educational researches. *OSU herald*, *9,* 81-82.