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INNOVATIVE TEACHING OF FUTURE MATHEMATICS TEACHERS

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CONTENT

PREFACE

The development of Ukrainian higher education is connected with solving a number of social, psychological and pedagogical problems. One of the problems that requires an intergrated study is the improvement of professional and pedagogical preparation of undergraduate students to teaching activity through their mastering of fundamentals of professional skill.

Increasing requirements for the professional preparation of future teachers of mathematics requires a qualitatively new theoretical and practical preparation in the conditions of higher education institution. During studying, students should acquire not only knowledge of basic sciences, but also to master the ability to use new pedagogical achievements, to apply various educational technologies in practice. According to the Industry concept of continuous pedagogical education development, one of the ways of improving the quality of pedagogical education, ensuring its integration into the European Higher Education Area is the use of information and communication technologies, interactive teaching methods and multimedia tools.

The Master's Degree Program in methods of teaching mathematics in higher education provides the study of the following topics:

- modern pedagogical technologies and their introduction into the process of teaching mathematics in higher education;
- personally oriented education and personally oriented technologies in higher education;
- technology of group educational activity organization of students. Interactive learning technologies.

These topics directly or indirectly involve the study of methods and technologies of interactive learning in higher education. Successful mastering of innovative teaching technologies will help the undergraduates to become organically involved in teaching activity and to start practical application of the acquired knowledge in professional activity after graduating the university.

The manual describes the characteristics of interactive learning and its types, as well as specific examples of methodological features of interactive teaching of mathematical disciplines in higher education.

The manual consists of two sections. The first section reveals the basic theoretical provisions of interactive learning, namely: the essence of interactive learning, the history of origin, types of methods and technologies of interactive learning, etc. Given analysis of the use of computer technologies in the interactive learning environment, shown specific examples of the use of educational teaching software. The second section gives examples of the use of methods and technologies of interactive teaching of mathematical disciplines.

Using the materials contained in the manual, undergraduates can master the theory and practice of not only giving mathematical knowledge to others, but also to form a basic level of professional competence in the interactive teaching of subjects of mathematical cycle in higher education.

Although it is mainly aimed at students, the peculiarity of this training manual is that it will be useful for both graduate students and beginner teachers, as well as for those who already have some teaching experience, but want to deepen their creative search. We hope this manual will also interest teachers of mathematics, as some approaches and specific developments can be used at school, especially in upper school.

Section I. Theoretical foundations of interactive learning

1.1. Interactive learning as a pedagogical problem

The need for significant changes in the system of training future teachers is recognized by experts in various scientific fields in many countries. The system of pedagogical education, which was influenced by the past and was in the transfer of knowledge and skills, does not meet the needs of modern and constantly dynamic world. Leading mathematicians and methodologists offer various models of improving teaching of future teachers at pedagogical university (I. A. Akulenko [4; 5], V. H. Bevz [17; 18; 19; 20], M. I. Zhaldak [64; 65], I. H. Lenchuk [104; 105], O. I. Matiash [118; 119], M. V. Pratsovytyi [175; 176; 177], Yu. S. Ramskyi [184], S. P. Semenets [192] and others). Recently, the deserved recognition and active use in practice is acquired by interactive teaching of future teachers, including teachers of mathematics (D. Ye. Hubar [57], O. A. Komar [83; 87], H. F. Krivchykova [98]).

In order to reveal the essence of interactive learning and to identify the current state and prospects of its use in the higher education institutions, at first we identify the characteristics of traditional and interactive learning, identify their positive and negative aspects, consider the features of each of these types of learning.

The characteristics of traditional learning and the need for the transition to new pedagogical technologies are well-disclosed in the work edited by S. P. Bondar [27]. Let us briefly outline the main features of traditional learning by transforming them into higher education.

Traditional is called learning aimed at mastering knowledge, skills and abilities. In the era of industrialization (from the second half of the eighteenth century to the second half of the twentieth century), the need for all kinds of knowledge grew rapidly: knowledge about nature, society, man and the world in whole. F. Bekon's statement "Knowledge is power" was put into the enlightenment (knowledge) paradigm of education that produced knowledge, skills and abilities.

This type of education provided literacy education for all citizens, raising the education of a large part of the population, training of professional staff, etc.

A characteristic feature of traditional learning is the predominance of explanatory and illustrative learning technologies. New information which students should learn is submitted, explained and proved by the teacher. Students perceive, comprehend and learn the course material, reproduce it in their own words, use it to solve tasks. The application of knowledge in practice occurs mainly by sample or by ready instruction. That is, explanatory and illustrative learning is characterized by the fact that the teacher reports the educational material in a "ready" form and controls its assimilation by students and students perceive, memorize and reproduce the information provided by the teacher.

The specificity of traditional learning in the context of personality formation is revealed by the authors of the manual [27] through external conditions and internal processes occurring in the minds of teachers and students. The main external condition of the traditional learning system is the predominant dominance of learning over teaching. The teacher performs three functions: informational (presentation of educational material), controlling (determining the level of understanding of this material by students), evaluative (expression in points of accuracy of reproduction of the submitted material). The internal conditions of traditional learning include "the emphasis on classroom learning under the guidance of a teacher" [27], which results in students' indifferent attitudes to the learning and cognitive activities that are related to them, partial or total abandonment of such activities.

The analysis of different teaching technologies, including the traditional ones, was carried out by H. K. Selevko [189], where the traditional is referred to a lecture-seminar-credit form of teaching: at first the educational material is submitted to the group by the lecture method and then it is processed (assimilated, consolidated, revised, applied) on seminar, practical and laboratory classes, as well as in independent work. The results of the assimilation are checked in the form of credits (exams). Traditional lecture, which is considered to be

the main form of study in the higher education institution, by H. K. Selevko describes it so – it is a consistent presentation of material in the logic of this science which is carried out mainly by verbal means in the form of a teacher's monologue. This form of studuing has long been used in higher education institutions. Students' mastering knowledge and skills formation during traditional learning is based on:

- message of ready knowledge;
- training on a sample;
- inductive logic: from partial to general;
- conversations, verbal presentation of educational material;
- questioning methods – reproductive reproduction.

It is impossible to agree with the extreme assessments of traditional learning (as the only correct learning or which is not conducive to personal development). Nowadays traditional education is not used in its pure form, but is modified in the direction of "education for human", which aims at the individual development of self-worth and purpose, but not as a means of social development. In the context of traditional learning, different methodological approaches (personality-oriented, activity-oriented, developmental, etc.) have been found, different methods (expedient tasks, problematic presentation, partially-search method, etc.), are used and various forms (collective, group and individual, auditorium and extra-auditory, etc.).

Lectures play an important role in various forms of educational work in higher education institution. Defining the lecture as the main link in the didactic cycle of study, Z. I. Sliepkan in the manual "Scientific Principles of the Pedagogical Process in Higher Education" states that the purpose of the lecture is not only to transfer the knowledge system and create a basis for further mastering of the educational material by students, but also in the purposeful influence on the formation of the student's consciousness and involvement methods of science and future professional activity. [207, p. 119].

O. I. Matiash [119], considering the system of methodical training of the future teacher of mathematics in terms of competency approach prefers academic and educational-developmental lectures at the level of

beliefs that are formed in the terms of positive emotions and conscious understanding. We support the opinion of O. I. Matiash that the lecture form of teaching at a higher pedagogical school has evolved from a classical to a lecture of a problematic nature (lecture-dialogue, lecture-press-conference, etc.). For example, using the lecture-dialogue there is a transition from the simple submission of educational material to the active assimilation of the content of methodological preparation with the involvement of mechanisms of theoretical thinking and the whole structure of mental functions, the importance of the personal component in forming the methodological competence of the future teacher is enhanced. Obviously, such lectures require a teacher-lecturer of high pedagogical culture and professional skill.

Considering the peculiarities of lectures, practical classes and independent work on mathematical analysis, Professor H. O. Mykhalin in the monograph "Professional training of mathematics teachers in the process of teaching mathematical analysis" [125] emphasizes that it is important to conduct practical classes so that each student is not only busy with hard independent work related to solving problems, but also evaluate the activity of his classmates who work at the board and act as a teacher, explaining how they solve a particular task. Each practical training should be a unique model of mathematics lesson at school and the teacher should pay special attention to future teachers of mathematics. Many years of experience at the pedagogical university have led the author to the following scheme of practical training in mathematical analysis:

• begin almost every practical lesson with a small independent work that aims to test how well the students have learned the material related to the topic of the previous practical lesson and how well they have prepared for the lesson (15 – 20 minutes);

• check the students' homework while they're writing their individual work;

• to identify the problems that caused the most difficulties, to reveal the basic ideas of solving these problems and to offer the students appropriate consultation (5 – 10 minutes);

• to disclose the purpose of the practical lesson and to organize the work of students to solve problems related to the relevant theoretical material, paying sufficient attention to both typical, algorithmic tasks (formulating an appropriate algorithm if necessary) and non-standard tasks (60 – 70 minutes);

• a teacher should not allow a student to write certain facts silently on the board, but should offer that student to feel like a teacher explaining to their students how to solve the relevant problem;

• at each practical lesson, students should get their homework, which always consists of two parts: theoretical (which theoretical material should be worked out) and practical (what problems should be solved).

The positive aspects of traditional learning are: systematic nature of learning; orderly, logically correct submission of educational material; organizational clarity; constant emotional impact of the teacher's personality; relatively not much time spent by the teacher in effective managing of the learning process. But at the same time, it has several disadvantages: the reproductive nature of students' educational activities, pattern-building of the educational process, uniformity prevails; depriving students of the functions of goal-setting, planning, evaluation; poor feedback of the teacher and students during the lesson; a mediocre approach that is not always appropriate for everyone, etc.

In order to carry out a comparative analysis of traditional learning and interactive learning, we will reveal the features of interactive learning, which is not a completely new organization of the educational process, but it has recently been given considerable attention to it. The evolution of interactive learning is covered in our article [244].

In the context of the research topic, we will look at the basic definitions associated with interactive learning. The term "interactive", which comes from the combination of Latin words, deserves detailed analysis: "inter" – between and "action" – active. In English, the word "interection" is translated as cooperation.

In philosophy, "interaction" is considered as "philosophical category, which reflects the special type of relationship between objects

in which each object acts (affects) on other objects causing them to change and at the same time undergoes action (influence) on the part of each of these objects, which in turn causes the change of its state. The action of each object on another onet is determined by its own activity of the object, the manifestation of its dynamics and the reaction of the object to the action of other objects" [251, p. 78].

In pedagogy [219, p.9] the term "interactive" is interpreted as a movement that occurs between objects:

- external – activity that takes place between individuals;
- internal – activity that takes place in the person, which leads to changes in his views, thoughts, behaviors, etc.

The key concept that defines the essence of interactive learning is "interaction". Interaction is understood as direct interpersonal communication, the most important feature of which is the ability of a person to "accept the role of another one", to imagine how he/she is perceived by a partner or a group and accordingly to interpret the situation and control his/her own actions [169].

According to O. I. Pometun [169] pedagogical interaction is an exchange of activity between the teacher and pupils (students), in which the activity of one is conditioned by the activity of another.

S. M. Utkin considers a somewhat different interaction [247, p. 57]. He associates the term "interactive" with computer learning, emphasizing the fact that in most cases computers work in a "man-machine, software environment". He considers interactive learning to be one of the possible models of the pedagogical process, which enables the teacher and student to communicate using computer.

Let's consider some more approaches to interpreting the concept of "interactive learning". It is considered as:

- learning based on psychology of personal relationships and interactions (B. Ts. Badmaiev) [11, p. 30];
- organization of the educational process, which is characterized by constant, active interaction of all pupils (students), the equivalence of the teacher and the students, as subjects of learning (O. A. Bida,

O. A. Komar, L. V. Pyrozhenko, O. I. Pometun) [24, p. 5; 55, p. 173; 169, p. 21; 170];

- a set of technologies that are formed into a pedagogical system, which is based on joint activity and has a problem-seeking nature (O. V. Yelnikova) [61, p. 53];

- learning, which is built on the interaction of learners with the learning environment, where the central source of knowledge is the experience of the participant of learning (M. V. Klarina) [77, p. 13];

- the process of acquiring knowledge both in the course of teacher-directed interaction with other students during the joint speech-thinking activity, as well as in the process of independent creative and search activity aimed at solving problem situations (H. F. Krivchykova) [98, p. 5];

- didactic tool for the development of students' skills of designing, production and presentation of prepared educational product (N. Yu. Pakhomova) [148, p. 46].

- learning, which is based on technologies of human interaction (E. I. Fedorchuk) [249, p. 10];

- didactic application of scientific knowledge and scientific approaches to the analysis and organization of the educational process, taking into account the empirical innovations of teachers to achieve high results in the professional competence and development of students' personality (D. V. Chernylevskyi) [255, p 53];

- the process of acquiring knowledge in the course of pedagogical interaction through polylogy between the subjects of the educational process [262, p.18];

- model of joint pedagogical activity on designing the organization and carrying out the educational process with unconditional provision of comfortable conditions for students and the teacher (H. K. Selevko) [190, p. 15].

Analyzing the views of scientists, it can be argued that in terms of interactive learning, the interaction of teacher and students changes: the activity of the teacher is determined by both the activity of the teacher

and the activity of students. In the work on the interpretation of the term "interactive learning" we will follow the opinions of O. I. Pometun and L. V. Pyrozhenko [170]. In the process of such learning the teacher acts as an advisor, partner in the work of students, encourages them to creativity, self-education, self-realization and so on.

Such teachers as: (E. Yu. Batalshchykova [14], N. H. Biletska, O. A. Bida, H. L. Voloshyna [25], S. M. Honcharov [53], H. F. Krivchykova [98], O. I. Pometun [165]) distinguish the following features of interactive learning:

- two-side character;
- joint activity of teacher and student;
- process management by the teacher;
- special organization and variety of forms;
- integrity and unity;
- motivation and connection with real life;
- education and development of the student's personality simultaneously with the process of assimilation new knowledge.

Here are the advantages of interactive learning over traditional:

- all students are involved in active work;
- students learn to work in a group;
- forming friendly attitude towards the opponent;
- each participant of the educational process is given the opportunity to offer and defend his/her opinion;
- creating a "success situation";
- acquiring a large amount of material in a short time;
- forming skills of tolerant communication;
- developing the ability to reason your opinion, to find an alternative solution to the problem.

The main components of the training system of future mathematics teachers at the pedagogical university are the subjects and objects of the system, the purpose and tasks of the pedagogical process, the content and organizational structure of teaching, pedagogical activity and its result. The manual [44] identifies 4 main components of

the pedagogical process that "cement" the system (Fig. 1.1)

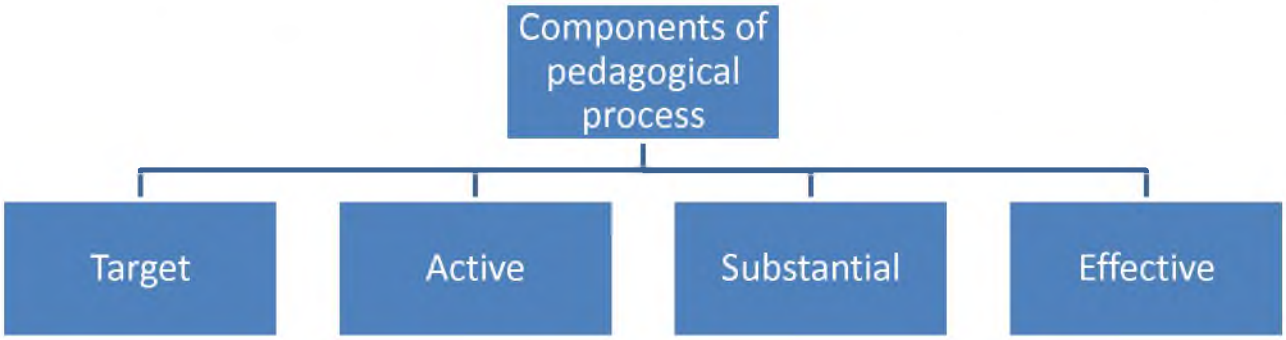


Fig. 1.1. Components of the pedagogical process

Using this structure, we compare traditional and interactive learning, highlight their distinctive features (Table 1.1).

Table 1.1

Comparative analysis of traditional and interactive learning

Components	Traditional learning	Interactive learning
Target component	Information and education of students. Formation of knowledge, skills and abilities defined by the program and features of the future specialty. Preparing students for future professional activities.	Students acquire knowledge and experience for lifelong professional development. Development of initiative and mobility of students, creation of conditions for realization of their creative potential and formation of readiness for professional activity.
Substantial component	Presentation of the finished educational material defined by the program and features of the future specialty. Mastering information in the process of remembering.	Individual search and mastering knowledge. Using information from the learning process for personal development and creating his/her own creative product.

Active component	The dominance of learning over teaching. Individual or frontal work, reproductive, explanatory and illustrative methods. Student – object of pedagogical influence, teacher – presenter of knowledge.	The dominance of teaching over learning. Various forms of joint activity, independent work, productive, creative, search, research methods. Student – subject of study, teacher – mentor, humanist, assistant.
Effective component	Specialist in a particular field of knowledge who has knowledge that he/she has acquired during learning. The real adaptation to professional activity and the formation of professional competences which happens mainly in the workplace.	Initiative, self-confident specialist with a sufficient level of subject and professional competence, focused on constant self-education and teamwork. Well prepared for professional work, teamwork and innovation.

Using the data of the table, we can conclude that interactive learning helps to activate the learning and cognitive process, the formation of deep internal motivation, provides opportunities for intellectual and creative development, expression of initiative and also develops students' communication skills. However, there are some drawbacks to interactive learning, such as:

• the use of forms of interactive learning takes a lot of time;

• every form of interactive learning requires the prior consideration and training of students in this form;

• the teacher has less control over the volume and depth of the material studied, the time and course of learning;

• student outcomes are less predictable.

Using interactive learning is a system of rules for organizing productive interaction between students mastering new experiences, gaining new knowledge and provides an opportunity for self-realization of the individual. Interactive learning is focused on: socialization of the individual and formation in the process of upbringing and education of skills of active moral action, development of the person who is capable to critically evaluate events that take place in society.

1. 2. History of introduction to interactive learning

If we turn to the history of the emergence of interactive learning, its origin dates back to ancient times. So, Socrates encouraged his listeners to find the "truth" by asking questions and answers. Plato suggested educating children from the age of 6 and developing them through games, conversations, fairy tales, songs and etc.. Confucius did not adhere to the time and content of the lessons at the school he founded. Education and upbringing took place in the process of arbitrary conversations, which were often heuristic. The ideas of J. Pestalozzi, J.-J. Rousseau, J. Dewey on Free Development of the Personality, A. Bell and J. Lancaster's Group Learning, E. Parkhurst's Dalton Plan, and P. Peterson's Jain Plan System.

The Bellancaster system (derived from the surnames of pastor-teacher A. Bell and teacher J. Lancaster) became a type of group learning within the classroom system. Developing the ideas of J. Komensky, the authors of this system proposed a system of mutual learning. Classes were held in halls for 300 or more students, divided into groups of 10-15 people assigned to monitors (senior students), who received assignments daily from the teacher and worked with the younger ones. Pupils in such schools were quicker in acquiring skills and abilities than at usual schools, but their knowledge was not sufficient for further learning [180].

In the early twentieth century, the United States of America created a system of individualized learning, the so-called Dalton plan,

whose name comes from the American city of Dalton (Massachusetts). The author of this technique, teacher, Ellen Parkherst, proposed this technique as an alternative to the lessons of the "memorizing" and the poll. The students had the opportunity to choose the content of the lesson, to vary subjects. All the material was divided into parts – tasks. Each of them was specified on a separate card in the form of a short written assignment, asking questions and identifying sources where students could find answers to the questions asked. Each student made a contract with the teacher to work individually on the material at a certain time. Tasks were performed at a pace accessible to each of them individually or in a group (3 to 5 students). The accounting of educational work was carried out on the cards: teacher's laboratory card, individual student's accounting card and class card. The students worked in separate subject laboratories. Thence is the name – the laboratory plan. However, the Dalton Plan gave rise to unhealthy rivalry among students, asserted individualism, wasted time.

In the 20-ies of the twentieth century in the territory of modern Ukraine a collective form of education emerged which is now a kind of interactive learning. Its essence was that there were no lessons on the schedule and students in turn, having studied different topics, taught each other.

In the former Soviet Union (30-ies – early 40-ies, in eastern Ukraine) emerged the idea of a brigade-laboratory form of training, which was called "the brigade-laboratory method". This form of work became very popular and gradually became a universal form of organization of the educational process. The main unit of students studying the material and doing tasks was the team (group, unit). The foreman who led the group was selected among the students. The work in such groups (teams) was organized in different ways: one task was collectively discussed, the results of different tasks were compared and etc.. This prompted to a lively discussion as each group had new material for themselves. Then the results obtained by the groups were compared. Unfortunately, these new forms of learning were implemented without proper experimental testing. Therefore, using

such forms of learning, significant drawbacks were quickly identified: a reducing in the role of the teacher, the lack of motivation for students to learning, uneconomical use of time, so errors that were characteristic also to the Dalton plan. The brigade-laboratory method was condemned and over time the rational grain of this technique was lost.

Only in the 1960s Soviet didactics became interested in group form education.

In the 1970s an important area of the research in general forms of education was related to the educational and cognitive activities of pupils in the context of collective, group, individual work in the classroom (A. Aleksiuk, Yu. Babanskyi, I. Lerner, . Liimets).

Elements of interactive learning are mentioned in the works of V. Sukhomlynskyi, as well as in the works of innovators of the 70 – 80's (Sh. Amonashvili, V. Shatalov, Ye. Ilin, S. Lysenkova and others), the theory of developmental learning.

At the end of the twentieth century, interactive learning technologies became widespread in the theory and practice of American schools. In the 1980s, a national training center (USA, Maryland) conducted a study confirming the effectiveness of the use of interactive technologies. The results of these studies were reflected in a scheme called the "Pyramid of Learning" (Fig. 1.2).

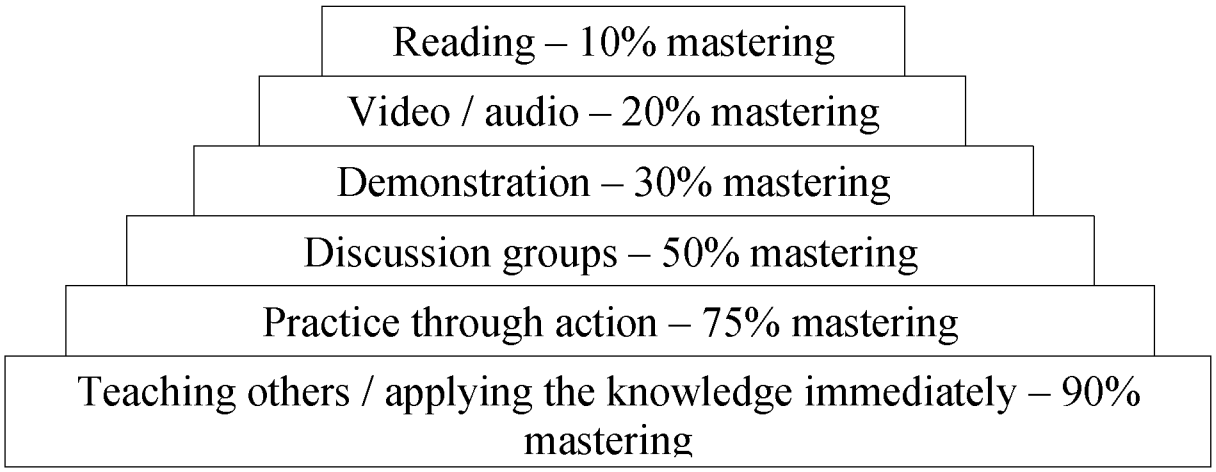


Fig. 1.2 Pyramid of Learning

The pyramid shows that the best results can be achieved in the context of interactive learning, namely: discussion groups, practice through action, teaching others. In the case of passive learning, such results cannot be achieved.

Modern Russian and Ukrainian psychologists and educators also confirm the research of their American colleagues. According to their estimates, reading through eyes a person can remember 10% of the material, listening – 26%, considering – 30%, listening and considering – 50%, discussing – 70%, personal experience – 80%, joint activity with discussion – 90% , teaching others – 95% [168, p. 8 – 9].

Soon, interactive technologies started using in higher education institutions, transferring the experience of using active technologies from school to the use of such technologies by teachers of higher education institutions.

1.3. Forms of interactive learning at the pedagogical university

Scientific and methodological works use different in its essence the concepts characterizing the problem of interactive learning:

- "forms of interactive learning" [30; 31; 37; 81].
- "methods of interactive learning" [29; 42; 43; 56; 72; 75; 82; 97; 101; 102; 201; 249].
- "interactive learning technologies" [10; 14; 22; 24; 25; 26; 34; 53; 60; 66; 79; 87; 110; 116; 123; 147; 152; 157; 164; 168; 172; 186; 195; 198; 247; 259; 260; 261; 262; 263; 264].

Analyzing the above-mentioned sources, it was concluded that technologies, methods and forms are considered in the context of interactive learning. In our work we will carry out research of forms of interactive teaching of future mathematics teachers.

The word "form" in Latin means appearance, outline. In pedagogy, the form of learning is understood as "a way of organizing a

learning activity that is governed by a certain, predetermined order; the external expression of the concerted activity of the teacher and the students which is carried out in a certain order and in a certain mode" [36, p. 615].

In higher education the form of learning means the outside of the ordered, interconnected activities of students and the teacher aimed at solving learning tasks [146].

In *the form of interactive learning* in higher education we shall understand the external expression of purposeful, clearly organized, content-rich and methodically equipped activity of the teacher and students, which is carried out in a dialogue mode based on active communication and interaction of the subjects of the learning process.

Analyzing the psychological and pedagogical literature, it is revealed that at the present stage there is no common accepted systematization of teaching forms. They are divided according to different criteria:

- by the number of students – individual forms of learning, micro groups, group, collective, frontal forms of learning;
- by the place of study – classroom forms: lectures, practical classes; extracurricular forms: colloquia, consultations, course and diploma projects, circles, problem groups, theme evenings, olympiads, etc.

The scientist V. L. Ortynskyi [146] identifies the following four groups of organizational forms of learning:

- educational classes (lecture, seminar, practical class, laboratory class, individual class, consultation and others);
- practical training (educational and production practice);
- individual work (individual learning of certain educational material, participation in scientific circles and problem groups, research work, etc.);
- control measures (exams, credits, unit tests, solving qualification works).

Since interactive learning is one of the types of learning, the above-mentioned general forms of learning apply to it. At the same

time, each of these forms is realized through specific forms of interactive learning that provide a dialogical learning style.

Heuristic talk, presentations, discussions, "brainstorming", "round table", "business games", competitions of practical works with their discussion, role-playing games, educational trainings, collective creative problem tasks solving, case method, practical group and individual exercises, modeling of a certain type of activity or situation, designing and writing business plans, various programs, discussing videos, including own actions recording, etc., are related to forms of interactive learning of S. O. Sysoeva [199, p. 39–40].

Each teacher should choose the most effective forms of interactive learning, taking into account the purpose of the lesson, their own desires and opportunities. It is important that the proposed forms interest students and help to enhance their educational and cognitive activities.

According to the above four groups of organizational forms, let us consider in more detail the forms of interactive learning.

The use of interactive forms of learning during the lesson (lecture, seminar, practical lesson, laboratory work, individual lesson, consultation, etc.). *Lecture* can take many forms. They are distinguished by common goals (educational, propaganda, advocacy, developing, etc.); in content (academic and popular); by influence (at the level of emotions, at the level of understanding, at the level of belief) [205].

In terms of interactive learning, depending on the form of presentation of the educational material, the following lectures are distinguished: problem lecture, lecture-visualization, lecture with planned mistakes, binary lecture, lecture-press-conference, etc. All these specific forms of lectures are inherent in interactive learning, as they involve a reciprocal interaction between the subjects of learning.

The problematic lection begins with the problem statement which needs to be solved in the process of presenting educational material. We suggest starting such a lecture on the form of "Brainstorming", "Circle of Ideas", "Continuous Scale of Thinking", which activates students' educational and cognitive activities, stimulates the search for ways to

solve the problem and facilitate research activities. The form of interactive learning "Circle of Ideas" is effective in the process of solving urgent contradictory issues. This form allows you to create a list of ideas for solving a specific task, involving all participants in the discussion. This form of training should be used when discussing a question or speaking from small groups. The work should be organized as follows: the teacher raises a discussion question and proposes to discuss it in each group (having previously divided the student audience into several groups), creating a list of ideas that emerged during the discussion. After the discussion time has passed, each group presents only one aspect of what they have discussed. Groups are expressed in turn (in a circle) until all the answers are exhausted. When discussing a topic, a list of ideas that should not be repeated is put on the board.

Lecture-visualization will provide the transformation of oral information into a visual form by technical means of learning. The principle of clarity is based on this form of lecture. The condition for successful preparation of the lecture-visualization is the availability of a set of technical training tools. When updating basic knowledge, such forms as "Microphone", "Incomplete sentence" and others are widely used on such lectures. After all, using a multimedia board will allow the teacher to return to the previously discussed material or question.

The latest information technologies, including Smart technologies, should be actively used for lectures-visualization. The advantage of using the SMART Board software is during the class a teacher can easily rebuild the teaching process depending on the circumstances, make adjustments, backgrounds, additional illustrations, pictures etc. The multimedia board software enables to get the information during the demonstration process, the sequence of actions of the board users, fix changes in the demonstration materials, annotate them and play back saved messages. However, using technical means in the process of classes, it should be assumed that they are not an end in themselves, but only a means of solving specific educational tasks.

For the lecture using the touch board, you should prepare a presentation using the appropriate software, which is a part of the SMART Board interactive complex. For example, a custom program to prepare a PowerPoint slide presentation is in the software on such a board. Using a multimedia board, the lecturer can highlight the pieces of training material that need attention, SMART technologies allow you to rotate objects, move them. For example, when using such a board in lectures on analytical geometry on the subject "Learning of second-order algebraic surfaces by their canonical equations", a teacher can not only show the surface drawing, but also rotate the surface around the axis. The surface can be constructed by the teacher in the program GRAN-3D, which has a convenient interface.

Also, the multimedia board is effectively used in lectures on methods of calculation. Due to the interactive whiteboard, lectures can reveal the possibilities of using ICT in the study of this discipline, because SMART Board supports both Microsoft Office and other mathematical programs. For example, when studying the topic "Solving Linear Algebraic Equations" or "Methods for Solving Nonlinear Equations", a lecturer may demonstrate the possibilities of using this subject to study ET Excel and MathCad in a lecture.

Also, it is advisable to use GRAN1, GRAN-2D software when learning "Calculation Methods" on topics that involve solving problems graphically (for example, separating the roots of nonlinear equations graphically; constructing an interpolation polynomial for a tabulated function; processing experimental data, etc.). And using a touch board will provide students with visual support for solving a task with a demonstration of work with a specific program.

A binary lecture is advisable to use when there are different approaches to problem solving or to make cross-curricular connections when one problem becomes integrated for teachers of different disciplines. A binary lecture is a mini-game that creates an emotional, positively colored background and increases students' interest.

A lecture of two or as it is called a binary lecture or a discourse lecture is a continuation and development of a problematic presentation

of material in a dialogue between two teachers. Such a lecture is appropriate if, for example, there are different approaches to solving problematic questions and each teacher defends his or her own position or to make cross-curricular connections if one problem becomes integrated for teachers of different disciplines. Teachers' and audience dialogues raise the problem and analyze the problematic situation, raised and disputed hypotheses, resolved contradictions and found solutions.

Preparation of a binary lecture involves preliminary discussion of theoretical issues by its participants, their intellectual and personal compatibility; possession of advanced communication skills; rapid reaction and improvisation ability. Consider a few examples.

1. The teacher and the student from the stream for which they are lecturing. The student is instructed to submit separate sections of the lecture:

- historical information (bibliographies of scientists, quotations from the history of the topic);
- cross-curricular links;
- application of the topic being studied in the activities of people;
- place of a topic in a school mathematics course.

2. Teacher and undergraduate student. For example, when teaching students the topic of "Applying a function derivative to a function study," a teacher of mathematical analysis can conduct a lecture with an undergraduate student who is well versed in applied software. The teacher provides students with theoretical information, demonstrates the scheme of functions study, select the function and gradually carry out its study together with students. The undergraduate student assists the teacher and students in the research process, and most importantly demonstrates students the use of applied software for charting. Emphasizes at those stages of work with a mathematical program that are important for visual representation of the graph, namely how to choose the right scale of the drawing, the thickness and color of the line, how to enter certain mathematical symbols, etc. Of course, the lecturer can give such a lecture himself, without the help of

the undergraduate student, but with the development of computer technology and software, students are much more aware of this issue than the teachers.

Involvement of the undergraduate student in cooperation will promote his professional growth, formation of students' interest in organizing and conducting non-standard forms of work, activating the cognitive activity of all present in the audience. At the same time, the lecturer is gaining experience in the use of computer technologies and thus develops his teaching skill.

3. Two teachers of different disciplines. This type of lecture, for example, can be done while learning mathematics teaching methods when students do not have a sufficient level of mathematical preparation, on the topic "Cartesian coordinates and vectors on a plane" together with the teacher of analytical geometry. Similarly, it is possible to conduct such class in the course of mathematics teaching at the high school "Cartesian coordinates and vectors in space". Students in the course of analytical geometry had to deepen their school knowledge of coordinates and vectors on the plane and in space. The teacher of mathematics teaching methods will tell you how to explain and convey properly this topic to students and the teacher of analytical geometry identifies the questions by which the educational material that students have developed in the first year is updated. Such a lecture will be especially useful when teachers will consider solving stereometric problems in a coordinate and vector way, as the level of students' mathematical culture is low recently. The teacher of methodology together with students determines the place of the topic in School Course of Mathematics, emphasizes that the guide rule for solving positional problems and the algorithm for solving metric problems by vector method in stereometry is the same as in planimetry. Students are encouraged to remember this guide rule and algorithm for solving it.

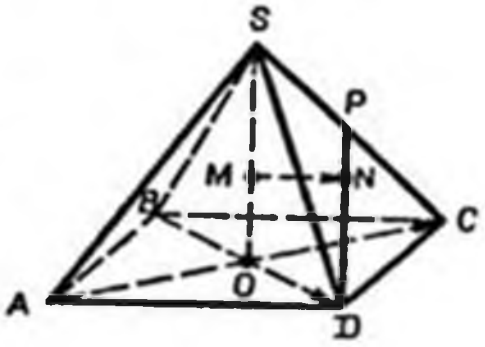


Рис. 1.3

Their application can be conveniently illustrated by the example of such a problem.

Problem. Each edge of a regular rectangular pyramid is equal to *a*. Determine the distance between the height of the pyramid and the side height of the pyramid with it (Fig. 1.3).

In solving the problem, the teacher of mathematics will focus on the required heights and the teacher of analytical geometry will remind students about the condition of the perpendicularity of vectors, the determination of the projection of the vector onto a vector, etc.

To summarize the lecture task, you can use such forms as "Select position", "Situation analysis" etc. "The Situation Analysis" form requires the student not a short answer ("yes" or "no") to a specific question, but a complete answer with arguments.

For example, to summarize lessons of elementary mathematics while studying polyhedra, students may be asked the following questions:

- How many visible edges can a rectangular pyramid have in the figure?
- Can the pyramid be depicted so that all its edges are visible?
- Is the cut pyramid a pyramid?
- Is the right triangular pyramid the right polyhedron?

More detailed in using forms of interactive learning for lectures in mathematical disciplines is discussed in paragraph 2.1 and in the works [226; 228; 238; 246].

Practical classes take a significant place in the system of training specialists. According to teachers and methodologists [44; 119; 146], the practical classes must meet the following requirements:

- students' understanding to have necessary basic theoretical knowledge;
- awareness of the need to develop skills and competencies that have a professional focus;
- providing conditions for the formation of skills and abilities;
- ensuring the individual activity of each student;

- keeping systematic and logical consistency in formation of students' skills and abilities;
- development of tasks for the classes of professional orientation;
- inclusion of creative tasks in the system of practical classes;
- systematic control over carrying out of practical tasks;
- encouragement of students' educational activities.

Only in practical classes it is possible to implement widely the forms of interactive learning both in the whole lesson and in its individual direction of activity. On practical classes the main tasks of the topic are considered, so to motivate and activate the educational and cognitive activities of students, it is necessary to use different forms of educational activity. V. L. Ortynskyi notes [146] that in the process of organizing student learning it is important to provide the necessary conditions for communication at the level of "student – teacher", "student – student" on the basis of democracy and tolerance. So, only under the conditions of free expression of their thoughts, their substantiation, the process of cognition is activated, the motives of learning are formed. For example, using a form of brainstorming is effective when solving a particular task.

Although the topics covered by the lectures are practiced, it is advisable that a small theoretical part is preceded by a practical part. This directs students to a scientific approach to the implementation and analysis of practical works, increases their quality.

The unity of the content of the educational material and the form of the organization of educational activity increases the efficiency of solving the complex of educational and cognitive tasks: strength and depth of the acquired knowledge; development of creative thinking, communicative skills; desire for self-education and self-control of knowledge.

Considering the possibility of introducing interactive learning elements for actualization basic knowledge, it is effective to use the forms "Microphone", "Finish Thought", "Unfinished Sentences" and others. And to check homework, you can use the form of "Chain", which will allow students to take turns to answer a certain stage of

homework. Also, forms of interactive work during homework checking include on-line check on the Moodle platform, on social networks, by means of e-mail.

To acquire subject and professional competences, the use of the "Mosaic" form, which combines group and front work, is effective in practical classes. The peculiarity of this form is the work of small groups on different tasks, after which the groups are transformed so that each newly created group has experts on every aspect of the problem. Using this form, the program material is repeated, summarized and systematized. Also at the stage of practical lesson it is effective to use such forms as: "Working in pairs", "Rotary triples", "Aquarium" and others.

To develop independence in the acquisition of new knowledge and experience, it is effective to use such forms of work as: "Joint project", "Work on discussion questions". This form of interactive learning has become widespread as a case-method that requires active individual student involvement and leads to a redistribution of teacher and student roles in the classroom.

More detailed about forms of interactive learning in practical classes are discussed in paragraph 2.2 and in the works [224; 227; 228; 229; 232; 239; 246].

Consultation is a type of individual and group learning. A group form of counseling can at the same time acquire forms of interactive learning. In this case, a group of students in need of consultation is involved in a collective creative discussion of the problem using forms of interactive learning. An example of carrying out this type of training is the consultation using the form of "Chain of mutual verification". The essence is that the teacher first explains the theoretical material, focusing students in those places where the difficulties most often occur, then consider the examples with a detailed explanation. In order to check the quality of the acquired knowledge, the teacher invites students to solve tasks (all students receive the same task). The first student who completed the task hands it over to the teacher for verification, if the task is completed correctly, the work of the second

student is already checked by the first student. If the task of the second student is done correctly, then he checks the work of the next and so on. If one of the students did the job incorrectly, then the student who checked his/her work should explain to him/her the course of the correct solution.

Having analyzed the psychological and pedagogical literature [25; 53; 98; 102; 123; 152; 153; 179; 180] we have found that at present stage the introduction of interactive learning during the classroom lessons (lectures, practical, laboratory, seminar) is mostly investigated.

Interactive learning is not only limited to classroom forms of learning organization, but also extends to forms of extracurricular work that ensure students' autonomy, development of their professional skills. Extracurricular work includes such forms as: pedagogical practice, conferences, individual work, individual research work of students, etc. Under the conditions of interactive learning, all these extra-curricular forms of work are introduced through specific forms of interactive learning. Let's consider some forms of extracurricular work in interactive interaction.

Use of interactive forms of learning during practical training (training practice). This type of educational activity of students as pedagogical practice has great opportunities for introducing interactive learning. During the course of pedagogical practice the student performs several functions at the same time, namely: the subject teacher, the class teacher and the student-teacher. This, in turn, creates all the necessary conditions for the introduction of interactive learning during which the student can be not only an active participant of this type of learning, but also its initiator. Taking lessons and extracurricular activities in the context of interctive learning gives the opportunity to: the student – to test himself as a teacher; methods teacher – to check the quality of mastering the student's knowledge and skills obtained during the classroom lesson, in particular on methods of teaching mathematics; subject teacher – to assess the level of pedagogical skills of a future colleague.

An element of interactive learning, which has always been carried out during pedagogical practice is the analysis and discussion of a student's lesson, which takes the form of discussion. Usually, the student first self-examines his/her lesson, then one of the students who attended the lesson does an analysis of the lesson and then the rest of the students enter the discussion process. After all students have spoken, the practice leader enters the discussion process. He does his lesson analysis, pointing out the positives and mistakes. This type of work will help students to develop professional competence and experience.

Use of interactive forms of learning during individual work (participation in scientific circles and problem groups, research work, etc.).

Such forms of work allow students to express their creativity, mastery, independence of thoughts, etc., but provided the teacher's counseling and reliable control over the independence of preparation.

Student *Conference* is one of the important forms of teaching that promotes the formation of students' knowledge, skills, their strengthening and improvement, deepening and systematization; is a complex form of generalization of the students' independent cognitive activity results under the guidance of the teacher, which is carried out through the joint efforts of the teacher and students. The purpose of this form of study is to deepen, strengthen and broaden the range of students' knowledge; forming a positive attitude towards their independent acquisition of knowledge; development and self-development of students' creative abilities, their activity. The main thing in the conference is a free, open discussion of problematic issues.

The conference can also be organized for a specific group or student stream. It can be done online: email correspondence with students, social networks, using the Moodle distance learning environment, free Skype software that provides text, voice and video communication over the Internet.

Use of interactive forms of learning during the control measures (exams, credits, modular control works, solving qualifications).

In the course of such control measures as examinations, there is no wide variety of forms of their conduct. However, it is possible to combine the traditional form of the exam with the forms of interactive learning. According to the credit-modular system of organization of studying in higher education institutions, the final assessment of the discipline is the sum of the rating points obtained for individual evaluated forms of education activity: current and final testing of the level of mastering theoretical material during lessons and independent work (module control); points for individual research task and etc. The exam will effectively be conducted by the teacher together with the student examiner. That is, among students, the teacher should choose the student who scored the highest number of points on the rating system. Such a student, together with the teacher, will take the exam in his/her classmates, but in assessing the answer of each student, the examiner should justify his/her opinion, point out mistakes or inaccuracies that were made. Meanwhile, the teacher at the same time evaluates both the reporting student and the evaluating student.

Similarly, it is possible to carry out credit classes. And modular control can be tested on-line using computer-based test programs, Moodle platforms, etc., which will provide communication of teacher and student with the computer.

Modular control can also be organized as follows: all students in the group are offered a set of tasks that is differentiated by difficulty levels. Students can collectively solve such tasks or individually. However, at the control lesson the teacher selects different tasks for each student from the list, which he should individually solve with a detailed explanation.

Analysis of literature [72; 83; 87; 110; 171; 168; 110], observation results and own work experience made it possible to systematize forms of interactive learning according to the forms of organization of educational activities in higher educational institutions, selecting only

those forms that can be used in teaching of future mathematics teachers (Table 1.2).

There are some forms of interactive learning that are universal and can be used both in general education institutions and in higher education – "Microphone", "Finish the Sentence", "Cluster" and others.

Table 1.2.

Systematization of interactive learning according to forms of educational activity organization

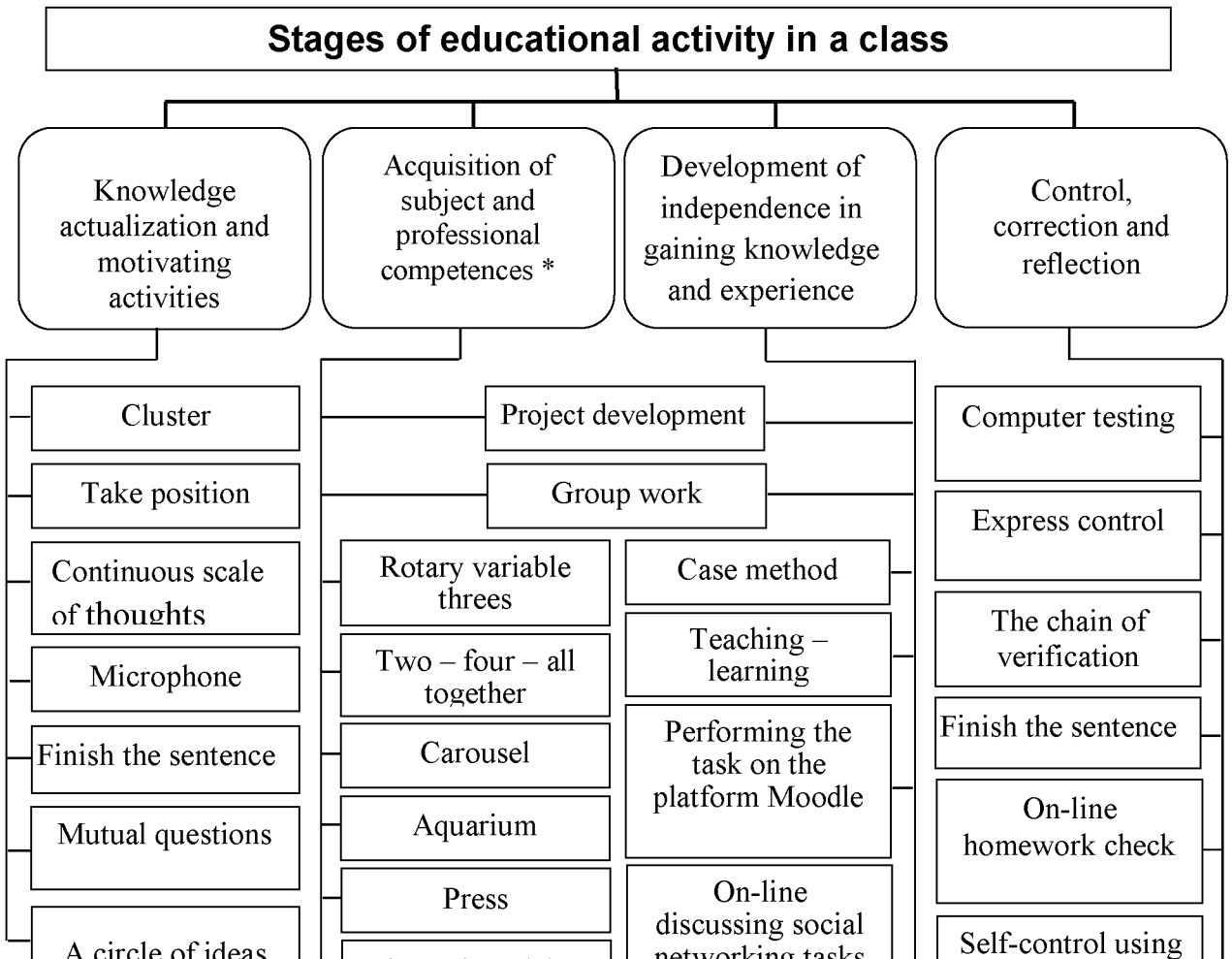
Forms of educational and cognitive activity organization		Types of interactive learning		
		Cooperative learning (small groups)	Collective and group learning	Situational learning
Auditory work	Lecture	"Search for Information", "Project Development"	"Microphone", "Finish the Sentence", "Teaching – learning"	"Press", "Take Position", "Discussion", "Continuous Scale of Thoughts"
	Practical classes	"Work in pairs", "Rotary Variable threes", "Two – four – all together", "Carousel", "Dialogue", "Aquarium", "Joint project"	"Microphone", "Finish the Sentence", "Teaching – learning", "Cluster", "Jigsaw", "Chain"	"Public Hearing", "Case Method", "Discussion", "Debate", "Continuous Scale of Thoughts", "Take Position"
Extracurricular work	Practice	–	"Teaching – learning", "Problem discussion in a general circle"	"Discussion", "Take position"
	Individual research task	"Project development", "Work in Pairs", "Search for information"	–	–
	Students' individual work	"Project Development", "Group Work", "Search for information"	–	–
	Circles	"Search for information"	"Teaching – learning", "Problem	"Case Method" "Debate",

			discussion in a general circle"	"Continuous scale of thoughts", "Take position"
	Consultations	"A circle of ideas"	"Chain", "Problem discussion in a general circle" "Teaching – learning"	"Continuous scale of thoughts", "Take Position"
	Conferencies	"Search for information" "Joint project"	–	"Case Method"

Since it is not always possible to introduce interactive learning during the lesson, it is advisable to organize the forms of interactive learning according to the directions of activity in the lesson (Fig. 1.4.).

It will allow the teacher, to introduce elements of interactive learning on separate parts of a lesson, without spending a lot of classroom time.

Below are some algorithms for performing some forms of interactive learning that can be introduced in both classroom and extracurricular work.



1. Forms of cooperative learning

"Work in pairs" – such work is used both as a separate form and as a preparatory stage for work in groups. Working in pairs promotes a positive attitude to learning, develops the ability to adapt to working in groups, prepares the ground for the wide and effective use of interactive forms. It is very effective in the initial stages of learning. In the case of pair work, all participants are able to speak, express their opinions. Working in pairs gives students time to think, to share ideas with a partner and only then express their thoughts. It develops communication skills, ability to speak, critical thinking, persuade, and have a discussion. When working in pairs, you can quickly perform exercises that, in other circumstances, take a long time.

"Rotary (variable) threes" student activity in this case is similar to working in pairs. This variant of cooperative learning promotes active, thorough analysis and discussion of new material in order to comprehend, consolidate and assimilate it. To organize the work with this form it is necessary for the teacher to develop clear questions or tasks. Students should be grouped into threes and placed so that each of them can see a group of three on the left and three on the right. Together, all three must form a circle. Each of the three the teachers asks a question or task (the same for all students). The teacher breaks the task into certain stages, the number of which is equal to the number of threes. Each member of the three in turn should either answer the question or provide a solution to the task. After a brief discussing of the task and agree to the task, participants are calculated "on the first, second, third". Students with the number one go to the next three clockwise and the

students number two go to the two three counterclockwise. Students with the number three remain in place and are permanent members of their three. As a result, new threes are formed. At the last stage of the task, the initial three (the one that was formed at the beginning of the task) must be formed. Assessing the students' solving of the problem, pointing out remarks, corrections, clarification, if any, the teacher summarizes the students' work.

"Two – four – all together" – this option of cooperative learning is derived from pair work, effective for developing group communication skills, ability to persuade and debate.

To organize properly this form of interactive learning, you need to ask students questions for the discussion or set up a task for joint solving. Students should be paired together to discuss their ideas. It is necessary to define the time clearly for each pair to express and discuss together. Pairs should agree in answering the question or solving the task. Then, the pairs are grouped into fours, discussing the results achieved previously on the task. Just like in pairs, making a joint decision is a must and then group the fours into larger groups or discuss the tasks with all students in the group.

"Carousel" – this option of cooperative learning is the most effective for simultaneous involvement of all participants in active work with different partners. It is used to discuss any acute problem, to gather learning material on a particular topic, to check the volume and depth of available knowledge, to develop skills to argue their own position.

To organize the work in this form, it is necessary to arrange chairs for participants in two circles. Students sitting in the inner circle are with their backs to the center and those who are sitting in the outer circle are facing the center, so the students are facing each other. The inner circle is fixed, the outer circle is moving: at the signal of the teacher, all its participants move one chair to the right and face the new partner. The purpose of this form is to go through the entire circle, completing the tasks. There may be several options for this activity.

"Dialogue" – the essence of this form is in joint search of the agreed task in groups. This is reflected in the final text, the list of features, the scheme etc. Dialogue excludes confrontation, criticism of the position of a particular group. The focus is concentrated on the strong moments of other positions.

The group is combined into several working groups and an expert group consisting of strong students. Working groups are given 10 – 20 minutes to complete the task. The group of experts makes up their own version of the task, monitors the work of the groups and controls the time.

After completing the work, representatives from each working group make a summary record on the board or on sheets of paper. Then, in turn, one speaker from each group is given the floor. Experts fix joint view, and in the end offer a generalized answer to the task. Groups discuss and complement it. The final version is recorded in the notebook.

"Joint project" has the same purpose and grouping as the "Dialogue" form. But the tasks that the groups receive are different in content and highlight the problem from different points of view.

"Search for information" is a kind of example of small group work is a team search for learning material (usually supplementing a lecture or a previous practical lesson) and then answering questions. It is used to revive dry, sometimes uninteresting material.

Groups are asked questions that can be found in various sources, or a task whose algorithm is still unknown to them. The sources of information that students can use include: handouts, documents, textbooks, reference publications, available computer messages.

Students need to be grouped together. Each group receives questions or tasks on the topic of the lesson. The time to search and analyze the material is determined. At the end of the lesson, messages from each group are heard which are repeated then and may be extended by the whole group.

"Circle of Ideas" – the purpose of this form of interactive learning is to resolve urgent controversial questions, create a list of ideas and

involve all students in discussing a given question or task. The form is applied when all groups have to perform the same task, which consists of several questions (positions) that the groups present in turn.

"Aquarium" is one of the variants of cooperative learning, which is a form of student activity in small groups, effective for developing small group communication skills, improving the ability to discuss and justify their opinions. It can only be offered if students have already good team work skills.

To organize properly this form of work, you need to group students into 2 – 4 groups and familiarize them with the task. One group is asked to sit in the center or in the beginning of the middle row in the classroom and form a circle. Announce the beginning of the discussion of the problem by the algorithm: 1) read aloud the task; 2) discuss it in a group, apply a method of discussion; 3) reach a joint solution in 3 – 5 minutes. The rest of the students should listen, without interfering with the discussion, to observe whether the participants in the discussion adhere to the rules. When time for the discussion is over, the group returns to their seats and the teacher asks all participants: 1) Do you agree with the opinion of the group of students who were in the aquarium? 2) Was this opinion sufficiently proven? The duration of such a conversation is about 2 – 3 minutes. Then another group takes the place in the "aquarium", discussing the next task.

Using the Aquarium form during their studying, students need to take many logical steps orally, which has a positive effect on creative thinking and promotes students' intellectual development. In addition, students enrich their imagination, learn to predict the outcome, encourage their culture of language and a flow of thought that is needed for the future teacher and learn to evaluate responses by commenting on the assessment.

This form can also be carried out in another way. For example, set one task in one of the groups in the same stream (let it be group № 1). Students should discuss each stage of solving out the task loud, and then, upon agreement, to write down detail solving course on the board. The whole process of solving should be recorded on video. When

students complete their work, the teacher should usually point out to their mistakes, if any, and where there were false reasoning. The teacher's explanation is unnecessary to record on video, as this video can be given to another stream group (group № 2). When students of group № 2 watch a video with the problem-solving process and relevant comments from students of group № 1, they should perform a detailed analysis of the task-solving process that they were asked to do. That is, the students of group № 2 should make the following conclusions: were there any mistakes in the solution, if yes, where exactly; whether the rational way of solving the problem was chosen by group № 1, etc.

When students finish discussing the video, the teacher comments on their conclusions. That is, whether mistakes were made by group № 2, whether group № 2 correctly indicated the mistakes of group № 1, etc.

2. Forms of collective and group learning

"Problem discussion in a general circle" – is a well-known form, which is usually used in combination with others. Its purpose is to explain certain provisions, to draw attention to complex or problematic issues in educational material, to motivate cognitive activity, to actualize basic knowledge etc. The teacher should encourage everyone to equal participation and discussion.

To organize properly the work in this form, it is advisable to arrange tables and chairs in a circle. This way, everyone can freely discuss the task. Students express themselves at will. Discussion continues until there is a willingness to speak. The teacher can finally enter the discussion.

In order this form to be effective, it is necessary for the teacher to avoid short-answer questions ("yes" or "no").

"Microphone" is a form that allows everyone to say something quickly, in turn, by answering questions or expressing opinion or position.

To organize the work in this form, the teacher asks questions to all students of the group. For greater efficiency, students are offered some item (pencil, pen, etc.) that will act as an imaginary microphone.

This will help students during the discussion, as the student has the right to express his or her opinion only when holding an imaginary microphone. Before discussing or answering the question or the course of the task solving, students should be told a time limit, so the answer should be clear and concise. Before the end of the discussion, the teacher does not discuss or comment on the students' answers.

This form of interactive learning is convenient to use both during lectures (checking students' knowledge of the previous lecture) and during practical lessons.

"Brainstorming" is a form of interactive learning that is widely used to find several solutions to a specific problem. Brainstorming encourages students to express their imagination and creativity and enables them to express their thoughts freely.

The purpose of "brainstorming" or "problem-solve" (also called this form) is to gather as many ideas as possible about the problem from all participants in the learning process for a limited period of time.

After clear formulating the task, the teacher writes it down on the board so students can read it again during the discussion. The teacher invites all students to express their ideas about solving the problem. It is forbidden to comment or deny any statements made by students. All student proposals are written on the board. Students should be encouraged to make as many statements as possible. It is necessary to teach students to change, develop their colleagues' ideas, combining 2 – 3 ideas into one.

When the discussion is complete, the teacher together with the students, evaluates the proposed ideas.

"Teaching – learning" – this form is used in the study of a block of educational material or in the generalization and repetition of the studied material. It enables students to participate in the transfer of their knowledge to groupmates. The use of this form increases the interest in learning.

The form "Teaching – learning" can be applied in different ways. For example, at the beginning of the lesson, you can hand out cards to the students with material to be learned. Distribute to each student one

card containing a certain amount of learning material. Within 10 – 15 minutes, students should acquaint themselves with the message on the card. If the material presented on the card is not understood by the student, then the teacher approaches and explains it. When the time to study the material is over, students are invited to walk around the audience and introduce their material to other students. A student should report his/her learning material to only one classmate. The task is to share your facts and get new learning material from another student. The teacher should make sure that each student communicates with as many of their classmates as possible.

After completing the work on this form, the teacher invites students to answer questions regarding the newly learned material. In this way, the teacher will understand the level of students' learning material.

Also, the form "Teaching – learning" can be carried out somewhat differently. It is necessary to inform the students about the lesson plan in the previous lesson. It is necessary to assign one or several students to each task.

At the lesson, the teacher offers students who prepared a question to ask their classmates. If this is a practical lesson, then the student should choose the tasks and know how to solve them. The student who prepared the material acts as a teacher, that is, either he reports the new material to his/her classmates or chooses students to solve problems. However, if none of the students can solve the problem he has chosen for the topic, then he or she must solve the task himself/herself and explain it on the board.

Working on this form will help students feel like a teacher and activate their educational and cognitive activities.

"Jigsaw" ("Mosaics", "Jigsaws) – this form is used to create a classroom situation that allows students to work together to absorb a large amount of educational material in a short period of time.

In order for the lesson to be meaningful, the teacher in the previous lesson should hand out multicolored cards (for example five different colors) with a specific number (1 to 5). Thus, in the class a

certain number of so-called "home" groups will be formed depending on the color scale. Each group will be given questions and problems according to the task. Group members should exchange messages about their task, interview each other, find solutions to the tasks. After that, the teacher suggests students to join in "expert" groups by numbers. So, groups are formed with an expert on a specific task. Participants tell, explain the topic and solve problems.

"The Decision Tree" helps educators analyze and understand better difficult decision-making mechanisms. To organize properly the work in this form, you should choose a task that does not have a clear solution. The teacher should provide the necessary additional educational material for solving the task. They group students into small groups and offer to solve a problem in two ways. The discussion group needs to come up with one solution. If there is no unity, you can apply voting.

3. Forms of situational modeling

"Simplified Court Hearing" – a form of simplified court gives students the opportunity to get an idea of the decision-making process, to take part in the exercise related to analysis, critical thinking, decision-making.

The simplified court form allows students to litigate on a specific case with a minimal number of participants. This process can be conducted even with the participation of three persons: a judge who will listen to both parts and make a final decision, the prosecutor and the accused or their representatives.

To organize the work in this form, you need to choose a situation to study. A plan for a court hearing should be prepared (its rules should be written on the board) and the group should be familiarized with the procedure for the hearing. It is necessary to divide the group into three subgroups: judges, prosecutors and accused.

Judges should be instructed on the judicial process and give them time to prepare questions and prosecutors should be given time to prepare for the opening speech and arguments. For the accused, they should be given time to prepare for the opening statement and defense.

Carrying out this form, it is necessary to offer the judges to sit in different corners of the audience and give them "judge" plates. It should be suggested that one prosecutor and one accuser join each judge. The judges should know that when both players are near them, they can start "court". The court is held in accordance with the procedure:

a) Introductory statements of the participants in the appropriate court order. These statements should be limited to a specific timeframe.

b) The accused states the essence of the defense and is questioned by the judge.

c) The prosecutor presents the argument and is questioned by the judge.

d) The judge makes a decision and informs it after the whole group has reunited.

"Public Hearing" – the purpose of the form: modeling of public hearing through a simulation game allows students to understand the purpose and procedure of hearings, as well as the roles and responsibilities of members of government bodies, committees, and commissions. In addition, students gain practical experience in identifying and explaining ideas, interests, and values related to the subject of the hearing.

4. Forms of discussion questions

"Press" – is a small form which is worth to start on teaching students to discuss. It is used when discussing questions and when conducting exercises in which you need to take and explain clearly a particular position on the problem being discussed. This form of work teaches students to produce and formulate arguments, express opinions on a discussion question in a clear and concise form, to persuade others.

When organizing work on this form, it is necessary to distribute materials to students, which indicate the four stages of the PRES form:

1) Express your opinion, explain what is your point of view (start with words ... I think that...).

2) Explain the reason for this thought, that is, what is the evidence based on (start with words ... because ...).

3) Give examples, additional arguments to support your position, name the facts that demonstrate your evidence (... for example ...).

4) Summarize your thoughts (conclude with the words: thus ... so ...).

It is necessary to explain the mechanism of stages of the PRES form and to answer possible questions of students. You can apply the "Press" in all classes where students need to argue their opinions.

Using this form first helps students develop their communication skills and helps them to argue and defend their opinions.

"Take a position" – this form demonstrates the diversity of views on the problem being studied or after students learn a certain material of the problem and realize their possibility of opposing positions to solve them.

Everyone is given the opportunity to express themselves, to express different opinions on the topic, to substantiate their position, to find and express the most convincing arguments, to compare them with the arguments of others.

To organize properly the work in this form you need:

1) Offer students a discussion question and ask them to determine their position on it.

2) Discuss the rules for the form implementation.

3) Select several participants and offer them to substantiate their position or offer everyone who share the same view, discuss it and come up with common arguments for its defense.

4) After presenting different views, it is necessary to ask whether someone of the participants has changed his / her opinion and does not want to move to another subgroup.

5) If there are students who have changed their opinions, they should be encouraged to go to a subgroup that has a different opinion and justify the reasons for their transition.

6) Participants should be asked to name the most compelling their own arguments and the opposite side.

"Continuous scale of thoughts" (Infinite chain) is a form of discussion questions that aims to develop students' personal decision making skills and improve their ability to argue their opinions.

To organize the work in this form, the teacher should choose a discussion problem, which should provide the existence of substantiated, diametrically opposite positions. Characterize the different ways of solving tasks are related, each of which should be considered in sufficient detail, thoroughly. The teacher should give students time to reflect and argue their position. In order the work on this form is interesting and meet the requirements of higher education, it is necessary that students should be encouraged to make their position public, taking a place in the chain, depending on their views. Students should explain why they have chosen this position. Participants can explain the reason, but do not argue. It is important for students to be able to evaluate opposing views. Students can change their position and take their place in the chain again.

"Discussion" is a broad public discussion of a controversial question. It is an important tool for cognitive activity, promotes the development of students' critical thinking, gives the opportunity to determine their own position, develops argument skills and defend their opinions, deepens knowledge of the problem being discussed.

When organizing work on this form, the teacher should choose a topic for discussion and propose a plan to the participants in advance. Students need to prepare material, which they will work on at home or provide a list of recommended sources. The teacher should prepare a list of questions in advance.

During the discussion, an atmosphere of trust and mutual respect should prevail in the audience. To do this, it is necessary to discuss the basic rules for participating in a discussion with students. Students should be aware that active gesture and facial expressions help to support discussion without interrupting it. Participants should listen carefully to others, watch the discussion, the mood, not allow them to deviate from the topic. The teacher, together with the students, should make sure that the discussion does not turn into a heated dispute, but

there's no necessity to reduce all manifestations of emotions. The teacher should know that by asking specific questions, you will generate discussion and, by asking abstracting ones, you will cool the passion. It is necessary to give enough time for the final part and to offer students to summarize individually.

"Discussion in the style of television talk shows" – its purpose is to provide students with the skills of public speaking and discussion, expressing and defending their position, forming civic and personal activity. This form is important for the future professional and scientific activity of students, because the profession of a teacher requires the ability to attrack the attention of the audience.

To organize properly the work, you need to inform the participants of the discussion topic in advance. It is worth choosing about 5 participants to be experts. Other students should first come up with questions or tasks beforehand to the experts and determine their position on the task. Experts should prepare additional reference material on the topic of discussion. Teachers and students should come up with a talk show name and choose a presenter. The audience should be organized according to the type of studio, that is students should form a circle around experts.

At the beginning of the discussion, the teacher should announce the topic and recommend the presenter and experts to the participants. The presenter should remind the participants that they need to speak concisely and concretely. Participants are allowed to speak only when the presenter gives them the floor to speak. The presenter may stop the speaker who has exceeded the time limit. The expert presentation should be no more than 5 – 7 minutes for each member of the expert group. Students should ask the experts questions or post within 3 minutes. Experts also have the right to ask each other questions. Finally, the results of the discussion should be summarized in terms of content and form.

"Debate" is one of the most difficult ways to discuss problems. Debate can only be conducted when students have learned to work in groups and have mastered the problem-solving form. It is important that

the debate participants do not convey emotions to each other, but communicate calmly. In debates, the division into opposing camps becomes most acute, since students need to prepare for a long time and publicly justify their position. Each group must convince its opponents and persuade them to change their position. However, there is another challenge to solve the problem together. In this case, students will have to express their position carefully and listen to their opponents.

To properly organize the work, you need to tell the students the topic of the debate, group them together. In preparation, the group should share roles, think about how best to use the allotted time for speeches and prepare questions for other groups. The teacher should ensure that the regulations are strictly adhered to.

The above mentioned forms of interactive learning can be used in the process of studying all mathematical disciplines, but the basic idea and algorithm for conducting the same form will not change. Undoubtedly, they will have their own peculiarities, differ in content and purpose in use. The choice of form of interactive learning in a particular lesson depends on the teacher's vision of the learning process, his creativity, the age and individual characteristics of students, their mathematical abilities, etc.

Forms of interactive learning diversify the process of learning in higher educational institutions, provide for the activation of educational and cognitive activities, stimulate them to acquire new knowledge and skills, contribute to the formation of professional abilities. The diversity of forms of interactive learning provides the largest space for students to self-realize, as the learning process must be organized on the basis of effective multilateral communication. In the process of such learning, the teacher becomes the organizer of the learning process, consultant, interlocutor, like-minded person.

1.4. Using computer technologies in interactive student teaching

Modern society is characterized by rapid development of computer and information learning technologies. The rapid development and use of computer technologies in all spheres of life has contributed to a corresponding change in education.

The transition to the information society has a significant impact on the professional training of specialists. According to S. Sysoeva, this applies not only to the content, forms and methods of teaching, but also to the understanding of modern professional education as a continuous, aimed at the formation of a creative personality in the globalized information society of the 21st century, capable of self-development and lifelong learning.

The use of computer technology in the educational process poses new requirements for training of professional qualities of future teachers. For this reason, one of the indicators of professional training students of pedagogical higher educational institutions is the possession of basics of necessary knowledge and skills of practical use of computer technologies, as well as the skills to use them effectively in the educational process.

Today, much attention is paid to interactive learning methods using computer technologies that implement a lifelong learning approach. The means of implementation of this approach are complexes of software means, by which educational and cognitive activity of students in higher educational institutions is carried out. The use of computer technology in interative learning process includes modern technical learning tools, computer training systems, pedagogical software, electronic knowledge testing systems, etc.

Modern learning tools have significant advantages over those previously used because the level of development of recording and reproduction technologies of image and sound achieved today, the transition to digital media and software-controlled playback means, provides the ability to dynamically control the process of reproduction of educational material.

The emergence of interactive whiteboards, graph projectors, multimedia projectors, modern digital media playback facilities, the

development of a global Internet network, its use in educational institutions contribute to the accelerated filling of educational Internet resources, actualize the entire arsenal of learning tools.

Computer training systems widely used in higher educational institutions include: electronic manuals, electronic reference books, computer models, constructors and simulators, computer tasks, electronic laboratory practical training, etc.

Today, electronic manuals have become the most widely used in higher educational institutions among computer training systems. Analyzing the scientific and pedagogical literature, you can notice that there are several interpretations of this concept. According to I. H. Zakharova, electronic textbook is ... "a program complex with educational materials and tests in a separate discipline". In her opinion, the electronic textbook should perform such functions as:

- managing (to effectively manage the student's activity in the process of studying the discipline);
- stimulating (stimulate educational and cognitive activity);
- unifying (to provide rational combination of different types of educational and cognitive activity taking into account didactic features of each of them and depending on the results of mastering the educational material; rationally combine different technologies of the presented material (text, graphics, audio, video, animation));
- organizing (to arrange virtual seminars, discussions and other classes based on communication technologies when posting in the network).

M. I. Zhaldak, V. V. Lapinskyi, M. I. Shut provide an in-depth description of content of the concept "electronic textbook", as they believe "it is characterized by the hypertext structure of educational material, the presence of a control system with elements of artificial intelligence, self-control blocks, "developed" multimedia components" [64].

Pedagogical software tools (PST) that focuse on computer support for a mathematics course or any other discipline can be divided into

three types, depending on their impact on content and teaching methods [64]:

• PST aimed at improving the effectiveness of the current teaching methods;

• PST packages that provide the opportunity to transition to new methods of teaching mathematics;

• PST package systems that create conditions for essential changes in teaching mathematics based on the widespread introduction of new information technologies.

When studying mathematical disciplines, it is advisable to use different types of educational program tools. In particular, M. I. Zhaldak defines the following types:

1. Demonstration programs, which first outline the required theory and then provide examples how to solve problems. Such programs are useful in the study of functions and constructing their graphs, in the study of rules of differentiation of functions, methods of integration, etc.

2. Control programs that provide a system for assessing knowledge, skills and abilities of pupils or students. With their help, you can give appropriate advice, point out to mistakes, correct the answer, prompt, and if necessary, analyze your knowledge and skills. These programs can be used to test knowledge of a table of derivatives and integrals, the ability to differentiate and integrate functions, solve differential equations, etc. For the implementation of quality control and correction of knowledge, the program can provide multivariation within a given type of exercises, which, in turn, should be multilevel, which corresponds to the idea of teaching differentiation. Such programs can also be used for multilevel test control.

3. Calculating programs are designed to perform calculations in the study of boundaries, derivatives, integrals, differential equations, etc. The application of these programs allows you to perform the simplest calculating experiments that help you to comprehend and better understand the essence of theory and illustrate its application to solving practical problems.

4. Training programs are designed to form a strong link between knowledge and skills through repetition and practical support. Such programs can be used in the study of boundaries, derivatives, integrals, differential equations, etc.

5. Research programs are intended for individual creative activity. They include the study of mathematical models by studying the properties of functions, differential equations, etc. Consideration of mathematical models in the educational process nurtures the ability to penetrate into the essence of nature phenomena, to notice regularities in the surrounding world.

Nowadays, a significant number of software tools have been developed for use in studying mathematics. These are such programms as: GRAN, Cindirella, Maple, MathCAD, Mathematika, MathLab and others. These software tools are primarily intended for solving a wide range of tasks by modeling objects that appear in the problem condition. Below, we take a closer look at the benefits and examples of using the software complex GRAN (GRAN1, GRAN-2D, GRAN-3D) and 3D Plotter computer program in teaching mathematical disciplines.

In the process of interactive learning, systems of electronic testing are widely used in the "teacher – computer – student" interaction. The computer-based testing system, on one hand, provides self-control for the user and on the other hand provides current or final control. The efficiency of using testing system is significantly higher if it allows you to accumulate and analyze test results. Below we take a closer look at the systems of electronic testing of mathematical disciplines.

1. The software GRAN1, GRAN-2D, GRAN-3D

The GRAN program was developed at the National Pedagogical Drahomanov University by a prominent scientist of the Department of Theoretical Foundations of Informatics for purposeful use in the educational process in the study of the mathematical cycle disciplines. The name of the GRAN program comes from its purpose – a graphical analysis of the function. There are different versions of GRAN: GRAN1, GRAN-2D, GRAN-3D.

The use of the GRAN1 software provides interesting learning opportunities for conducting educational research, that include not only problem-solving, but also their setting; helps in conducting graphical and calculating experiments, on the basis of which the student comes to formulation of hypotheses concerning the studied regularities.

Using the GRAN1 program (developers M. I. Zhaldak and Yu. V. Horoshko) allows you to build quickly various closed and open broken lines, calculate their lengths, areas and perimeters of polygons, volumes and areas of body surfaces of rotation, to solve planimetric problems for build, to perform polynomial transformations – parallel transitions, rotations, deformations, to build schedules of several functions, to compare them with each other, to find the largest and smallest values of a function on a given segment, to solve equations and inequalities with one and two unknowns and systems of such equations and inequalities, to calculate certain integrals, to determine the area between two curves, the volumes of bodies of rotation about the axis *Ox* or the axis *Oy*, to calculate the statistical probabilities of certain random events, to perform statistical processing of experimental data with the construction of appropriate schedule images, build polynomials (up to 7th degree) of the best approximation of a table-set function using the least squares method, etc. The problem is only to find out the essence of the phenomenon or the process under study and to construct a corresponding mathematical model. Investigating the model using a computer with the program does not cause any difficulties [65].

In manual [63], the authors provide examples of the use of computer mathematics tools in each section. For example, to calculate the integral $I = \int_{\sqrt{\pi/4}}^{\sqrt{3\pi/2}} \sin(x^2)dx$ [10, p. 38]. Using Gran1 programme you can only calculate NL integrals from elementary functions of an actual variable and only numerically. It is clear that such a calculation is approximate. The accuracy of the calculations is set in the menu *Corrections > Adjustment of program parameters* ... from 0 to 6

decimal places after coma. It is also possible to view on the screen a figure whose area is expressed by this integral.

So, to calculate the integral, you should do the following:

1) Go to *Object* menu > *Create*.

2) A window will appear where you need to enter the function Y (X) = SIN (X^2) and the segment: A = SQRT (Pi/4), B=SQRT (3 * Pi/2) and press *Ok*.

3) To see a figure whose area expresses the desired integral, it is necessary to build first a graph of this function. This is done through the *Graphic* menu > *Build*.

4) Through the *Operations* menu > *Integrals* > *Integral* ... a window will appear. By clicking *Calculate*, we will get the result in the same window. At the same time (if the function graph was constructed), a shaded figure (Fig. 1.5) will appear on the screen, the area of which is equal to the calculated integral.

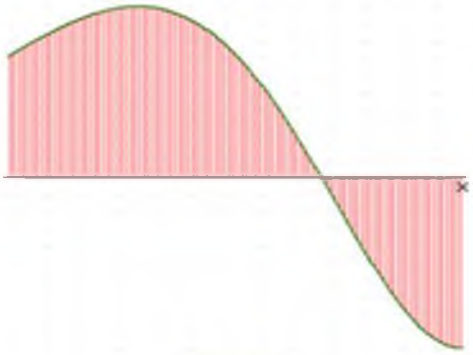


Рис. 1.5

Gran1 program can be used to illustrate the basic properties of a Riemann integral. Consider examples of solving such problems [63]:

1. Given figures $\Phi_1 = \left\{(x, y) : x \in [-1;2],\ 0 \le y \le 2^{-|x|}\right\}$ and $\Phi_2 = \left\{(x, y) : x \in [-1;2],\ 0 \le y \le 3 \cdot 2^{-|x|}\right\}$. It is necessary to depict these figures in one drawing, to find the areas S_1 and S_2 of these figures and the relation S_2: S_1. First, we define the functions and construct their graphs (Fig. 1.6).

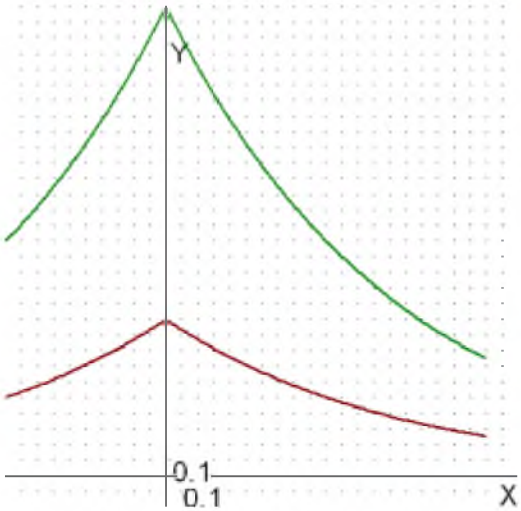


Fig. 1.6

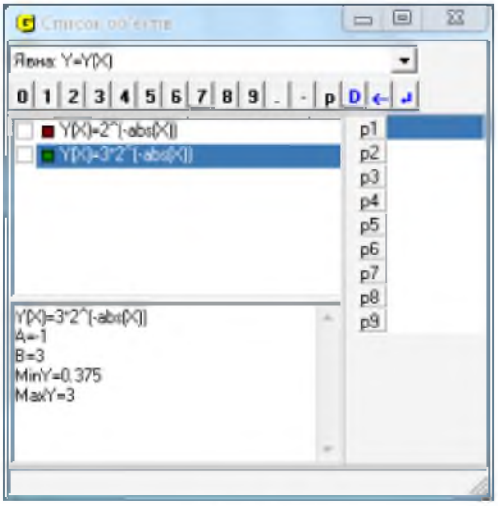


Fig. 1.7

Next, in the window "Object List2" (Fig. 1.7), one by one we put the labels against the first and then against the second function and calculate their integrals with entry in the answers. As a result, the figures F_1 (Fig. 1.8) and F_2 (Fig. 1.9) will be shaded and their areas calculated (Fig. 1.10).

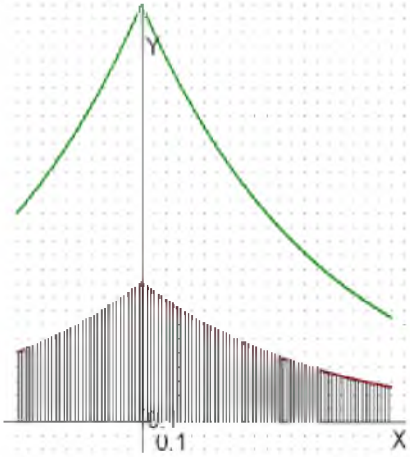


Fig. 1.8

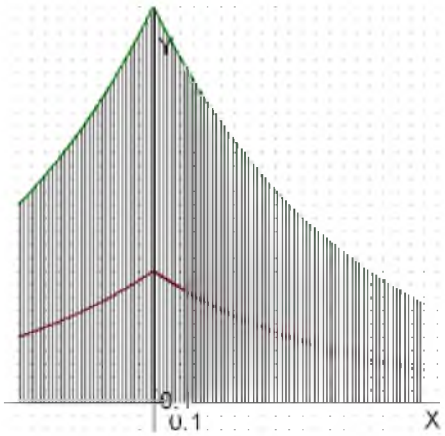


Fig. 1.9

After that, we use the calculator to divide the second integral by the first and thus find the ratio of the areas S_2: S_1 = 5.95112 / 1.98371 = = 2.99999. We conclude that when stretching a figure in 3 times its area also increases threefold. An error of 10^{-6} is related to the fact that the calculations using a computer use not exact numbers, but their decimal approximations (Fig. 1.10).

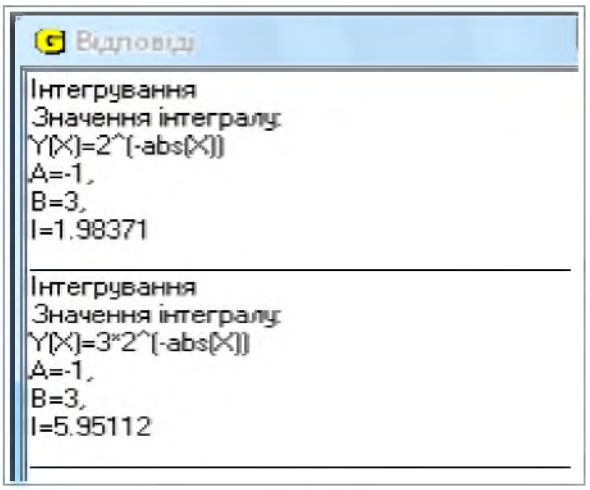


Fig. 1.10

2. Given the figures $\Phi_1 = \{(x,y): x \in [0;\pi],\ 0 \le y \le \sin x\}$ and $\Phi_2 = \{(x,y): x \in [0;\pi],\ 0 \le y \le x^2\}$.

Depict these figures and find the areas S_1 and S_2 of these figures, and also depict the figure having the area $S_1 + S_2$. The linear property of an integral figure with area $S_1 + S_2$ can lie under the graph of the function $\sin x + x^2,\ x \in [0;\pi]$. Therefore, you can first enter 3 functions and draw their graphs and then mark each of these functions individually by calculating their integrals. In this case, the corresponding figures will automatically be shaded (Fig. 1.11).

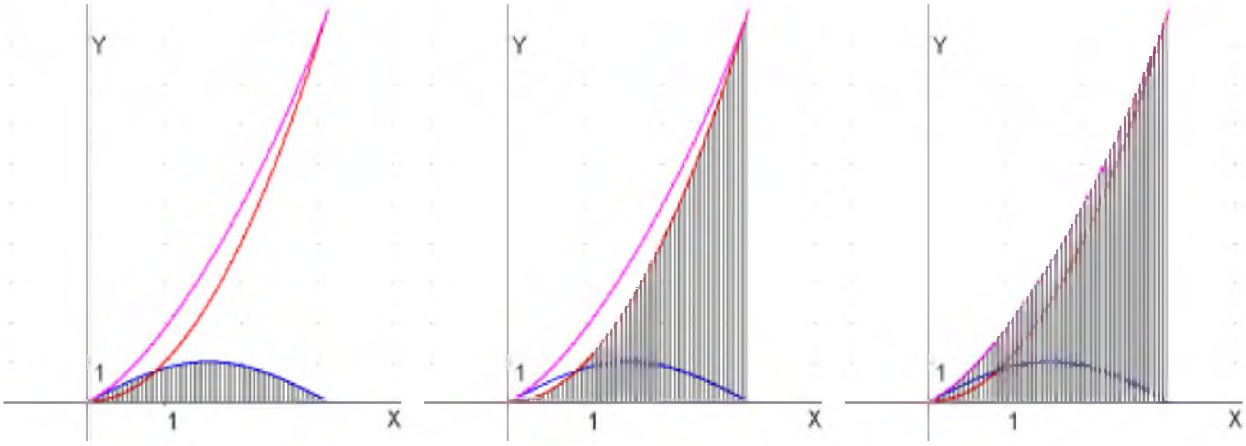


Fig. 1.11

In this case, it is also possible to analyze whether the area of the third figure is equal to the sum of the first two.

3. Given figures $\Phi_1 = \{(x,y): x \in [-1;1],\ 0 \le y \le x^2\}$ and $\Phi_2 = \{(x,y): x \in [1;2],\ 0 \le y \le 2 - x\}$. Depict these figures and find their area S_1 and S_2, and also depict a figure having an area $S_1 + S_2$.

As the condition is given for functions on different segments (having a common point of contact), then the figure with the area $S_1 + S_2$ can lie under the graphs of both functions by the additive property.

Therefore, we first define the two required functions and draw their graphs and then alternately calculate the integrals from each of these functions separately and from both at the same time (Fig. 1.12). This will illustrate the additive property of the integral.

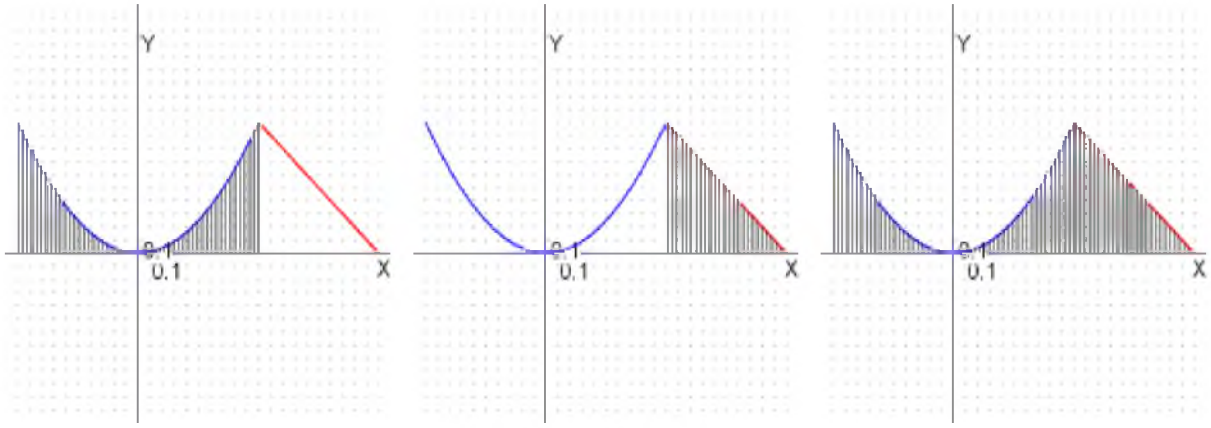


Fig. 1.12

The given answers allow us to make sure that the area of the shaded figures is calculated.

Analogically, using the Gran1 program, it is convenient to illustrate the properties of an integral such as monotonicity, integral of a module, of an even (odd) or periodic function.

The use of the GRAN-2D package (developers M. I. Zhaldak, A. O. Kostiuchenko and O. V. Vitiuk) allows:

– to create dynamic models of geometric shapes and their combinations in the same way as classical constructions using a compass and a ruler, as well as to use elements of analytical geometry (system of coordinates, equations of straight lines and circles, algebraic dependences between parts of construction, graphs of functions, etc.);

– make measurements of geometric quantities;

– explore the geometric locations of points;

– to analyze dynamic expressions, to make assumptions, to establish regularities;

– build graphic images using comments, buttons, hints and hyperlinks;

– export drawings to graphic formats for embedding them in other applications and for creating geometric illustrations etc.

In the course of analytical geometry, the use of *GRAN-2D* is possible when studying the topic “Straight on the plane”, “Curves of the second order”. Different types of equations of the line and their

application, the distance and deviation of the point from the line, the geometric content of linear inequalities with two unknowns, the mutual placement of lines, finding the angle between the lines are studied in this topic. With the help of the program, we have the ability to construct: a line on two points, construct parallel and perpendicular lines, find the coordinates of the midpoint of the segment, find the point of intersection of two geometric objects, construct curves of the second order (circle, ellipse, hyperbola, parabola) and other [6, p. 12].

Here are some examples [6, p. 12 – 15]:

1) Given a triangle with vertices $A(-1;2)$, $B(2;-2)$, $C(1;3)$. Make the equation of a line passing through the vertex C parallel to the side AB.

To solve this problem, you need to construct a triangle on these points, namely the sides of the AB, and then use the button *Create of a parallel line*, which is located in the toolbar.

To construct a triangle with vertices $A(-1;2)$, $B(2;-2)$, $C(1;3)$, we do the following: click on the *Create Point* icon in the toolbar and place the first point with a single left mouse button click, then without moving the mouse cursor from the place click the right mouse button and select *Properties*, in the window that appears, enter the parameters of this point. The same steps are repeated for the other two points ($B(2;-2)$, $C(1;3)$). Further these points, for this purpose we select the button *Create a segment*, in turn we connect previously created points, clicking on them.

Next we draw a straight parallel to the side AB. To do this, in the toolbar select the button *Create a parallel line* (Fig. 1.13) and point which vertex it will pass, in our case it is vertex C, moving over the cursor mouse on this point and do one left-clicking on it, then point to the side, which will be parallel to our straight line by clicking on it.

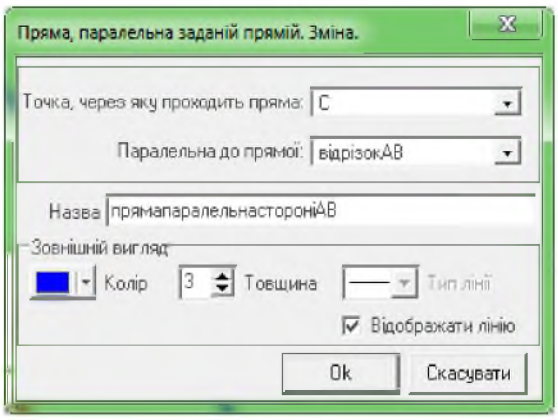


Fig. 1.13

In the *Object Properties field*, we see that a line passing through the vertex C parallel to the side AB looks like: $4x+3y-13=0$.

After completing all the operations, we get the graph shown in Fig. 1.14.

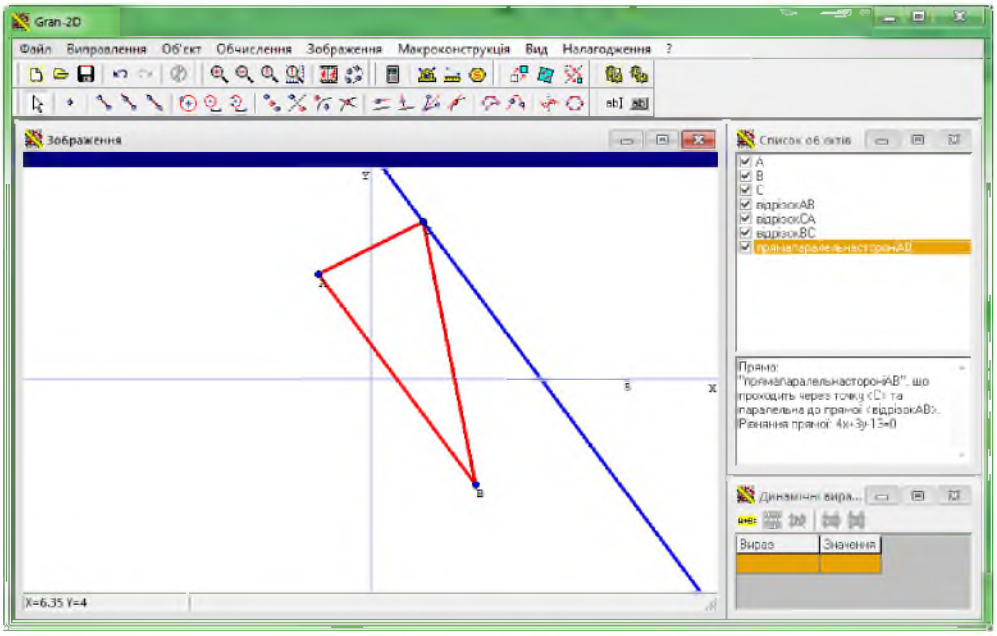


Fig. 1.14

2) Given the coordinates of the triangle vertices ABC: $A(2;4)$, $B(6;3)$ $C(4;-3)$. Draw up the median equation AD.

To solve this problem, you need to construct a triangle on given points, find the middle of the side BC, using the *Create Midpoint function*, and then use the *Create a segment* button, which is located in the toolbar.

To construct a triangle, you need to use the same algorithm as in *Example 1*. Define the midpoint of the BC, to do this, use the button from the toolbar *Create a midpoint*, and press in turn on point B and C. Now we have a point D , we can see the coordinates of this point in the object properties field, that is point D (5; 0) (Fig. 1.15).

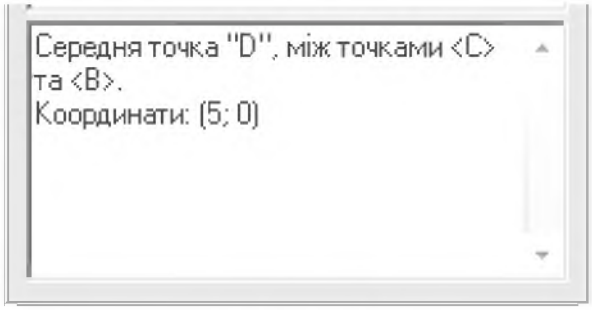


Fig. 1.15

Next, you can draw a median between the AD points using the *Create Segment* button and change its properties if needed.

After completing all the constructs (Fig. 1.16), we see in the object properties field that the median AD equation looks like $-4x-3y+20=0$.

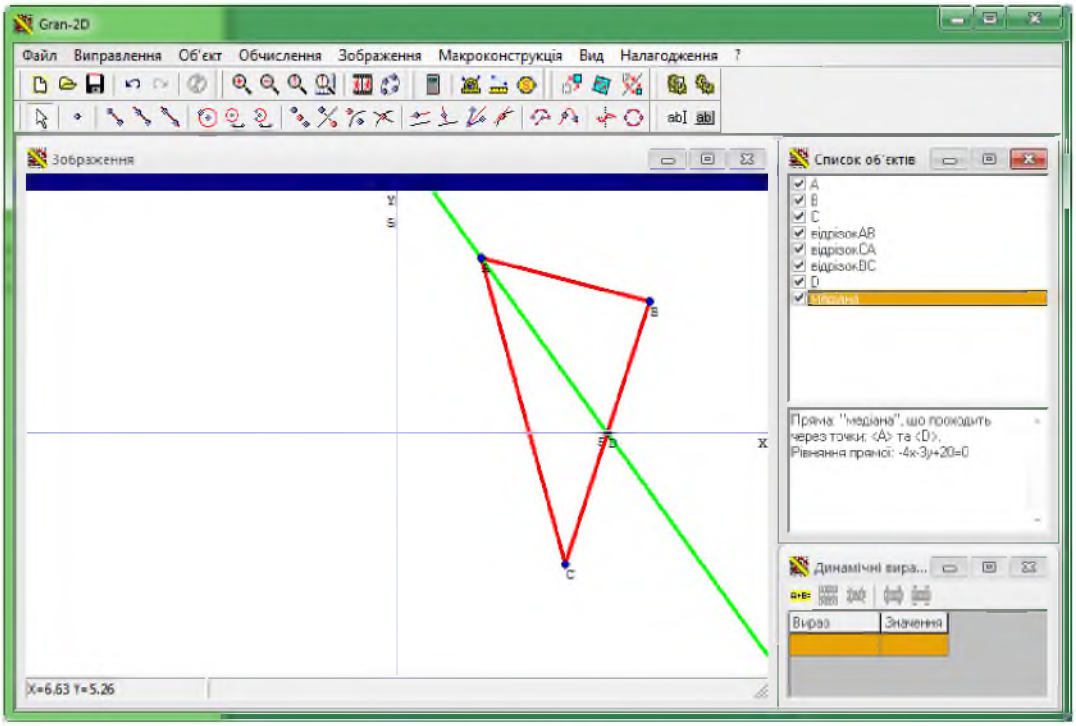


Рис. 1.16

The use of the GRAN-3D package (developers M. I. Zhaldak and O. V. Vitiuk) enables:

– create and convert models of basic spatial objects;

– perform cross sections of polyhedra by planes;

– calculate the volumes and surface areas of polyhedra and rotation bodies;

– to measure distances and angles [64].

In the course of analytical geometry in the study of topics “Plane in space”, “Straight line in space”, “Theory of straight lines and planes in space”, “Study of the second order surfaces by their canonical equations”, “General theory of the second order surfaces” using pedagogical software with *GRAN-3D*, we have the ability to: construct a point, a line and a plane in space, a surface, a surface of rotation, find the distance between two points, the distance between a point and a straight line, the distance between a point and a plane, the distance between two straight lines, and the distance between straight line and

plane, calculate angles between straight line and plane between two planes etc. [120].

Here are examples of the use of this software in the study of lines and surfaces of the first and second order in space [120]:

1) Find the angle between the planes $2x+y+3z-1=0$ and $x+y-z+5=0$.

To find the angle between the planes, you need to: construct the plane data and use the *Angle between the two planes* button located in the toolbar to find the angle.

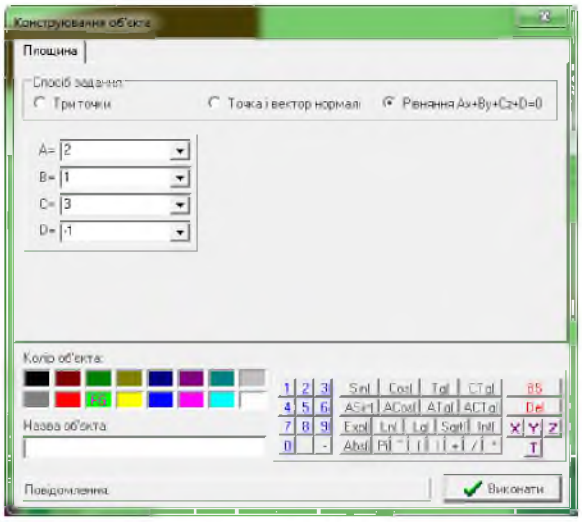


Fig. 1.17

Construct planes by their equations $2x+y+3z-1=0$ and $x+y-z+5=0$, to do this, follow these steps: in the toolbar, select the *Create Plane* tool. Then, in the window that appears (Fig. 1.17), choose the method of setting the plane and enter the following data *A = 2, B = 1, C = 3 and D = -1*. Using the same algorithm, we create the second plane.

After constructing the planes, we proceed to calculate the angle between these planes. To do this, use the button in the toolbar *Calculate the angle between the two planes*. Selecting this tool, following and doing the instructions, tooltips, indicate the first and the second planes. We see the result of the calculations in the report field Fig. 1.18.

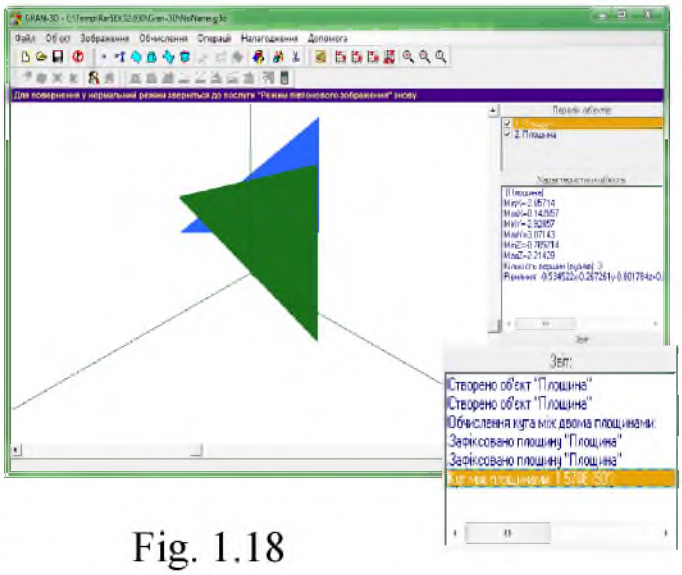


Fig. 1.18

Therefore, the angle between the two planes is 90^0.

2) Find the intersection of the surface $z = x^2 + y^2$ with the plane $x + y + 2z - 2 = 0$.

In order to find the intersection we need to construct a surface and a plane.

Constructing a surface: in the toolbar, click on the *Create surface* button. Then in the window, *Construct an object* (Fig. 1.19), enter the equation $z = x^2 + y^2$ and if necessary, make other adjustments (object color, object name) and click *Perform*.

To construct the plane $x + y + 2z-2 = 0$ first it is necessary to express z through x and y, and then use the button to perform the construction.

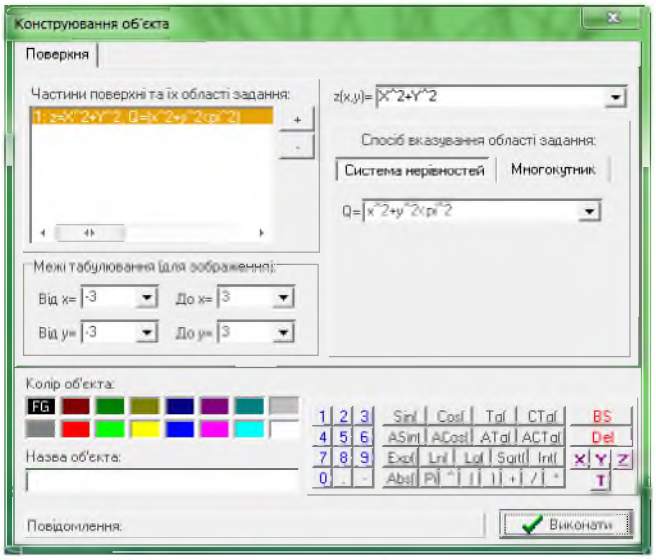


Fig. 1.19

After constructing the plane and the surface, we can press the *Halftone Image* button and view the section (Fig. 1.20).

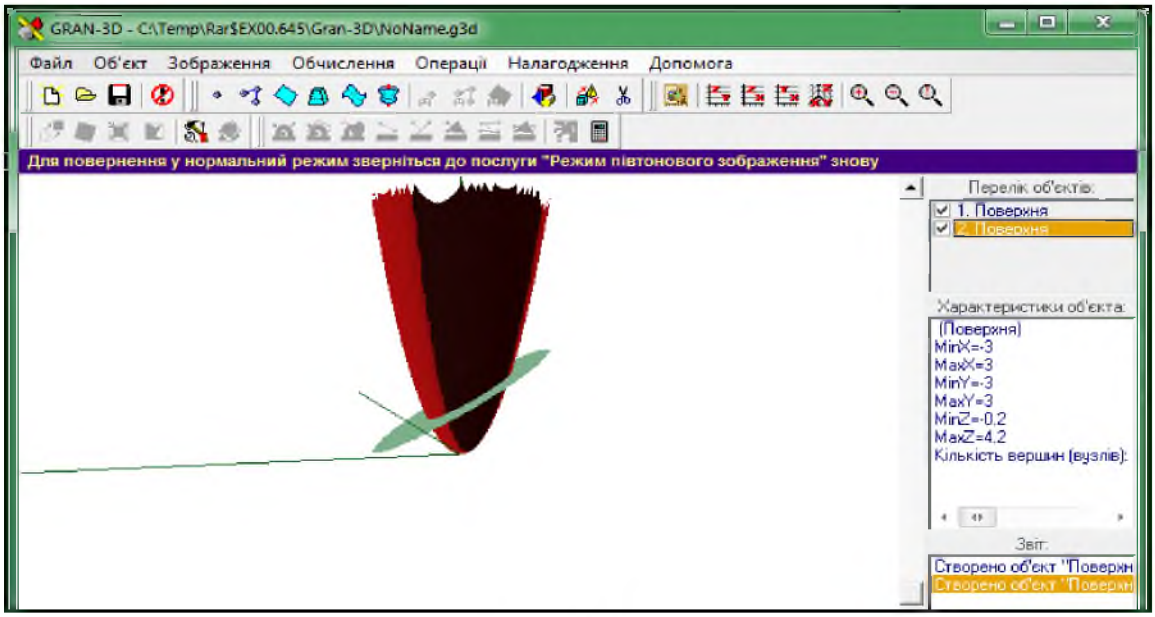


Fig. 1.20

From Fig. 1.20 we see that the intersection of two surfaces is an ellipse curve.

Undoubtedly, the use of the Gran software package in the study of mathematical disciplines, positively contributes to the formation of students' informational competence, professional knowledge, skills, abilities, and enhance their motivation for learning.

2. 3D Plotter computer software

3D Plotter is intended for visualization of geometric images of surfaces and curves given analytically, as well as for approximate calculations of the values of expressions, definite, double and curvilinear integrals.

In the training manual, the authors describe in detail the methodological aspects of using this program when studying separate sections of analytical geometry.

When studying the theme "Theory of straight lines and planes in space" 3D Plotter program allows you to construct both straight lines and planes, which allows you to investigate the mutual placement of planes and lines, and change of their location in space by changing the corresponding parameters in their equations [120]. However, in the manual "3D Plotter Computer Program for Line and Surface Study" it is stated that 3D Plotter is fully implemented during the study of the "Lines and Surfaces of the second order" module, because this software is largely focused on the construction and study of spatial geometric images. The manual provides examples of tasks that reveal the possibilities of using this computer program [120]:

1) If it is necessary to construct a geometric image of the function *y=sin(x)* on the interval [-Pi; Pi], when rotating it around the vector *(1,1,1)*, you can use the object **"Rotation surface"**, as the possibilities of this object completely satisfy the condition (Fig. 1.21).

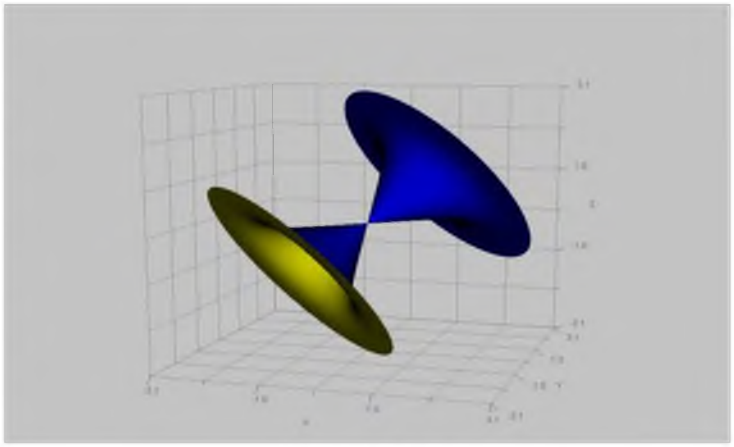


Fig. 1.21

If you want to construct a section of surfaces, you can use any objects except curves. It should be borne in mind that the more points the surfaces contain, the longer the calculations will be performed. If it is necessary to find the line of intersection of the surface with the plane, it is desirable to set the minimum number of points for the plane – 2. For example, we give a graph of the line intersection of the surface $z = x^2 + y^2$ with the plane $z = -\frac{1}{2}x - \frac{1}{2}y + 2$, as we see this is ellipse (Fig. 1.22).

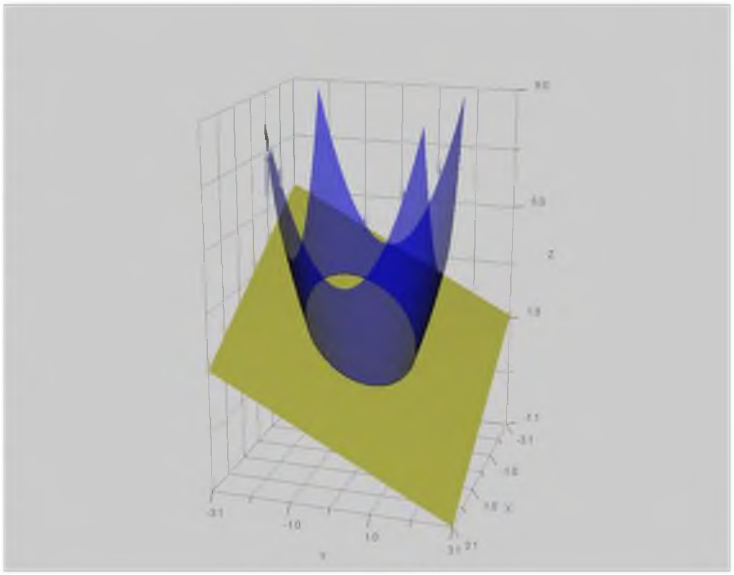


Fig. 1.22

The manual provides a variety of tasks that can be solved using this software. The authors claim that 3D Plotter, in the context of the use of computer models of geometric images, has a broad perspective on its use in the educational process.

3D Plotter software can also be used in mathematical analysis classes. When studying the module of "Integral calculation of one variable function", the use of 3D Plotter software as a computer model of geometric images is possible in the following directions: construction of geometric images of subintegral functions; approximate calculation of defined integrals; calculating the areas of flat figures and surfaces, the volumes of bodies of rotation.

The use of the proposed software in studying the module "Differential calculation of many variables function" is possible in the following areas: construction of geometric images of two variable functions; construction of level lines; construction of the domain of definition of function of 3 variables; construction of level surfaces.

Particularly relevant is the use of the software 3D Plotter in the study of integral calculation of functions of many variables, as the possibilities of this program are quite wide: from the construction of the

geometric image of a sub-integral function to the approximate calculation of integrals. Thus, the use of this software is possible in the following areas: construction of geometric images of sub-integral functions (both surfaces and curves); construction of areas of integration (intersection of surfaces, design of intersection lines on coordinate planes); approximate calculation of double integrals; approximate calculation of curvilinear integrals of the first kind; surface area calculation.

Here is an example of using 3D Plotter software in a practical lesson on "Calculating of Dual Integrals".

When studying dual integrals, 3D Plotter allows you to build both the area and the sub-integral function on one coordinate system, allowing you more accurately represent both the common picture as a whole and more precisely define the area of integration in particular. The sequence of actions in 3D Plotter programme in the calculation of double integrals can be as follows:

1) construct curves that define the area of integration;

2) construct a geometric image of a sub-integral function;

3) calculate the approximate double integral.

The value of point 3 shouldn't be overestimated, as the main task of this software is to illustrate which should help to find the right solution, and therefore approximate calculating should be used only as a way of verifying the result, not as the only way to obtain it.

Summarizing, it can be noted that the use of computer training programs in the educational process can positively affect the quality of learning and intellectual development of students; their readiness for further learning, their ability to use mathematical methods and computer technology in research and in solving practical problems.

3. Electronic knowledge testing systems

Recently, various tests have become widespread in the educational process. Tests can be used for different purposes. Typically, they are used to diagnose and adjust students' current knowledge, skills and abilities while studying a particular topic or module or to evaluate their learning outcomes.

Lately, various test programs and electronic testing systems have been developed to allow computer-based testing. The capabilities of these systems allow them to be used both during the classes and in extracurricular time.

One of the main characteristics of such systems (given the different levels of computer owning by both students and teachers of different disciplines) is the relationship between the ease of use and their functionality.

Here's an example of using a program to create Tester tests. This program is free, it allows you to create only one type of tests in which you need to choose only one correct answer. The program has a very simple interface and does not require much configuration. The disadvantage of the program is the fact that you can only use text in questions and answers. Such a program can only be used to test knowledge of the definitions and formulations of theorems, concepts, etc. For example, such a program can be used to test knowledge of mathematics teaching methods for third-year students (Fig. 1.23).

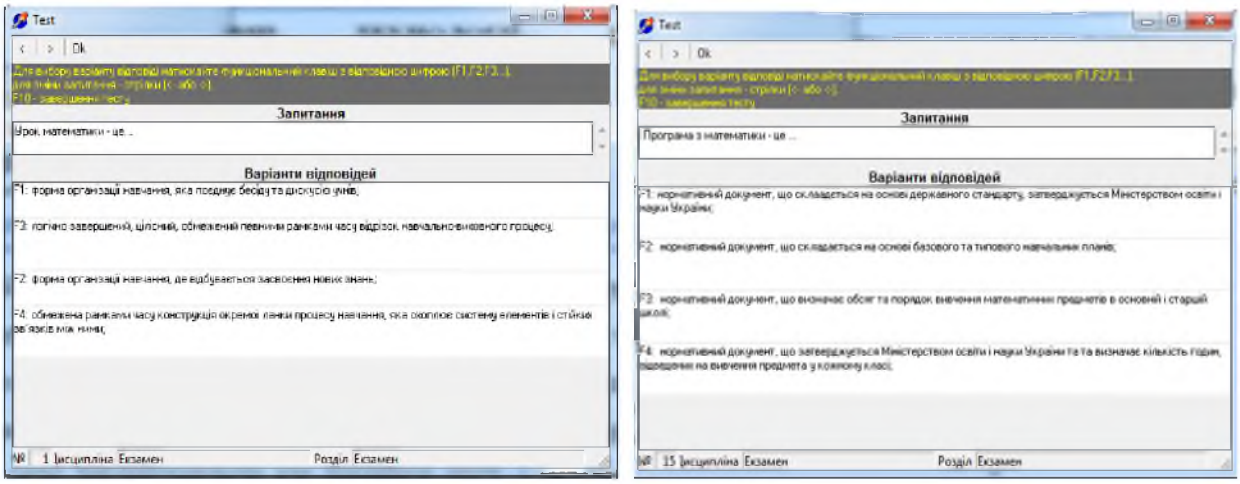


Fig. 1.23

After completion of the test, the program produces a result indicating the number of questions, the total number of answers and the number of correct student answers. The program independently calculates the percentage of correct answers and scores (Fig. 1.24).

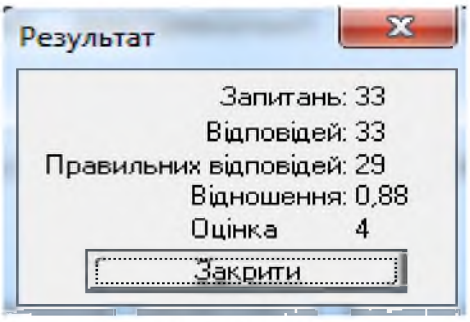


Fig. 1.24

Test-W2 programme is also widely used. This system is designed to control the knowledge of pupils and students, to identify the level of academic achievements of students in any discipline using a computer. The system is quite easy to use and this is one of its main advantages.

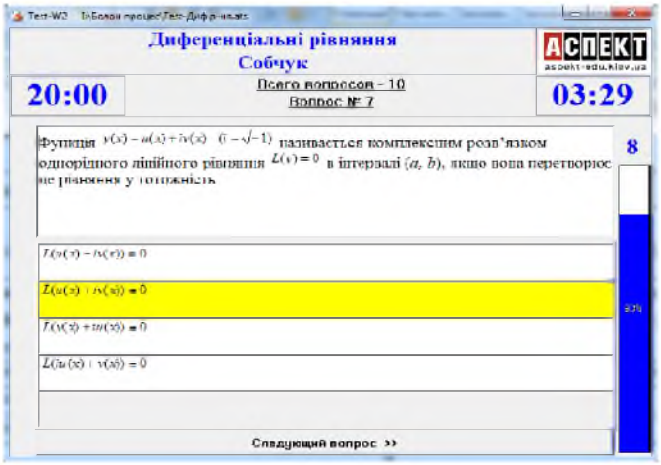


Fig. 1.25

An example of using this electronic testing system is to test knowledge of the discipline "Differential Equations" (Fig. 1.25).

After the test is completed, a dialog box opens for the student to indicate the number of questions, correct answers and mistakes made, as well as the student's result (Fig. 1.26).

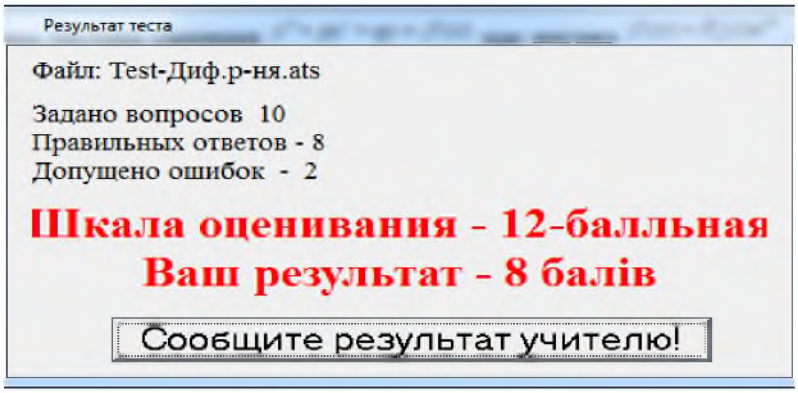


Fig. 1.26

The Moodle platform, a modular, object-oriented dynamic learning environment is now widely used in the education system. It is a software package for creating and conducting distance learning courses. One of Moodle's interactive elements is tests.

Computer-based testing is intended to conduct an in-depth examination of learnt topic or section of the curriculum and to eliminate gaps in students' knowledge and skills. Electronic testing is a means of education both in the pedagogical system of distance learning and in the organization of the educational process within the traditional educational system.

Computer testing offers the following opportunities:

- quick user-tool feedback
- easy access to processing results;
- possibility of many times repetition;
- control over the results of assimilation;

The main benefit of computer-based testing is that teachers and students need not be at the computer at the same time. For example, the use of Moodle testing in the discipline “Mathematical Analysis” (Fig. 1.27 a, Fig. 1.27 b).

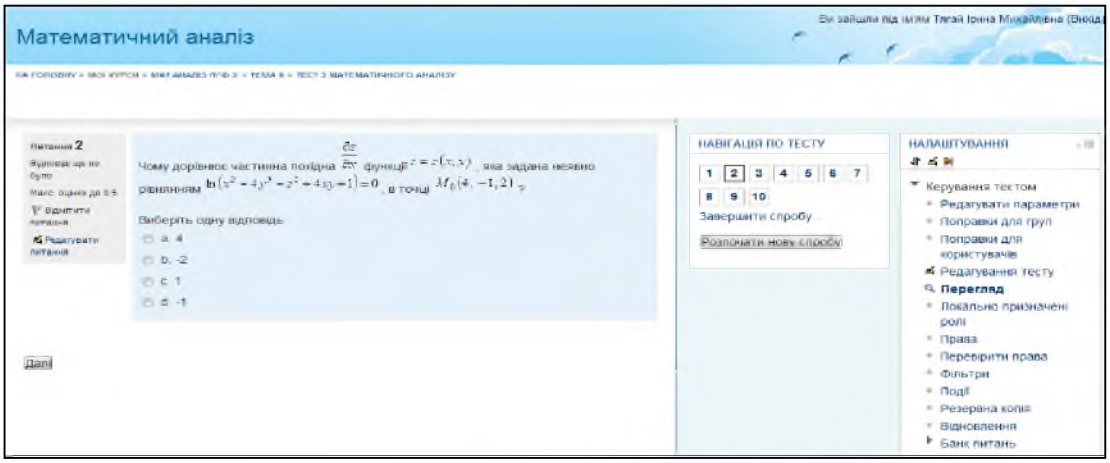


Fig. 1.27 a

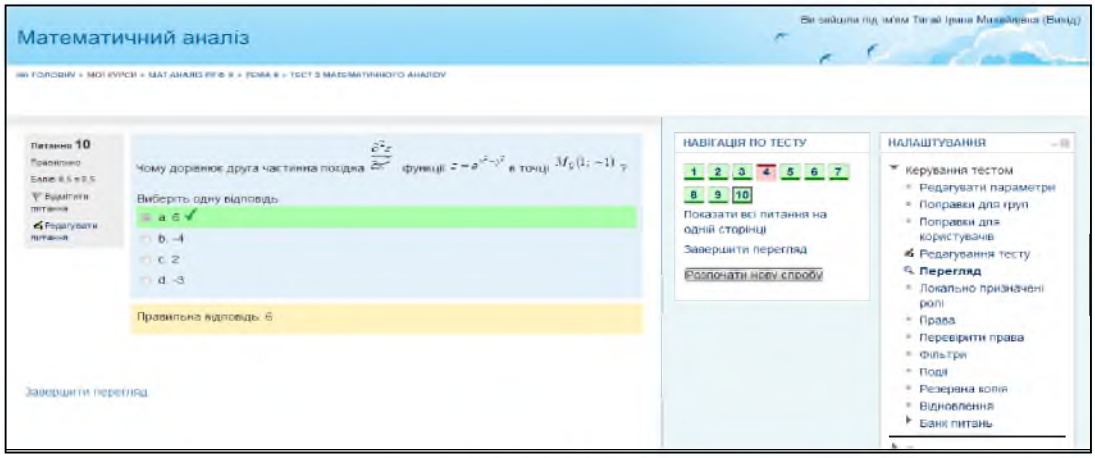


Fig. 1.27 б

After completing the test and reviewing the answers, the student sees his / her overall test results (Fig. 1.28).

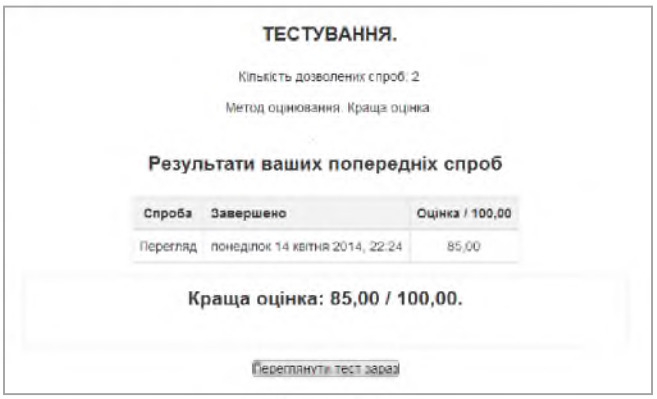


Fig. 1.28

Today, computer-based testing expands the ability to monitor and evaluate the level of academic achievement of students and is an alternative to traditional methods of assessment. Using this method of assessment, the teacher is able quickly, objectively and effectively diagnose the results of students' learning activities. So, it can be argued that the electronic testing system is an effective and promising form of control of students' academic achievement.

Section II. Pedagogical skill of the teacher, its essence and ways of formation

2.1. The essence of teacher's pedagogical skill and its influence on the effectiveness of the educational process

At the present stage of the pedagogical science development, the notion of the teacher's professional skill becomes one of the basic concepts of pedagogical acmeology. A significant number of scientists believe that the modern period of consideration of the issue of teacher's pedagogical skill begins in the second half of the twentieth century. (The genesis of the formation and development of pedagogical skill issues has been discussed earlier in our article [7]).

In the 60's – 80's of the XX century many studies of pedagogical work were concerned with the study of the pedagogical skill problem: the scientific and theoretical ideas about its essence and content were greatly enriched and complicated, which were reflected in various definitions of this definition (N. V. Kuzmina, O. I. Shcherbakov, V. O. Slastionin, Yu. P. Azarov, N. M. Tarasevych, M. V. Kukhariev and others); highlighted features of pedagogical skill and its structural composition, including professional and pedagogical orientation (N. V. Kuzmina, V. O. Slastionin, Yu. M. Kuliutkin, I. A. Zaziun), high level of personality self-organization in professional activity (I. A. Zaziun, M. V. Kukhariev, N. M. Tarasevych), systematic psychological and pedagogical knowledge, professional competence, sensitivity to the child as an object of pedagogical activity (N. V. Kuzmina, O. I. Shcherbakov, F. N. Honobolin), the presence of different pedagogical abilities – communicative, organizational, perceptive (V. A. Kahn-Kalyk, N. V. Kuzmina, V. A. Krutetskyi, O. I. Shcherbakov, M. D. Nykandrov) [17, p. 31].

It was at this time, that an influential Ukrainian scientific school, headed by the academician of the National Academy of Pedagogical Sciences of Ukraine I. A. Ziaziun, was formed. Significant contribution to the development of the pedagogical skill problem was made by the works of such Ukrainian scientists as L. M. Akhmedzianova (1996),

S. O. Shvydka (1996), Ye. S. Barbina (1998), L. O. Karpynska (2005), L. L. Korol (2006), O. M. Pynzenyk (2010), and others. All these scientists made clarifications and additions to the content and structure, as well as gave their interpretation of the pedagogical skill concept in their research.

According to Lazarev M. O., "pedagogical skill is a set of certain qualities of a teacher's personality, which is conditioned by the high level of his psychological and pedagogical preparation, ability to optimally solve pedagogical tasks" [13, p. 207].

Akhmedzianova L. M. defines pedagogical skill as "a synthesis of professionally significant properties of the whole psychological structure of the teacher's personality, his / her knowledge and skills, which are found in the results of his pedagogical activity" [3, p. 520].

The Ukrainian pedagogical dictionary contains the following definition of pedagogical skill: "This is a characteristic of a high level of pedagogical activity. The criteria of pedagogical skill of the teacher are the following features of his / her activity: humanity, scientific, pedagogical expediency, optimal character, efficiency, democracy, creativity (originality). It is based on high professional level of the teacher, his / her general culture and pedagogical experience. Necessary conditions of pedagogical skill are the humanistic position of the teacher and professionally significant personal traits and qualities " [8, p. 251].

The following definition is stated in the glossary of terminology on pedagogical skill: "The skill of the teacher is a complex of personality traits that provide a high level of self-organization of professional pedagogical activity" [20, p. 28].

We shall rely on the definition of the National Academy of Pedagogical Sciences of Ukraine academician I. A. Ziaziun in our study. He defined "pedagogical skill" as a complex of personality traits that provides a self-realization of a high level of professional activity on a reflective basis. The scientist attributed the humanistic orientation of the teacher's activity to these properties, which is a system-forming factor in the structure of a person capable of self-organization;

professional competence, which is the basis of professional skill; pedagogical abilities that provide speed of self-improvement; a pedagogical technique that must be based on knowledge and ability and enable one to discover the inner potential of the teacher. All of the above components are interrelated, self-development is inherent to them, which is provided by the teacher's self-development and then through the development of the student [15].

An important contribution to the development of the problem of pedagogical skill is the dissertation research for the degree of Doctor of Pedagogical Sciences Barbina Ye. S. on theme "Formation of pedagogical skill in the system of continuous pedagogical education" (1998). The scientific research revealed the content and functions of pedagogical skill, as well as developed organizational and methodological foundations and technologies for its formation in future teachers.

According to Barbina Ye. S., pedagogical skill is "the process and result of creative professional activity, integration of personal qualities of a particular performer with the activity essence of a certain profession, an integrated indicator of the level of readiness of a particular person to fulfill the professional duty of teacher and educator" [4, p. 20].

According to Zolotukhina S. T., the components of pedagogical skill are general, psychological and pedagogical culture of the teacher, his /her personal and professional abilities, pedagogical technique [9].

As noted by scientists Barbina Ye. S., Semychenko V. A., the components of pedagogical skill are:

1) Humanistic orientation (interests, values, ideals).

2) Professional knowledge (knowledge of the subject and methods of its teaching, pedagogy, psychology, physiology, ethics, logic, etc.).

3) Pedagogical abilities (communicative, social-perceptive, dynamic, emotional stability, creativity).

4) Pedagogical technique (ability to manage oneself, ability to interact) [5, p. 249].

Let us describe the elements of pedagogical skills in more details:

1. Humanistic orientation is the main characteristic of skill, which is directed at the personality of another person, affirmation by word and work of the highest spiritual values, moral norms of behavior and relationships.

2. Professional competence. Knowledge – is one of the most important factors that determines the ability of the teacher in his / her pedagogical activity. After all, knowledge is the foundation of pedagogical skill, as the teacher-master should have subject, psycho-pedagogical and general knowledge. An important feature of professional pedagogical knowledge is their complexity, which requires the teacher to be able to synthesize material for successful solution of pedagogical tasks, analysis of pedagogical situations, which determine the need to understand psychological essence of phenomena, choice of means of interaction.

3. Pedagogical abilities. The set of mental characteristics of a teacher, which are necessary for successful mastering of pedagogical activity. The textbook "Pedagogical Skill" lists six leading abilities for pedagogical activity [16, p. 28]:

1) communicative – the professional ability of the teacher, characterized by the need for communication, the willingness to interact easily, evoke positive emotions in the interlocutor and enjoy communication;

2) perceptual abilities – professional insight, vigilance, pedagogical intuition, the ability to perceive and understand another person;

3) personality dynamism – the ability to actively influence another person;

4) emotional stability – the ability to self-control, maintain self-control, to exercise self-regulation in any situation, in spite of the strength of external factors that provoke an emotional breakdown;

5) optimistic forecasting – predicting the development of the individual with a focus on positive and the transformation of the entire structure of the personality through the impact on positive qualities;

6) creativity – the ability to create, the ability to generate unusual ideas, move away from traditional schemes, quickly solve problem situations.

In addition, we can name organizational skills as important, constructive (the ability to select and logically build material), gnostic (the ability to learn new), didactic (the ability to teach others) and others.

V. O. Slastionin examines pedagogical skills from the point of view of a teacher-researcher, who "builds his / her activity in accordance with general rules of heuristic search ..." [19, p. 68]. Also O. A. Abdulina recognizes creative character in pedagogical skills, and states: "Teacher's pedagogical skills are a creative, conscious mastery of the methods and techniques of organizing the pedagogical process" [1, p. 44].

4. Pedagogical technique. According to Shvydka S. O., "pedagogical technique is a set of skills and properties of behavior of the teacher, which provide optimal conditions for the implementation of the requirements, principles and methods of educational work in communication with a separate pupil or a student collective" [23, p. 36].

The definition of "Pedagogical technique" – the ability to use own psychophysical apparatus as a tool of educational influence is provided in the textbook "Pedagogical Skill" [16, p. 37]. It is the possession of a set of techniques that give the teacher a deeper, brighter, more talented opportunity to express his / her position and succeed in educational work".

The main elements of pedagogical technique include: technique of speech, expressive expression of feelings and attitudes, professional self-presentation by the teacher of his / her mental state. That is, those skills that help the teacher to convey their thoughts and feelings to the pupils, promote creative behavior and effective interaction with children [22, p. 14].

Speech technique is an important component of pedagogical skill, a tool of professional activity of the teacher, which helps to solve

various pedagogical tasks. The famous teacher A. S. Makarenko made the following conclusions: "I became a true master only when I learned to say "Come here" with 15 – 20 shades, when I learned to give 20 nuances on face, figure and voice. And then I was not afraid that someone would not approach me or hear what was needed" [14, p. 262].

Speech technique is a basic component of professional skill that is associated with the formation of a pedagogical voice, phonial breathing, clear diction and is a means of pedagogical influence [12, p. 45].

Teacher's speech is an indicator of his / her pedagogical culture, a means of self-expression and self-affirmation of the personality. When analyzing a teacher's speech, they often use the phrase "communicative behavior", which influences the creation of an emotional-psychological atmosphere of pedagogical communication. The communicative component of the teacher's activity influences the effectiveness of the educational process through the following indicators: ability to establish business and personal relationships with students that would facilitate their mastering of the educational material; ability to adapt the content of educational material to the level of development and preparation of students; the ability of the teacher to stimulate students' interest in knowledge, a positive attitude to the learning process in general and the subject in particular; ability to create pedagogically appropriate emotional background of the learning process (business, purposeful, optimistic, friendly); ability to influence student behavior due to the nature of relationships and authority.

The pedagogical effectiveness of speech depends on both the level of language proficiency and the style of communication chosen by the teacher in communication with students. Therefore, the level of proficiency in speech activity is determined by the level of the teacher's speech culture and the direction of his / her communicative behavior.

Scientists consider the following functions of pedagogical speech: communicative, psychological, cognitive, organizational.

Communicative is one of the leading functions of a teacher's speech. This function helps to ensure the humanistic orientation of

student development, that is, to build education and learning on the basis of cooperation.

Psychological function is responsible for creating conditions for ensuring the psychological freedom of student, the disclosure of individual identity. Teacher's speaking in higher educational institution can help a student to become confident in himself / herself, initiate his / her activity.

Cognitive function is manifested in students involvement to creative search, interest to the new. When presenting new material, the lecturer's speech should meet certain pedagogical requirements, that is: logical, clear, convincing. It is especially important for the teacher to interest students, to form an emotional and valuable attitude to knowledge in them. After all, inaccurate speech, inconsistency of non-verbal behavior will not facilitate activation of students' educational hearing.

The organizational function of pedagogical speech is realized in attracting speech means for the organization of work, ensuring the optimum rate of cognitive activity. In other words, the teacher will be able to better ensure the development and education of the students through his language, his communicative behavior.

Scientist I. A. Ziaziun noted, "the teacher (university teacher) is both a screenwriter, and a director, and a performer". The teacher in his professional activity creates, designs the educational process in general, from the beginning to the end of interaction with the student within the discipline. The teacher, who has formed a certain level of pedagogical skill, independently chooses different forms of education organization; selects the optimal forms and methods of learning depending on the specific conditions of educational process; implies difficulties in students' educational activities; creates models of a lesson.

The quality of work of a higher educational institution teacher is determined not only by professional knowledge, but also by the teacher's skills, the level of his /her psychological and pedagogical preparation and personal traits of the teacher. Therefore, only the teacher-master is distinguished by the ability to choose the optimal set

of teaching methods and technologies to achieve the set goals; to choose the appropriate structure of the lesson, depending on the state of study of the subject curriculum and the purpose of the lesson; ability to choose the quantity and volume of educational material depending on the time of study and the level of preparation of students; able to control the pace of learning from the perspective of effective interaction between the teacher and students and adjust it depending on the real conditions; control students' activities, evaluate the quality of their work; ability to create a situation of student involvement during the educational process.

The teacher-master on facial expressions, posture and gestures of students can determine their state of readiness to study, the desire to actively participate in the learning activity or the desire to avoid it, the level of understanding of educational material or the level of difficulty in thinking, etc. The results of such observations allow him / her to adjust the learning process and the interpersonal relationships that form within it, all of this have a profound effect on the effectiveness of the learning process.

According to the outlined structural elements, defined several levels of mastery of pedagogical skill:

- elementary level – the teacher has only certain qualities of professional activity;
- basic level – the teacher has the basics of pedagogical skill (this is the level specific to graduates of pedagogical institutes);
- perfect level – characterized by a clear orientation of the teachers' actions, their high quality, dialogical interaction in communication;
- the creative level is characterized by initiative, creative approach to professional activity.

Mastering such levels of pedagogical skill as perfect and creative takes place directly in the course of the teacher's pedagogical activity at school. And the formation of elementary and basic levels of pedagogical skill occurs already during the students' training at the pedagogical university. Thus, how well students will be able to master

elementary and basic levels of pedagogical skill depends on both teachers of higher educational institutions and students themselves.

2.2. Formation of pedagogical skill in future teachers in the process of teaching the subjects of the mathematical cycle

The foundation of the mathematics teacher's professionalism is formed during his / her studying at the pedagogical higher educational institution, in particular, and in the course of teaching professional disciplines. The strength of this foundation depends on how quickly a young teacher can create himself / herself as a teacher. Thus, the strategic task of higher education is to train a competent specialist who is able to effectively act in non-standard situations, to solve typical and problematic tasks in his /her own professional activity. A number of objective and subjective reasons hinder to achieve this objective. Subjective reasons include the low motivation of students to master professional activity and formal and executive character of mastering vocationally-oriented knowledge, etc. The objective reasons are hidden in the higher education system: the abstract nature of the information offered to the student in the study of professional disciplines is more abstract; traditional learning technologies aimed at the perception, comprehension and memorization of educational material; lack of systematic interdisciplinary connections in the disciplines etc.

Improving the teacher's teaching skill is inextricably linked to improving his or her pedagogical activity. According to the regularity of pedagogical cyclicality, the main cycles of teacher development in the process of independent activity are: mastering a profession; its improvement; approval and verification of the system of work; further improvement; generalization of experience; transfer of experience; summing up. It is not difficult to notice that activity improvement occupies the most important place in these cycles. First of all, it is

connected with the search for a new, with the creativity of the teacher [16, p. 143].

The educator must know and be able to apply various methods, tools and teaching techniques, depending on the purpose, form and type of a lesson. Therefore, by introducing innovative technologies in the process of teaching in higher educational institutions, we will help the student to master them and to apply technologies further in the pedagogical activity.

In our opinion, in order to increase the level of pedagogical skill of future mathematics teachers, it is appropriate to use technologies of interactive learning during the lessons of mathematical disciplines, in which the student will not only acquire new knowledge, but also gradually master the skills of pedagogical activity. After all, interactive learning involves modeling life situations, the use of role-playing games, joint problem solving based on an analysis of circumstances and the relevant situation. It effectively promotes the formation of skills and abilities, the development of values, the creation of an atmosphere of cooperation, interaction, enables the teacher to become the leader of the team. By introducing interactive learning in the process of teaching professional disciplines, the teacher thereby demonstrates to the student non-traditional methods of conducting lessons, teaches the future teacher to use them in their professional activity. Since interactive learning is based on the interaction of students in the environment where they find a part of their new experience, this approach will allow them to find new ways of organizing and implementing their future professional activity in terms of gaining professional competence and skills.

We have considered the levels of pedagogical skill, we will stop in more detail on the ways of forming the first two levels in students of pedagogical universities.

Elementary level. The formation of elementary level of pedagogical skill of the mathematics teacher should begin from the first moments of student studying at the university. According to the Concept of Continuing Teacher Education, the methodological

preparation of students in a pedagogical university is through and is carried out throughout the study period taking into account the specialties, specializations, their combination and two-cycle training of teaching staff, etc., and therefore, starting from the first course, it is necessary to provide development of methodical focus of fundamental subjects teaching. Like all levels of pedagogical skill, elementary should ensure the development of such components as humanistic orientation, professional competence, pedagogical abilities, pedagogical technique, pedagogical tact, etc. Let us demonstrate by concrete examples how to develop students' pedagogical skill in mathematical subjects.

In order to explore in more detail how interactive learning technologies enhance pedagogical skills, we suggest looking at some technologies that will help students develop pedagogical skills at least to the elementary level.

The curriculum of mathematics teacher training at the pedagogical university provides for the first year studying the discipline "Elementary mathematics". The purpose of this course is to summarize secondary school mathematics knowledge and skills; deepening and supplementing the secondary school mathematics course with new sections of elementary mathematics and even higher education. Perfect knowledge of elementary mathematics contributes to the professional competence of the teacher.

The elementary mathematics course should provide the student with strong knowledge of the school mathematics course, as well as some context for their effective use in further professional activities. Particular attention should be paid to this aspect. That's why, the teacher should create situations in which students don't only learn the learning material, but also produce the skills and abilities necessary for pedagogical activity in elementary lessons of mathematics.

"Elementary mathematics" is the discipline that allows you to implement interactive learning in the first year of studying, because students have a certain amount of knowledge that they have acquired at school. Here is an example of the use of "Jigsaw" technology. In order

for the lesson to be meaningful, the teacher in the previous lesson should hand out multicolored cards (for instance five different colors) with a specific number (from 1 to 5). Thus, a certain number of groups will be formed in the class depending on the color scale. Each group will be given questions and problems according to the task. Group members should share information about their task, interview each other, and find solutions to the tasks. After that, the teacher suggests students to join "expert" groups by numbers. So, groups will be formed, an expert on a specific task will be in each one. Participants talk, explain the topic and solve problems.

In the previous lesson, cards of different colours (yellow, red, blue, green) were given, numbered from 1 to 5. Thus, four groups were formed: "***red***" – to explain the principle of solving the equation $\cos t = a$, to solve and to explain examples; "***Blue***" – to explain the principle of solving the equation $\sin t = a$, solve and explain the examples; "***Yellow***" – to explain the principle of solving the equation $tgt = a$, solve and explain the examples; "***Green***" – to explain the principle of solving the equation $ctgt = a$, solve and explain the examples.

Students are grouped according to the colour of the card they received. They exchange information, interview each other, and solve problems. After a while, the teacher proposes to join in expert groups by numbers.

"**Red**" – start with the equation $\cos t = a$, (a – an arbitrary real number). Let's find out how many solutions the equation has depending on the value of a and what they are. For $|a| \geq 1$, the equation has no solution because $|\cos t| \leq 1$, for any t. We need to find all such numbers t, that $\cos t = a$. There is exactly one solution on the segment $[-\pi;0]$ – the number $\arccos a$. The cosine is an even function, so, in the segment 2π, the equation also has exactly one solution – a number $-\arccos a$.

Thus, the equation $\cos t = a$ for the segment $[-\pi; \pi]$ of length 2π has two solutions: $t = \pm \arccos a$ (which coincide if a=1). Due to the periodicity of the function $y = \cos t$, all other solutions differ from those on 2π, that is, the formula of the roots of the equation is as follows: $t = \pm \arccos a + 2\pi n$. But there are three "special" equations:

1) $\cos t = 1, \Rightarrow t = 2\pi n$;

2) $\cos t = -1 \Rightarrow t = \pi + 2\pi n$;

3) $\cos t = 0, \Rightarrow t = \frac{\pi}{2} + 2\pi n.$

"**Yellow**" – $\sin t = a$, has no solution at $|a| \le 1$, because $|\sin t| \le 1$ for any t. If $|a| \le 1$ is on the segment $\left[-\frac{\pi}{2}; \frac{\pi}{2}\right]$, then the equation has only one solution – $t_1 = \arcsin a$. In the interval $\left[-\frac{\pi}{2}; \frac{3}{2}\pi\right]$ the function $\sin x$ decreases and acquires all values from -1 to 1, so the equation has one root $\sin t_2 = \sin(\pi - t_1) = \sin t_1 = a$ on this segment.

Therefore, the equation on the segment $\left[-\frac{\pi}{2}; \frac{3}{2}\pi\right]$ has two solutions $t = \arcsin a,\ t_2 = \pi - \arcsin a$ (which coincide if a=1). Given the frequency of the sine, we obtain the following formulas to write down all the solutions of the equation:

$t = \arcsin a + 2\pi k$;

$t = \pi - \arcsin a + 2\pi k$.

It is convenient to write the equation solution not by two, but by one formula:

$t = (-1)^k \arcsin a + \pi k$

There are three "special" equations:

1) $\sin t = 1, \Rightarrow t = \frac{\pi}{2} + 2\pi k$;

2) $\sin t = -1, \Rightarrow t = -\frac{\pi}{2} + 2\pi k$;

3) $\sin t = 0, \Rightarrow t = \pi k.$

"**Blue**" $tgt = a$ – a set of values is a set of real numbers. Given the frequency of the tangent, we'll get the following formulas to write down all the solutions of the equation: $t = arctga + \pi n$. At $tgt = 0, \Rightarrow t = \pi n,\ n \in Z$.

"**Green**" $ctgt = a$ – a set of values is a set of real numbers. Given the frequency of the cotangent, we'll get the following formulas to write down all the solutions of the equation: $t = arcctga + \pi n$. At $ctgt = 0, \Rightarrow t = \frac{\pi}{2} + \pi n,\ n \in Z$

Students write down rules and tasks into copybooks, explaining material to each other that has been given a specific color scheme.

The group comes together to summarize. They share their impressions of this activity. To consolidate the material, students solve the following:

1) $\sin\left(\frac{x}{2}-30^\circ\right)+1=0$;

2) $2\sin^2 3x-1=0$;

3) $1+\cos\frac{x}{3}=1$;

4) $tgx=3$;

5) $ctg\frac{x}{7}=0$.

What are the components of pedagogical skill that we can develop in students through the use of this technology? Working in small groups, discussing the results provides a dialogical learning, gives the opportunity to form your own vision, substantiate it. It promotes upbringing of responsibility for doing some work, further development of self-control, formation of professional skills, abilities, takes them to a higher level of pedagogical thinking. Thus, the humanistic orientation is realized through the constant communication of students with each other, the formation of moral norms of behavior and relationships. Accordingly, during communication, students develop communication and didactic abilities. Professional competence is developed in the process of learning by interactive technology, as, although the educational material is known to students, their knowledge is deepened and adjusted. Explaining educational material to each other, engaging in discussion, students form a pedagogical tact, because they polish their speech, learn to be convincing.

Of course, this technology should also be used in other mathematics classes in mathematical disciplines. An example of the use of "Jigsaw" technology in the course of analytical geometry training is given in the manual "Interactive learning in higher education" [20].

In our opinion, it is useful to use the "Carousel" technology in the initial stages (the essence of this technology, the rules of carrying out

and examples of application are given in the manual [20]). This technology is used to discuss any acute issue, to gather information on a particular topic, to check the volume and depth of students' knowledge. As a result of work with the appropriate technology of interactive learning, students will develop the ability to argue their own position, express themselves concisely and clearly, convince and listen to the opinions of others.

It is important to teach future maths teachers to understand different ways of solving the same task, identify which one is more rational, teach students argue their opinion and explain the steps of solving the task. In such cases, it is advisable to use the interactive learning "Dialogue" technology, the essence of which is to jointly search for groups in a coherent solution of the task. Dialogue eliminates confrontation, criticism of the position of a particular group. The focus is on strong points in the position of others.

Working on this technology, the group is combined into several working groups and an expert group consisting of strong students. Working groups are given 10 – 20 minutes to complete the task. The group of experts draws up their own version of the task, monitors the work of the groups and controls the time. After completing the work, representatives from each working group make a summary record on the board or on a sheet of paper. Then, one speaker from each group is given the floor. Experts capture common views, and in the end offer a generalized answer to the task. Groups discuss and supplement it. The final version is recorded in the copybooks.

The use of appropriate technology in a practical lesson on calculation methods, as well as a significant number of other interactive learning technologies in classes in various mathematical disciplines is given in the manual "Interactive learning in higher education" [20].

Basic level. This level is reached by the end of the students' studying at the Pedagogical University. The ways to form a basic level of pedagogical skill are:

- mastering of mathematical knowledge;
- mastering of psychological and pedagogical knowledge;

- methodological preparation;
- pedagogical practice;
- study of advanced pedagogical experience;
- research activities (carrying out of research tasks, coursework and qualification works, etc.).

As the mastering of mathematical and psychological-pedagogical knowledge are integral parts of the elementary level of pedagogical skill, we offer a more detailed discussion of the methodological preparation of students and pedagogical practice.

According to the Concept of development of continuous pedagogical education, methodological preparation involves a deep mastery of teaching methods of subjects using the opportunities of information and communication technologies and methods of carrying out out-of-school and extracurricular work. It should be ensured through the students activities in educational institutions, laboratories, centers of practical training, through carrying out of educational, production (pedagogical) practices, as well as through the methodological orientation of teaching the basic educational disciplines (as mentioned above). Unfortunately, the lack of practical orientation of professional disciplines, their interconnection, as well as the lack of systematization of students' knowledge from separate courses, leads to the fact that sometimes successful students are completely unable to perform professional functions.

In the context of the transition to a competency-based learning model, the development of innovative higher education teaching technologies that focus on a competency-based approach becomes particularly relevant. In our opinion such technologies first apply the technologies of interactive and contextual education, which design the educational process in a higher education institution as closely as possible to the future professional activity.

Contextual learning is a realization of a dynamic model of student activity movement: from the actual educational activity (for example, in the form of lectures and practical classes) through quasi-professional (game forms, special courses) and educational and vocational (student

research work, pedagogical practice, etc.) to professional activity. The main characteristic of the educational process of contextual type is the modeling of subject and social content of future professional activity through the reproduction of real professional situations. But if the learning process is accompanied by methods and technologies of interactive learning that help students to master the components of pedagogical skill, then the process of transition to pedagogical activities will be much more effective, young specialists will be able to quickly realize themselves as educators.

Methods of teaching mathematics, one of the disciplines that creates all the conditions for the formation of pedagogical skill of future mathematics teachers. Systematic course "Methods of teaching mathematics" students begin to study in the third course. The content of methodological preparation of students – future teachers of mathematics – should be all components of their future pedagogical activity: knowledge (special, psychological-pedagogical, concrete-methodical, etc.), ways of activity of the mathematics teacher, certain vision of themselves in such activity, as well as experience of creative activity in theory and practice of teaching mathematics.

Practical and laboratory lessons in the methodology of teaching mathematics are marked by the possibility of maximum approximation of the content and forms of teaching to the professional activity of the future mathematics teacher. Practical lessons should be modeled, in particular, taking into account the effective use of interactive learning technologies, software pedagogical tools etc. Thanks to this, the teacher creates all the conditions under which the student becomes a direct participant in the implementation of traditional and new forms of system and methods of teaching.

The leading activity in the laboratory classes is a quasi-professional activity, which involves the reproduction of the conditions and dynamics of real-life mathematics lessons in primary and secondary school with the possibility of using innovative teaching technologies. Among such technologies are as follows: conducting of integrated mathematics lessons, the use of business games. It promotes

the development of students' pedagogical abilities, pedagogical equipment, professional competence, humanistic orientation.

However, not only teachers of mathematics methodology should help the future teacher to acquire practical pedagogical skills. A teacher of any professional subject, through the introduction of interactive learning technologies, can help the student to test himself as a teacher during the lesson. For example, "Tearning – learning" technology will help a student to find out how he / she knows educational material and how can explain it to others.

The "Tearning – learning" technology can be applied differently. For example, you can hand out cards with material to students at the beginning of the lesson to be learned. Each student will receive one card that will contain a certain amount of information and will have time to process it. If the information provided on the card is not clear to the student, then the teacher approaches and explains it. When the time to learn the material is over, students are offered to walk around the audience and to get acquainted with other students' information. The student should report his / her information to only one classmate. The task is to share your facts and get information from another student. The teacher should make sure that each student communicates with as many of his / her classmates as possible. Of course, the teacher has to check the students' level of mastering the new material, so after completing the work on this technology, he or she may ask students to answer questions regarding the new learned material.

Also, "Teaching – learning" technology can be performed somewhat differently. It is necessary to inform the students about the lesson plan in the previous class. Each question is assigned to one or more students. Then, at the class, the teacher invites students who prepared a question to report it to their classmates. If it is a practical lesson, then the student should choose the problems and know how to solve them. Thus, the student who prepared the material acts as a teacher, that is, he or she either reports new information to the classmates or chooses students to solve problems. If, however, no student can solve a problem that he / she has selected for the topic, then

he / she must solve the problem himself and explain it on the board. Working with this technology will help students to feel as a teacher and activate their educational and cognitive activities.

In order to increase the level of pedagogical skill, it is necessary to form students' independence in acquiring and deepening knowledge as traits of character, which will increase the competitiveness of future specialists in the world labor market. For example, it will help students to form a basic level of pedagogical skill of the task to individualy carry out a selection of tasks for a given topic, to find historical information, to prepare a collective project, etc. Checking of individual work using interactive learning technologies in the form of presentations of collective projects is given in the manual "Practicum for solving non-standard problems" [6].

An important element in the formation of pedagogical skill of future mathematics teachers at the university is the conduct of students' educational and industrial practices. Here, students have the opportunity to experience the real and not artificially created working conditions of their future profession. It is the best way of forming all the elements of pedagogical skill not only as a teacher of mathematics, but also as a class teacher.

Pedagogical skill of the mathematics teacher, on the one hand, is acquired in long-term practical activity, and on the other is the result of professional training at the university. The current state of formation of students' foundations of pedagogical skill does not meet modern requirements of training teachers of mathematics and acquires a particular relevance. Therefore, effective formation and development of pedagogical skill of future mathematics teachers is possible only if the teacher provides active learning, saturated with elements of professional activity.

Section III. Pedagogical conditions for effective organization of interactive teaching of mathematical cycle subjects

3.1. Pedagogical conditions as a categorical feature

At the stage of reforming modern higher education, one of the most interesting aspects is to identify, substantiate and verify pedagogical conditions that ensure the success of future specialists training.

There are different interpretations of the term "condition" in the reference literature. For example, this term is interpreted as: "A condition is a philosophical category in which the universal relation of thing to those factors by which it arises and exists is reflected in the Philosophical Encyclopedic Dictionary. Due to the existence of appropriate conditions, the properties of things go over from possibility to reality "[228, p. 482].

In the Great Interpretive Dictionary of Modern Ukrainian, it is stated: "Conditions are necessary circumstances, peculiarities of reality that enable the realization, creation, formation of something or contribute to something" [32, p. 1295].

Based on the meaning of the term "condition" the concept of "pedagogical condition" is interpreted. Here are some interpretations of this concept.

I. Ya. Lerner considers pedagogical conditions as factors that ensure successful learning [100, p. 76].

V.H. Maksymov interprets them as a set of objective and subjective factors necessary to ensure the effective functioning of all components of the educational system, depending on the goals, objectives, content, forms and methods of this system [107, p. 115].

V. M. Manko defines pedagogical conditions as an interconnected set of internal parameters and external characteristics of functioning, which provides high efficiency of the educational process and meets the psychological and pedagogical criteria of optimality [109, p. 153 – 161].

Scientists A. M. Aleksiuk, A. A. Ayurzanain, P. I. Pidcasystyi, under pedagogical conditions understand the factors that influence the process of achieving the goal, while dividing them into: a) external: positive relations between the teacher and the student; the educational process of the objective evaluation; place of study, rooms, climate, etc; b) internal (individual): students' individual characteristics (health status, character traits, experience, skills, abilities, motivation, etc.) [134].

Conditions that contribute to the development or slow down the educational process are considered to be pedagogical conditions, they are defined as a complex of means available at the educational institution for the effective implementation of the educational process [134].

O. M. Piehota considers pedagogical conditions as a system of certain forms, methods, material conditions, real situations that are objectively or subjectively created, necessary to achieve a specific pedagogical goal [143, p.5].

"Pedagogical conditions" are defined as the circumstances on which the whole productive pedagogical process of professional training of specialists, mediated by the activity of personality, by a group of people depends and occurs in the vocabulary-directory on professional pedagogy [188, p. 243]

In our study under the pedagogical conditions of effective organization of interactive learning of disciplines of mathematical cycle of future mathematics teachers we understand a set of factors that are determined and realized by the participants of higher educational institution, encourage teachers and students to activate their activities and increase the effectiveness of student learning.

Based on the analysis of scientific literature, methodological approaches and principles of teaching, taking into account the results of the ascertaining stage of pedagogical experiment and considering the subject of our study, two main pedagogical conditions for effective organization of interactive teaching of mathematical disciplines of future teachers of mathematics were established, namely:

1) Readiness of teachers of higher educational institutions to carry out interactive teaching of subjects of mathematical cycle in higher educational institutions

- the educator's conscious attitude to forms of interactive learning *(motivational component)*;

- the teacher's knowledge about the essence of interactive learning and the formation of skills and abilities for its implementation in their own pedagogical activity *(cognitive component)*;

- openness to pedagogical innovations, ability to create new, pedagogical skill of the teacher *(creative component)*.

2) Integrated use of interactive learning both by the forms of student learning (classroom and extracurricular), and by stages of their educational and cognitive activity:

- actualization of basic knowledge and motivation of educational and cognitive activity;

- acquisition of subject and professional competences;

- development of independence in acquiring new knowledge and experience;

- control and check of the acquired knowledge quality, implementation of correction and reflection.

The introduction of pedagogical conditions and the improvement of the organization of interactive teaching of mathematical disciplines of the future teachers of mathematics is possible and will be effective if the teachers and students have adequate training in the use of forms of interactive learning and the desire to use them comprehensively in pedagogical and educational activities. We will consider in more detail the specific ways of implementing each of our determined pedagogical conditions.

3.2. Readiness of higher education teachers to implement interactive teaching of mathematical cycle subjects in higher educational institutions

Interactive learning helps to create an atmosphere of interaction and collaboration, enables the modeling of different life and learning situations and their joint solution based on the use of role-playing games and other technologies of interactive learning. The introduction of interactive learning into the higher education process increases the quality of subject and professional training of future teachers; enables students to analyze educational material, creatively approach to its assimilation, develop skills of project activity, individual work, performance of creative works; find a common solution of the problem etc.

Using interactive learning in the process of teaching mathematical disciplines, the teacher thereby demonstrates unconventional methods of teaching to the student, teaches the future teachers to use them in their professional activities. As interactive learning is based on the interaction of students in such an environment where they find a part of new experience for themselves, then in the context of professional skills and abilities acquisition, such learning creates new ways to acquire skills for future professional activity.

Interactive learning enables students to be equal participants in the educational process, teaches them to respect the opinion of others, to choose a joint solution to the task. The development of professional competence, through the introduction of forms of interactive learning, is not just in the form of reproduction of educational material, which the teacher showed at lectures. Using one form or another requires students to be able to individually choose and acquire new information. In such circumstances, students receive a large part of the educational material due to their active participation in the educational process, which greatly improves the efficiency of their learning.

The basis of successful implementation of interactive teaching of mathematical disciplines is the personal experience of the teacher, his /

her methodical preparation, which is achieved as a result of raising the professional pedagogical level.

The application in practice of interactive learning in higher education is still episodic, non-systemic character due to the unpreparedness of most teachers to use modern technologies. The foundations of the future pedagogical technique, professional teacher culture and technological literacy are laid in the educational process of higher educational institution. The willingness to implement interactive learning enables the future teacher to adapt professionally to the conditions of modern school, solve successfully complex tasks of educational work, consciously analyze and adjust the results of the activity.

Organizing the process of preparing future mathematics teachers for the use of interactive learning, teachers of higher educational institutions should introduce technologies and methods of interactive learning in the educational process themselves. In order to a student – a future teacher – to build his or her own activity on an innovative basis, it is necessary for him to be a real participant of such a process in the period of professional formation to adopt as an example for imitation a way of constructing educational process on an innovative basis.

To the teacher, who will use forms of interactive learning in his / her professional activity, there are special requirements that he or she must meet, namely: *informative, project-constructive, communicative and didactic-organizational* [82], [117]. We will reveal the features of each of the above requirements in accordance with the components of the willingness of teachers of higher educational institutions to carry out interactive teaching of mathematical disciplines.

One of the components of the implementation of this pedagogical condition is the conscious attitude of the teacher to the forms of interactive learning, that is *the motivational component.*

This component is the core around which the basic qualities of the teacher as a professional are constructed, his / her pedagogical skill, because on what motivates the teacher his / her readiness to innovative activity depends the nature of participation in innovative processes.

Often the leading motive of innovative pedagogical activity is cognitive interest. The cognitive interests of a teacher focused on the implementation of interactive learning, concentrate around the need for scientific understanding of various aspects of personal orientation education; to reflect on their own experience, the degree of effectiveness of pedagogical activity, the formation of their position on changes in the education system; the use of new knowledge in their own practical activity.

The teacher's positive motivation for innovation testifies to pleasure of his / her personal and professional needs, such as the creation and use of something new, improving pedagogical skill, overcoming professional difficulties. Therefore, the use of interactive learning is considered by many educators to be the only important motive for personal and professional self-affirmation. Thus, the indicators of motivational component of readiness for implementation into the educational process of interactive learning are cognitive interest and personally significant understanding of their application.

When forming this component, the teacher has the following requirements:

1) to the ***information*** requirements include:

- sufficient knowledge of psychology and pedagogy, in particular didactics, mathematics teaching methods and mathematics teaching methods in higher education, which allow to use effectively the form of interactive learning that would most satisfy the content of the discipline, type of the lesson, its topic and student audience;
- ability to analyze pedagogical experience of interactive learning and to use it creatively in your own practice;

2) to the ***projective-constructive*** requirements include the ability of the teacher:

- to plan the educational process with the use of forms of interactive learning in accordance with the requirements of current curricula;
- to anticipate the results of their activities, the learning outcomes of each student and student group as a whole;

3) to the ***communicative*** requirements include the ability of the teacher:

- to make the necessary direct emotionally strong-willed influence on students in order to create a positive attitude to learning, prompting specific actions;
- to establish pedagogically motivated positive contacts with each student.

The motivational criterion points to the self-realization of the teacher as a professional in innovation, the level of susceptibility to novelty, the need to create innovative projects as a new way of solving pedagogical problems.

Another component of this pedagogical condition is the presence of the teacher's knowledge about the essence of interactive learning and the formation of skills and abilities in its implementation in their own pedagogical activity, namely *cognitive component*.

This component is the result of cognitive activity. It is characterized by the amount of knowledge (width, depth, systematic), style of thinking, formation of the teacher's skills.

The realization of the cognitive component of the teacher's readiness for interactive learning means for him the need to professionally self-determine, that is, to understand the norms, the model of the profession and to evaluate abilities accordingly.

When forming this component, the teacher has the following requirements:

1) to the ***information*** requirements include:

- the teacher has a certain amount of knowledge about the essence, content of forms of interactive learning, special components and algorithm for their conduct;
- constant desire of the teacher to supplement his knowledge by studying new psychological-pedagogical and methodical literature;

2) to the ***projective-constructive*** requirements include the ability of the teacher

- to design educational and pedagogical activity on a separate type of educational activity and in the system of forms of organization of educational and cognitive activity in higher educational institutions;

- to select and design in the educational process effective forms of interactive learning, appropriate ways of interaction of students in accordance with the type of educational and cognitive activity;

3) to the ***communicative*** requirements include the ability of the teacher:

- observe students to evaluate the student's actual involvement in a particular situation and the level of mastery of the course material;

- understand and evaluate the subjects of communication – individual students, groups, adequately perceive, understand the mental state of students in the conditions of interactive interaction;

4) to the ***didactic and organizational*** requirements include the ability of the teacher:

- to apply some or other components of forms of interactive learning according to the student audience;

- to organize monitoring and evaluation of students in the conditions of interactive learning;

- to teach students to self-evaluate their own educational achievements and to evaluate and justify the evaluation of the classmates' achievements;

The creative component, which is interpreted in openness to pedagogical innovation, the ability to create something new, pedagogical skill of the teacher is another component of this pedagogical condition. Signs of creativity are the unconventional approach to the organization of educational process, the ability to creatively solve any professional problem, the ability to develop the creativity of students, which would be embodied in their behavior. The creative component of readiness for innovative pedagogical activity is revealed through openness to pedagogical innovations; flexibility, critical thinking; creative imagination.

When forming this component, the teacher has the following requirements:

1) to the ***project and constructive*** requirements include the ability of the teacher:

- to carry out individual and differentiated approaches to students in the conditions of interactive learning;
- develop criteria and tools for evaluating of interactive learning;

2) to the ***communicative*** requirements include the ability of the teacher:

- regulate interpersonal relationships in student collective during interactive interaction;

3) to the ***didactic and organizational*** requirements include the ability of the teacher:

- to manage students' individual cognitive activity in the conditions of interactive interaction, to promote the development of their intellectual abilities, to form students' ability of independent cognitive activity, to choose appropriate forms of interactive learning;
- creatively apply forms of interactive learning, using different ways of interactive interaction.

Therefore, we can conclude that the teacher who implements interactive learning in the educational process of higher education should master a high culture of cognitive activity, professional skills to predict students' learning activity and their behavior in the context of interactive interaction.

3.3. Integrated use of interactive learning.

The organization of the educational process in a higher education institution is governed by the current regulatory documents of Ukraine, the standards of higher education, taking into account the principles of formation of the European Higher Education Area (EHEA).

The process of studying at high school is implemented within a multifaceted holistic system of organizational forms and teaching methods. The Regulations "On the Organization of the Educational Process" in various institutions of higher education state that the

educational process is a system of scientifically grounded organizational, methodological and didactic measures aimed at realizing the content of education at a certain level of higher education in accordance with the state educational standards using the chosen model of its organization.

In the Law of Ukraine "On Higher Education" the educational process in higher education institutions is carried out in the following forms: lessons, independent work, practical training, types of control.

Consider the essence of each form of the educational process, which are described in detail in the Regulations "On the organization of the educational process" (it follows from the analysis of the relevant regulations of different higher pedagogical education institutions, the definitions of these concepts are completely identical).

A lesson is the main organizational form of studying at the higher education institution, which is conducted in the form of lectures, laboratories, practical and seminars.

Independent student work is a form of organization of the educational process, in which the planned tasks are performed by the student under the methodical guidance of the teacher, but without his direct participation. The purpose of independent work is to master the curriculum in full and the consistent formation of the student's independence as a trait that plays a significant role in the preparation and development of a modern specialist of higher qualifications.

The practical preparation of students is a compulsory component of the educational process and aims at acquiring the student's professional (highly skilled, special) competences in accordance with various educational programs. The practice of students provides for continuity and sequence of its conduct.

Types of control include current and final control.

Current control is carried out during practical, laboratory and seminar classes. It aims to check the level of student preparation for the performance of specific work.

Final control is a semester control, conducted in the form of a semester exam, differentiated test or credit for the purpose of evaluating

the results of study at the final stage and/or at separate stages of each discipline of the curriculum and in terms set by the curriculum.

Among the priority directions of the state policy on the development of higher education in the context of European integration of Ukraine identified the problem of constant improvement of the quality of education, modernization of its content and forms of organization of the educational process; introduction of educational innovations. Therefore, the educational process in a higher education institution should be carried out with innovations (including forms of interactive learning), mechanisms and procedures defined in the European Higher Education Area.

Innovation in education is a regular phenomenon, dynamic in nature and developmental in its results, their introduction allows to resolve the contradictions between the traditional system and the need for qualitatively new education. Therefore, innovative forms of learning, including interactive ones, should be introduced at all stages of educational and cognitive activity, namely:

- actualization of basic knowledge and motivation of educational and cognitive activity;
- acquisition of subject and professional competences;
- development of independence in acquiring new knowledge and experience;
- control and verification of the quality of acquired knowledge, implementation of correction and reflection.

The analysis of all the above-mentioned forms of organization of the educational process, taking into account the interconnections between them and the peculiarities of their implementation are the basis of the interactive learning model (Fig. 3.1).

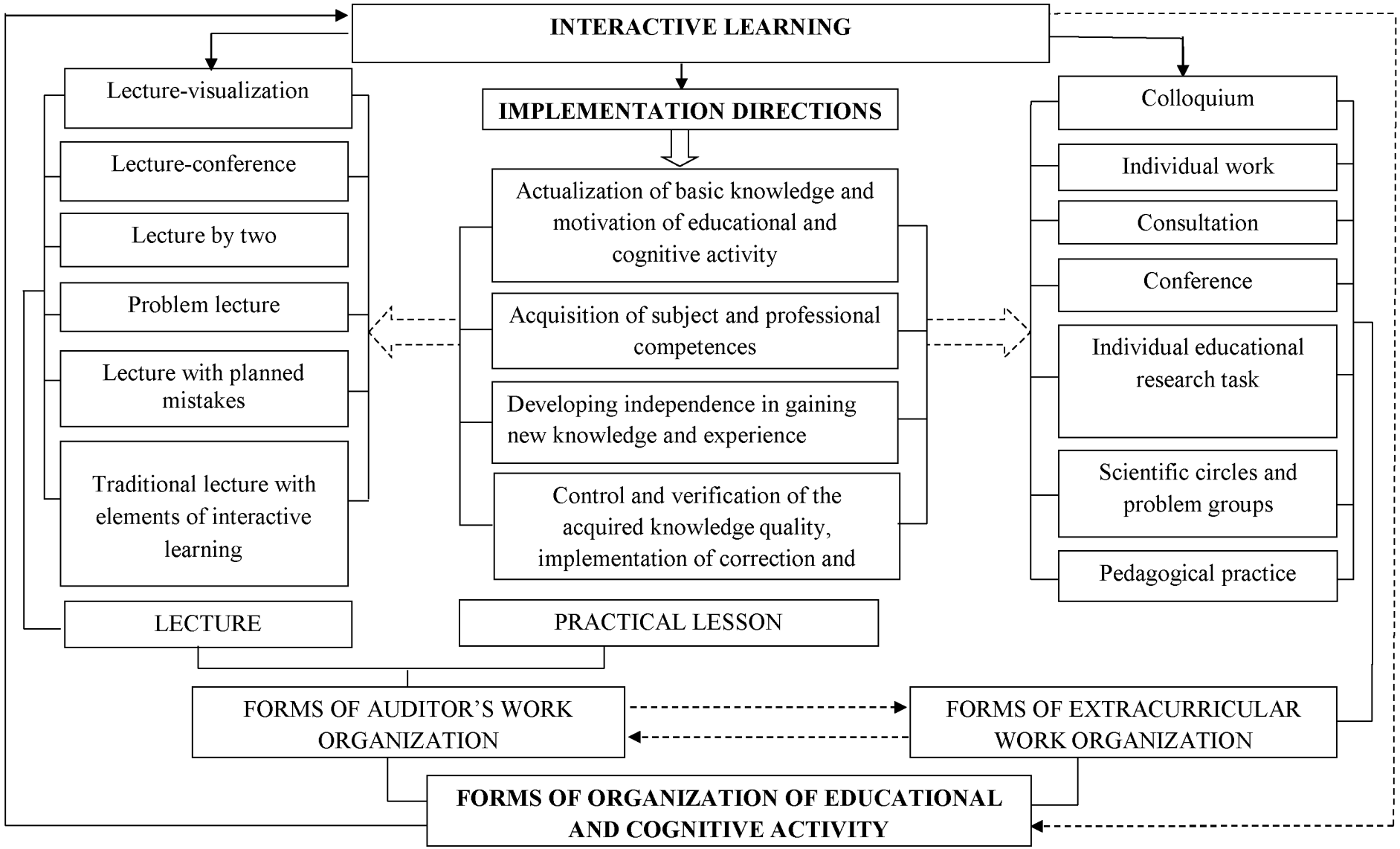


Fig. 3.1. Model of interactive learning

Let's consider the possible ways of interactive learning introduction in different forms of educational process organization, which we can conveniently combine into two groups, namely, classroom and extracurricular forms of work and on different stages of educational and cognitive activity of these forms.

Educational classes are an important form of the educational process, during which students acquire the necessary knowledge and skills. In accordance with the Law of Ukraine on Higher Education [68], individual classes and consultations are also included into classes. Therefore, considering this form of educational process in terms of time and place, to the classroom forms we include lectures and practical classes (practical, seminars, laboratory) in our work, and to extracurricular work – individual classes and consultations (although depending on time, place and the purpose of the lesson, they may also belong to the classroom classes).

Interactive learning will be effective if it is not solitary but of systemic character. That is, we believe that when studying one discipline, the teacher should apply forms of interactive learning in different types of the lesson (both during lectures and practical classes and during individual classes and consultations). Based on the observations and the experience of using interactive learning in high school, we found that it is not always advisable to conduct each lecture or practical training using interactive learning (we suggest to use either elements of interactive learning at one of the stages of the lesson, or interactively 1 – 2 times a month), but it is convenient and interesting to conduct individual lessons or to provide students with counseling using forms of interactive learning.

In our opinion, we should start to introduce interactive learning during the classroom work gradually. For this purpose it is necessary to consider each type of educational activity according to the stages of educational and cognitive activity. This form of educational process makes it possible to introduce interactive learning at any of the above stages of educational and cognitive activity.

CONCLUSIONS

The modern development of society and the individuality place high demands on the organization of the learning process in general and the future teachers of mathematics in particular. In the conditions of transition to the information society, change of educational paradigm, entry of Ukraine into the world educational space, it becomes an urgent need to create such a pedagogical education, which, on the basis of national heritage and European traditions, ensures the formation of pedagogical workers capable of making professional activity on innovative grounds. Educational practice requires the development and grounding of new pedagogical ideas. An effective way of updating the system of future teachers training is to implement interactive learning: collaboration and co-creation of learning subjects. In the dissertation the theoretical generalization of the problem of interactive learning implementation for some subjects of mathematical cycle in pedagogical universities, in particular, elementary mathematics, methods of calculations, practicum of solving non-standard mathematical problems, history of mathematics, methods of teaching mathematics and others and it is proposed to solve it.

Nowadays it is actual to train mathematics teachers with high creative potential, initiative and resourceful, ready for constant accumulation and updating of knowledge and skills, capable to creatively solve complex tasks, analyze, predict and model the results of their professional activity. That is why the organization of teaching future mathematics teachers needs modernization through the active implementation of interactive learning. The analysis of scientific and methodological literature, the results of students' questionnaires and teachers of pedagogical universities showed that there is a need and opportunity to teach students in the conditions of interactive learning and to prepare them for the implementation of elements of such learning in the process of teaching mathematics at school.

The integration of Ukraine into the European educational and scientific space, the need to improve the quality of education lead to

increased demands on the modern teacher. The formation of the professional competence of a future mathematics teacher becomes an urgent problem with such changes. The main components of the professional competence of a mathematics teacher are: mathematical competence, methodical competence, communicative and psycho-pedagogical competence. According to the outlined components, several levels of professional competence mastery are defined, namely: elementary level (the teacher has only certain qualities of professional activity), the basic level (the teacher has the basics of professional activity), the perfect level (characterized by a clear orientation of the teacher actions, their high quality, dialogue interaction in communication), creative level (characterized by initiative, creative approach to professional activity). Formation of elementary and basic levels of professional competence of future mathematics teachers should be addressed in teaching students at the pedagogical university using vivid examples by leading educators of the university.

Teaching of future teachers in the conditions of interactive learning develops pedagogical abilities, forms pedagogical technique and thus increases their level of professional competence. The high level of development of each of the components of professional competence creates the conditions for the formation of future mathematics teachers willingness to implementation of interactive learning in their future professional activity.

The effectiveness of interactive teaching of mathematical disciplines of future mathematics teachers is ensured by the complex use of this type of teaching during different forms of educational process organization (classroom and extracurricular) at different stages of educational and cognitive activity of these forms. Teaching mathematical disciplines of the future mathematics teachers in different forms of organization of the educational process is carried out also by the use of distance learning, the elements of which belong to interactive learning. Such forms of learning can be organized by means of a modular, object-oriented, dynamic Moodle learning environment that provides students with access to a variety of learning resources,

including study and work programs, lecture texts and presentations, examples of practical classes solving, and self-solving tasks, tests for control and self-control, etc.

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