Formation of Intellectual Skills for Future Mathematics Teachers

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Abstract **– This paper describes the model developed by authors whose intention was a formation of intellectual skills regarding the future teachers of mathematics. The study plans of physical and mathematical faculties within pedagogical universities of Ukraine are analyzed. The structure of intellectual skills among future teachers of mathematics in the process of professional training is determined. The authors propose a system of methodological approaches, principles and directions for improving the content, methods, forms and means of forming the intellectual skills for future teachers of mathematics in the professional training process.**

Keywords **– intellectual skills, future teacher of mathematics, professional training of future teachers, model, criteria, indicators and levels of formation.**

1. Introduction

The modern pedagogical process requires a fundamental change regarding the teacher's role in co-operation with the students. He or she would act not only as the bearer of knowledge, but also as the organizer of their cognitive activity. A competent teacher is the main performer in the development of the intellectual potential of the entire nation.

Shifting emphasis on the formation of the subjective competences of pedagogical staff, which will increase the quality of their basic training in general.

Formulation of the problem. Mathematics occupies a special place in the scientific, cultural and social life of each country, and it is one of the most important components of scientific and technological progress. The development of the modern Ukrainian state, the efficiency of the use of natural resources, functioning of the economy, defense capabilities of the country and creation of modern technologies depend on the level of mathematical science, education and mathematical awareness of the entire population, and on the effective use of mathematical methods. Qualitative mathematical education will prove the needs of the society in qualified specialists for high-tech and high-tech production.

The training of highly skilled personnel is one of the country's strategic objectives, as reflected in the National Strategy for the Development of Education of Ukraine for the period up to 2021 (2013), the Concept of the New Ukrainian School (2016), the Law of Ukraine "On Higher Education" (2017) etc.

Mathematical education is one of the basic elements of the system regarding profile education for future mathematics teachers. Their high-quality specialized mathematical training in pedagogical universities plays an important role in the formation of each personality. It affects the student's outlook, his relationship in society and contributes to the success of future professional activities. The study of mathematics provides the development of logical thinking and cognitive ability in the worldview for the future teacher. It creates conditions for the transfer to students, not only by the means of theoretical knowledge, but also the formation of their ability to apply acquired knowledge for practical needs in different situational problems. On the other hand, the important problem of teaching mathematics is the development of students' creative abilities in the choice and use of mathematical apparatus, which requires a high level of formation with respect to corresponding intellectual skills for future mathematics teachers.

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Analysis of the state of development comprises various aspects of the formation of intellectual skills for future mathematics teachers, and it has allowed to highlight a number of problems: low level of mathematical preparation for entrants at physics and mathematics faculties within pedagogical universities, which is caused by the fall of the pedagogical profession prestige, a significant decrease in classroom hours and an increase in the proportion of students' independent work, insufficiency of scientific research on the introduction of innovative technologies into professional training etc.

Confirmation of the problem existence regarding entrants' low level of mathematical training at physics and mathematics faculties within pedagogical universities is the result of external independent evaluation (EIE) of mathematics in Ukraine as a whole. They discovered that students had in-depth knowledge of school mathematics, some difficulties in solving typical tasks, and almost they did not know how to solve creative tasks. According to the statistics, the average passing grade of the external qualification for enrolling the state budget funds among the applicants who submitted the documents for participation in the competition for the pedagogical profession in 2017 was 146.2 points (the maximum score is 182.4 points, the minimum is 109 points). The tendency of enrollment in higher education institutions in the pedagogical specialty among applicants with low indicators of EIE was preserved also in 2017 (the maximum score is 166.3 points, the minimum is 134 points). According to the institutions rating regarding higher education and the average grade of external qualifications of entrants enrolled in the budget form of study in 2017, Ukrainian pedagogical universities occupy places predominantly from 146 to 215 out of 224 possible (Ukrainian Center for Educational Quality Assessment, 2017). Unfortunately, we cannot objectively solve this problem.

However, we can provide conditions for solving the problem of forming students' abilities to acquire the necessary knowledge on their own and use them in future professional activities through changing the fundamental approaches into the professional training of specialists and shifting the emphasis on the formation of the subject competences. In this context, in order to prepare future mathematics teachers, we see the prospects in focusing attention on the development of their intellectual skills in the study of fundamental mathematical disciplines.

2. Results and Discussion

The key to the successful development of school mathematical education is the availability of appropriate pedagogical staff whose mathematical preparation is somewhat different from the training of graduates of classical and technical universities. The future mathematics teacher has to obtain such a fundamental mathematical education that will provide him with the knowledge, skills and abilities that go beyond the school's mathematics, which are universal for teaching mathematical subjects at different levels of profiling. Such fundamentality is a means of training a mathematics teacher, but not just a goal [13]. Students of physical and mathematical faculties within higher education institutions respecting any mathematical course should ensure the training of highly skilled pedagogical staff, and optimally combine with the needs of their future professional activities. In addition, this process has to meet the requirements put forward by the state. Currently, the normative document of Ukraine, which regulates the educational activity for future mathematics teachers, is "Sectoral standards of higher education (Sectoral standards of higher education, 2002), Direction of Preparation "0101 Pedagogical Education", developed for the qualification-educational level "Bachelor" in 2004 [9].

The process of studying mathematical disciplines in pedagogical institutions of higher education can be divided into three levels:

1) Preparatory (1 semester), the main task of which is to form the closest kind of generalization of the basic educational elements of school mathematics;
2) Fundamental training (2-6 semesters) is intended for deep theoretical mastering of the basic provisions of fundamental mathematics and basic educational elements of school mathematics;
3) Professional-technological (7-8 semesters) is intended for the acquisition of technological methods of professional activity and methodological substantiation of the study of the basic elements of school mathematics [1].

The study of mathematical courses in the preparatory level ensures the implementation of the principle of continuity between the school and the higher education. Its goal would not be only to preserve the old links, but also to establish new ones. The need for such preparatory is because of the low level of mathematical knowledge among the first-year students, and the lack of formation skills in constructing logical structures of mathematical concepts and assertions. In the first semester the following mathematical disciplines are offered: "Selected questions of elementary mathematics",

"Linear algebra", "Algebra and number theory", "Analytical geometry" and "Mathematical analysis". When studying these courses, in particular, the basic numerical systems and their structures are considered, such as the theory of divisibility of integers and polynomials, the functions of one variable, the theory of boundaries, vector algebra and analytic geometry on a plane, etc. Thus, the main purpose of studying mathematical disciplines at the preparatory level is not only to repeat arithmetic, elementary algebra, geometry, initiation of analysis, but also to improve the skills of the possession of a mathematical apparatus.

At the level of basic training courses of "Mathematical analysis", "Algebra and number theory", "Differential geometry and topology", "Complex analysis", "Differential equations", "Projective geometry", "Fundamentals of geometry", "Probability theory and mathematical statistics", "Discrete mathematics" etc. are studied. All of them are aimed at forming future mathematics teachers who acquired basic mathematical knowledge and skills, including basic educational elements of school mathematics.

At the professional-technological level the course of elementary mathematics, which continues the main cross-cutting content lines, plays an important role. Its assimilation allows students to rethink the ideas and methods of mathematics at a new level of school tasks. On the other hand, this course lays the foundations for the methodological preparation for the future mathematics teachers, and it is closely linked to the methodology course of teaching mathematics.

At a pedagogical university a special role would be devoted to the study of mathematical structures, most important in terms of professional orientation. The process of formation and development regarding the concepts of mathematical structures would take into account the principle of historicity, the violation which can lead to certain difficulties in the perception of mathematics and its teaching. In this context the course "History of Mathematics" is important [2].

The total volume of the curriculum during the training for a bachelor degree within physical and mathematical specialties at the pedagogical universities is 240 ECTS credits. The share of general-professional mathematical training for the future mathematics teacher in the curriculum of the OCR "bachelor" in the direction of training "Mathematics" is about 47%. This confirms its importance in the professional formation of the future teachers of mathematics.

We have analyzed the curricula of the pedagogical universities of Ukraine (the Sumy State Pedagogical University named after A. S. Makarenko, the Pedagogical faculty of the Kamyanets-Podilsky National University named after Ivan Ogienko, the Uman State Pedagogical University named after Pavlo Tychyna) for the training of bachelors in the fields of "Mathematics" (specialization "Physics"), "Physics" (specialization "Mathematics"), "Informatics" (specialization "Mathematics"). In particular, according to the curriculum of the Sumy State Pedagogical University named after A.S. Makarenko for the preparation of bachelors in the specialty "014.04 Secondary education. Mathematics" with an additional specialty "014.08 Secondary education. Physics" grants 134 credits for the study of 18 mathematical disciplines (55.8% of the total academic load); on the specialty "014.08 Secondary education. Physics" (additional specialty "014.04 Secondary education. Mathematics") for the study of 11 mathematical disciplines is 22.08%; on the specialty "014.09 Secondary education. Informatics" (additional specialty "014.08 Secondary education. Mathematics") to study 11 mathematical disciplines is allocated 30% of the training load.

Analysis of the curricula allowed making such generalized conclusions on the place of mathematical disciplines, and regarding the structure of the educational process for the training for bachelors at physical and mathematical specialties:

- Curricula are similar. They contain approximately the same set of mathematical disciplines (sometimes some of them are united into one course);
- Mathematical disciplines occupy about one third of the total academic load (32%);
- About 44% of the academic load on mathematical disciplines is allocated to classroom work (lectures, practical, laboratories);
- Almost 56% of all planned who intend to study mathematical disciplines of educational time is allocated to independent work of students.

Summarizing the results of the scientific research on improving the professional training for future teachers of physical and mathematical specialties, the authors can make the conclusion that it is necessary to give more attention to the formation of their general mathematical culture and the development of intellectual skills.

According to the researches of G. Michalin [5], A. Teplitskaya [12], V. Motoryna [6], V. Zhukova [14] and others this process has to ensure the formation of such intellectual skills:

- to prove assertions of different levels of complexity, to prove every step in the chain of reasoning, to demonstrate the flexibility of thought, creative approach, broad mathematical outlook and intuition;
- to use different approaches and methods of introducing the most important concepts, proving

statements; submit the same material at different levels of severity;

- to disclose to students the essence of mathematical concepts and facts, their role in the life of a man and society;
- to solve mathematical problems, to construct mathematical models of processes and phenomena of natural science related to the material of the school course of mathematics, to analyze them, to interpret results, to systematize data, to synthesize, comprehend and formulate conclusions, to generalize, to predict the consequences of the decisions made and to evaluate them;

Table 1. Comparative analysis of curricula Sumy, Ternopil and Uman pedagogical universities

	Sumy State Pedagogical University named after A. S. Makarenko			**Ternopil National Pedagogical University named after Volodymyr Hnatyuk**			**Uman State Pedagogical University named after Pavlo Tychyna**		
	Specialty "Mathematics", specialty	Specialty "Physics", specialty	Specialty "Informatics", specialty	Specialty "Mathematics", specialty	Specialty "Physics"	Specialty "Informatics", specialty	Specialty "Mathematics", specialty	Specialty "Physics", specialty	Specialty "Informatics", specialty
Total credits	240	240	240	240	160	240	240	240	240
Number of credits for the study of mathematical disciplines	134	53	72	117,5	33,5	59,5	85,5	51,5	71
Number of mathematical disciplines	18	11	11	16	6	12	13	10	13
Percentage ratio of mathematical disciplines,%	55,8	22,08	30	48,95	20,94	24,8	35,63	21,46	29,6
The number of auditorium hours	1814	764	996	1692	622	1072	1108	740	1108
Percentage of classroom hours for mathematical disciplines,%	45,12	48,05	46,11	48	61,9	60,1	43,2	47,9	52,01
Number of hours of independent work	2156	806	1136	2533	725	1064	1142	795	1012
Part of the independent work among mathematical courses	53,63	50,7	52,6	71,8	72,14	59,6	44,52	51,45	47,51

- to teach students to think critically, to identify errors and incompleteness of reasoning, to build counterexamples and to generalize;
- to develop students' inclination towards creative activity;
- to use practically significant tasks and facts from the history of mathematics to increase the level of motivation for studying school mathematics;
- to use modern information technologies for preparation, support, analysis and adjustment of the educational process.

The analysis and synthesis of scientific pedagogical research, in which the improvement of professional training for future teachers of physical and mathematical specialties are investigated, allowed us to define the components of the intellectual skills for future teachers of physical and mathematical disciplines. Such components are theoretical, practical and research.

The theoretical component characterizes a set of theoretical mathematical knowledge of students which reflect the system of mathematics and they include the principles and content of the process of studies, the level of understanding of the applied aspect of mathematics and the possession of mathematical technologies for the construction and analysis of mathematical models while solving professional problems and problem situations. In the process of studies students would be focused on increasing the volume and depth of knowledge, on the development of their own cognitive and creative abilities, technological literacy. It will be a pledge for the development of cognitive and creative abilities of

students and the dynamism of their educational activities.

The theoretical component covers the following skills and abilities of students:

- Possession of the concepts of a certain mathematical theory;
- Ability to formulate statements in the form of necessary, sufficient, necessary and sufficient conditions;
- Understanding and reproduction of proofs of mathematical assertions;
- Knowledge of examples of mathematical objects that illustrate a given notion or mathematical statement, and counterexamples;
- Knowledge of the laws of the use of multiplicative theoretical and logical symbols in the writing of mathematical texts;
- Possession of different methods of constructing mathematical theories;
- Possession of the theoretical basis of the methodology for solving mathematical tasks;
- Knowledge of examples of specific mathematical and informational models of physical, biological, economic, informational processes etc.;
- Ability to prepare a review of scientific literature on the subject of mathematical research.

The practical component corresponds to the organization of the process of teaching mathematics in a form that brings it together by the forms and methods to professional activity and includes: a set of skills (analytical, computational, algorithmic, geometric, mathematical modeling, etc.), the ability to solve typical practical problems and solve problem situations using mathematical methods, the acquisition by students a set of skills for their further using in future professional activities, the formation of a system of skills for the application of modern technologies for solving professional problems.

This component of intellectual skills is expressed through the following skills and abilities of students:

- Ability to solve typical mathematical problems;
- Ability to apply methods of information and communication technologies in solving mathematical problems;
- Ability to build examples and counterexamples, in particular using information technologies;
- Ability to collect and use ready-made software (mathematical packages of applications) for symbolic form, graphical, numerical analysis of mathematical models of real objects;
- Ability to conduct a numerical experiment, including with the involvement of a computer;
- Ability to estimate errors in the numerical solution of the problem.

The research component covers a set of aspirations, views, attitudes, relations of the use of mathematical methods in the process of solving problems, solving non-standard situations in professional activity, self-evaluation of own mathematical activity, aspiration for improvement of professional activity by means of mathematics. An important element of it is the reflection, which we consider as an appeal to the inner essence of the future teacher, which makes it possible to observe, analyze, comprehend and evaluate their professional activities. It helps to consciously choose the best ways to solve problem situations and provides understanding and awareness of one's own behavior, determines the personal meaning of one or another reason.

The research component of intellectual skills is provided by the following skills and abilities of students:

- Possession of mathematics representations as a science in general and as a subject of study, understanding its place in the modern world and in the system of sciences;
- Ability to find out the structure of mathematical theory (concepts, scientific facts, laws, principles and links between them);
- Ability to use rationally the laws of logic, to analyze mathematical facts, laws and theories on the subject of logical rigor and completeness;
- Ability to use methods of cognition (modeling, analysis, synthesis, specification, comparison, analogy, etc.) for the formulation and solving of a mathematical problem;
- Awareness of the applicability of existing methods and the prospect of solving a mathematical problem, the ability to propose several methods for solving one problem;
- Ability to analyze the links of the studied mathematical object with known objects; correlate mathematical problems with scientific facts;
- Ability to distinguish between the elements of a real object, the process or the phenomenon being investigated, to create an appropriate mathematical model and analyze it;
- Ability to find effective methods for numerical analysis of mathematical models of different tasks; interpret, analyze and generalize the results of calculations of numerical experiment;
- Ability to build models of axiomatic theories, to substantiate the equivalence of statements, to check the inconsistency, completeness, categorical the system of the axioms and their independence;
- Ability to construct mathematical objects with predetermined properties;
- Ability to analyze known methods, techniques, means for their suitability for solving a mathematical problem;

- Ability to apply induction and deduction, analytical, synthetic, analytical and synthetic methods to solve a mathematical problem;
- Possession of component research activities (to determine the problem, to study the history and modern approaches and achievements in research of a scientific problem, be able to search for sources of information and to research them, to determine the theme of the research and to substantiate its relevance, to allocate the object, the subject and the purpose of the research, to build working hypotheses, compile a research program, choose methodological principles, methods and methods of research, systematize and classify information, formulate scientific novelty of results, define its practical value, do a scientific publication).

The social order of modern Ukrainian society is a professionally trained teacher of mathematics with the developed professional competencies and a high level of intelligence. In the context of the problem under study the authors have developed a model of the training for future mathematics teachers, aimed at the developing their intellectual skills in the study of fundamental mathematical disciplines.

The process of forming the intellectual skills of future mathematics teachers is a collaborative activity for both teachers and students. Therefore, the authors consider it is expedient to choose the following set of approaches: systemic, active, person-oriented and integrative.

In our opinion the analysis of the process of forming the intellectual skills for future mathematics teachers would be carried out primarily from the point of view respecting the system approach, which considers this process as a system in terms of its structure, content, functions, set of methods, systemic links, opportunities to transform pedagogical skills of a teacher into his practical activity. The process of formation of intellectual skills would include various forms of the educational process: lectures, practical classes, classroom and non-auditing independent work, self-education, research work. The system approach gives each teacher the opportunity to spread his subject in a complex one with other professional disciplines, taking into account their peculiarities, clearly define the priority directions of teaching, and structure teaching tasks [10].

Personality-oriented approach in the process of formation of intellectual skills for future mathematics teachers is taken as the basis for selecting the means, forms and methods within the organization of educational activities. Using this approach in the process of studying mathematical disciplines allows us to take into account the individual and personal qualities of students, the level of their basic mathematical preparation, understanding the need for mathematical knowledge for successful professional activity, readiness for learning, self-education and self-development [4], [8].

Active approach is aimed at the development of personal qualities of a student, who is capable of active professional, creative activity. Its main aim in developing intellectual skills is to teach students to define goals and plan mathematical activity, organize, regulate and control it, to carry out self-analysis and evaluate achievements. Thus, the active approach makes it possible to clearly define the structure of educational activities of students taking into account all its types (cognitive, research etc.) [11].

The use of an integrative approach is a prerequisite for defining a strategy of organization and modeling the process of forming the intellectual skills for future mathematics teachers. Its aim is to harmonize, streamline and combine the various components of the education content to ensure the integrity of the pedagogical system. The use of an integrative approach enables to deepen interrelationships between disciplines, combine knowledge and skills regarding educational activities among different disciplines into a coherent system, and facilitate the comprehensive application of knowledge [7].

The proposed complex of methodological approaches, generalization of pedagogical experience, modern tendencies for increasing the role of self-education, rapid development of information technologies, insufficient solving the problem of professional orientation of teaching mathematical disciplines among students who attend physical and mathematical faculties within pedagogical universities, has given us the opportunity to distinguish the set of principles that are used as the basis for determining strategy of research, and build a model for the process of forming the intellectual skills for future teachers of mathematics.

When constructing the author's model of the formation of intellectual skills for future mathematics teachers, the authors determined and substantiated the purpose of organizational and pedagogical activity:

1) Ensuring a conscious and lasting mastering of the system of fundamental knowledge, skills and abilities of professional mathematical disciplines and the ability to use them in future professional activities;
2) The development of creativity of thinking;
3) The formation of a scientific outlook.

The formation of intellectual skills for future teachers of physical and mathematical disciplines in their professional training involves improving the content, methods and means of training and the forms of organization respecting educational

activities of students. Improvement of the content requires modification of working programs, development or updating of educational and methodological complexes of fundamental mathematical disciplines. The authors emphasize the need for a deeper and systematic assimilation of mathematical knowledge, methods used in solving problems of higher complexity and creative tasks of the school's mathematics course. The authors stressed that a special course “Olympiad and creative tasks of school mathematics” has been developed and implemented in the academic process in the 7th semester for bachelors who specialize “Mathematics”.

Among the organizational forms of education that contribute to the development of the intellectual skills for future teachers of physical and mathematical disciplines, the authors made lectures, practical classes, seminars, independent study and research work [3]. A significant reduction of classroom hours for the study of mathematical disciplines requires the correct allocation of questions for classroom, independent study and transfers emphasis on improving the organization of independent and research activities of students.

When the authors choose the forms of organization of study, the authors take into account the fact that the mastering of mathematical material is impossible without special techniques and methods of work, without combining with productive technologies for the development of intellectual skills of the student. Therefore, the described forms of learning are realized through the use of methods and technologies, among them, in our opinion, effective ones for the formation of the intellectual skills for future mathematics teachers are: problem learning, heuristic, research and specific methods (mathematical modeling, axiomatic), interactive technologies.

The effectiveness of the studying process is provided by traditional (textbooks, tutorials, reference books, task-books, workshops, methodological guidelines) and innovative tools, which may include reference notes, structural and logical schemes, portfolio, technological maps, workbooks, computer-based tools of training, etc. The authors consider it expedient to introduce a Workbook in the educational process, which is a multifunctional tool that combines the functions of different didactic tools and provides organization the whole educational work in general and independent in particular. It contains various types which are of various levels of cognitive activities and the nature of the activities regarding the types of tasks. The tasks of all three blocks of the Workbook are aimed at forming theoretical, practical and research component of the intellectual skills. For example, in the third block there are tasks for the development of research and development component, critical and creative-thinking. The solution of the tasks requires a high level of autonomy, creativity, intuition. These tasks can be performed individually and in micro groups, the students may consult with the teacher in the form of online-consultations or consultations through the Internet.

Here is an example of such a task from the section “Functional series”.

1. Investigate the sequence $f_n(x) = nxe^{-nx}$ for uniform convergence with: 1) $0 < x < 1$; 2) $x \geq 1$.

2. Find the field of convergence (absolute convergence) of the functional series:

1) $\sum_{n=1}^{\infty} \frac{n}{n+1}\left(\frac{x}{2x+1}\right)^n$; 2) $\sum_{n=1}^{\infty}\left(\frac{x(x+n)}{n}\right)^n$;

3) $\sum_{n=1}^{\infty} \frac{2^n}{n^2}\sin^n x$; 4) $\sum_{n=1}^{\infty} \frac{\cos nx}{e^{nx}}$;

5) $\sum_{n=1}^{\infty} e^{-n^2 x}$.

3. Let be $f(x)$ - an arbitrary function defined on $[a;b]$ and $f_n(x) = \frac{[n^2 f_n(x)]}{n^2}$, $n \in N$. Prove that the sequence $(f_n(x))$ coincides uniformly for $f(x)$ on $[a;b]$.

The proposed model includes a diagnostic instrument for determining the level of formation of the intellectual skills for future mathematics teachers within professional training. According to the considered components of intellectual skills we chose the following criteria and defined their indicators:

1) The cognitive criterion: the indicators “Volume of knowledge” and “Depth of knowledge” which test the level of theoretical training of students for professional activities;

2) Procedural and technological criterion: the indicator of “Procedural skills and technological skills” determines the level of formation of learning skills and skills of students to perform certain actions in solving practical problems;

3) Intellectual criterion: the indicator of “Creativity of thinking” indicates the ability to think logically, establish intersubjective links, build mathematical models and analyze them; generates ideas for different methods of solving a task and choose the optimal ones, predicts results of the research and corrects them, transfers the acquired knowledge to new problem situations.

Thus, according to these indicators we have determined three levels of the formation of intellectual skills of future mathematics teachers: reproductive, heuristic and creative.

The reproductive level is characterized by the low level of understanding of the significance and importance of intellectual activity, the unstable interest to performing intellectually oriented tasks, low level of creative thinking, inability to use it in solving creative tasks, weak ability to control and correct students' intellectual activities.

The heuristic level is determined through understanding of the significance of intellectual activity, presence of motivation for its implementation, sufficiently developed creative thinking, ability to analyze, monitor and correct students' actions in solving creative problems.

The creative level involves internal understanding of the significance of intellectual activity, presence of stable interest in it, development of creative thinking and the ability to use it in some researches, control and correct students' scientific research.

In the case of inconsistency of the achieved result to the set aims and fixing of defects or errors in the process of formation of intellectual skills for future mathematics teachers, their analysis is carried out, the ways and means of their elimination are determined. This is the main aim of the analytical and correction block of the developed model.

It was conducted a survey of 164 first-year students of faculties of physics and mathematics of Pedagogical universities, which showed the difficulties they face while studying specialized disciplines. The obtained results are presented in Table 2.

Table 2. Difficulties faced by the first-year students of the Faculty of Physics and Mathematics of the Pedagogical University

Difficulties of students	Survey Results
Low level of training in school mathematics	87 %
Insufficient level of formation of abilities to reproduce information with the elements of logical processing of the material, to transfer knowledge to a new situation for solve the problem, to work with textbooks, to establish a sequence of actions for solve the problem, to find and explain causal links	85%
Insufficient level of formation of skills to solve creative and non-standard tasks	78%
Inability to apply known theoretical material	56%
Inability to express thoughts in writing or verbally	23%
A formal approach to solve a problem, the ability to compile an algorithm for solving a task is not formed, the inability to distinguish simple elements of complex tasks	45%
Inability to read the text critically and to highlight its logical parts, to identify the supporting content elements	15%
Computing skills at the automatic level are weakly developed	21%

The survey of 32 teachers of professional disciplines of physics and mathematics faculties within pedagogical universities as stated by disadvantages regarding modern mathematical training at pedagogical universities students showed the following results.

Table 3.Disadvantages of modern mathematical training of students of pedagogical universities

Disadvantages of Mathematical Training	Survey Results
Outdated techniques, domination of passive forms and methods of training	45 %
Formalization of mathematical knowledge, unformed ability to reproduce mathematical material	36%
Absence of intersubject links of mathematical disciplines with each other, and with disciplines of other cycles	32%
Insufficient level of formation of abilities to use a mathematical instrument while studying of special disciplines	28%
Weak skills in the use of mathematical instrument in the application of information technologies in future professional activities	24%
Weak motivation and inadequate level of formation students' abilities to work hard with learning material	82%
Outdated work programs that don't include modern scientific content	28%
The reduction of study hours, the transfer of more than half the learning material of mathematical disciplines to self-study, the practical removal of counseling and many other forms of monitoring of the level of knowledge from the professional training	86%

According to the systematization of the elaborate psychological, pedagogical and scientific-methodical literature, the analysis of curricula for the training of bachelors of physical and mathematical specialties at pedagogical universities, the experience of the authors, the results of the experiment allowed us to

distinguish a number of problems in forming the intellectual skills of future mathematics teachers:

- Low level of formation of intellectual skills and skills of individual work of the first-year students;
- Low level of educational opportunities of students of physics and mathematics faculties of pedagogical universities in studying professional disciplines;
- Insufficiently developed content, forms, methods of the educational process in the context of growing share of individual work of students (about 60%);
- Insufficient number of study hours for mastering the theoretical material, working out of skills and abilities of its application;
- Unpreparedness of students to individual study of the learning material;
- Insufficient attention to solving tasks of a higher level;
- Inconsistency in the study of mathematical disciplines with the needs of future professional activities;
- Insufficient connection of mathematical disciplines with each other, with other disciplines of the natural cycle, and with the school course of mathematics in particular.

For testing the effectiveness of the author's model of the formation of the intellectual skills for future mathematics teachers in the process of professional training the control (CG) and experimental (EG) groups of students were selected.

At the beginning of the experiment for determining the levels of the formation of the intellectual skills for future mathematics teachers in the process of studying of professional disciplines they were tested by using matching tasks, testing with theoretical questions, testing with individual research tasks and testing on the general intellect characteristics by R. Kettle. The evaluation was accompanied by statistical processing of the results. The calculated value of the *t*-criterion in our case $t_e < t_0 = 1.65$, which suggests that the level of formation of intellectual skills for future teachers of physical and mathematical specialties in the process of studying professional disciplines, at the beginning of the experiment in the control and experimental groups is the same.

Later on, the training of a control group was carried out according to the traditional and the most common methods, but in the experimental group the educational process was organized in accordance with the authors' model.

In the experimental group the implementation of the author's model of the formation of intellectual skills for future mathematics teachers in the study of professional disciplines has led to the increase of the intellectual skills level.

Table 4. Levels of formation of intellectual skills of future mathematics teachers in the process of study professional disciplines at the end of the experiment

Level	**Frequency** %, CG	**Frequency** %, EG
Reproductive	18,02 %	6,77 %
Heuristic	69,42%	64,00 %
Creative	12,56 %	29,23 %

The preliminary visual analysis in Table 4, data confirmed our assumption that there are significant differences between the control and the experimental groups in terms of the general level of intellectual skills.

At the same time, the main hypothesis on the absence of differences between the samples and the alternative shows the significant difference between the results of the samples. The value of Student's *t*-criterion for all indicators after the experiment was calculated.

Table 5. The value of the t-criterion for the indicators of the level of the formation of the intellectual skills of future mathematics teachers in the study of professional mathematical disciplines after the experiment

The indicator	***t*-statistical**
The depth of knowledge	2,88
The volume of knowledge	5,43
Procedural and Technological Skills	5,11
The creativity of thinking	6,59

The calculated value of *t*-criterion $t_e > t_0 = 1.65$ allows to affirm the alternative hypothesis on the significant difference between the results of the samples that is valid at the significance level of 0.05. That is, the level of formation of the intellectual skills for future mathematics teachers in the study of professional disciplines at the end of the experiment in the control and experimental groups is significantly different, and the difference in the total score of each sample cannot be explained only by accidental circumstances.

3. Conclusions

1. The professional training system for future teachers of mathematics in modern society does not take into account the current state of mathematical training of entrants and does not fully satisfy the requirements of the social order of society. In the conditions that the orientation regarding the studying process, which comprises personal development and the development of intellectual skills. The quality of mathematical education in higher pedagogical institutions depends on the content of the courses, the availability of the established methodical system of training within

professional disciplines, and it is determined, first of all, by the level of intellectual skills of a student.

2. The structure of intellectual skills for future teachers of mathematics, which combines theoretical, practical and research components, is investigated.

3. The authors' model of the formation of intellectual skills for future mathematics teachers included in the professional training, in which the idea is realized, developed and scientifically substantiated: the high level of the formation of intellectual skills ensures a conscious and strong mastery of the system of fundamental knowledge, comprising both skills from professional mathematical disciplines and those to use them in the future professional activities.

The presented work does not pretend to become exhaustive study of all aspects of the problem under research. Further development requires a thorough theoretical and methodological analysis of the pedagogical conditions, and the development of technologies for the formation of intellectual skills for future mathematics teachers.

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