FORMATION OF THE LOGICAL COMPETENCE OF STUDENTS BY LEARNING MATHEMATICS AT THE UNIVERSITY

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Basing on the competence approach to education, the author reviews some aspects of teaching techniques for development of the logical competence of students, as a part of their professional competence, during their learning of mathematics at the university.

Keywords: outlook, logical competence, developing education

The current global social and economic changes urge people to broaden their minds, develop their creative abilities, learn to cope with the growing amount of information, master new technologies, make independent decisions and adapt quickly to constantly changing social and economic conditions. The above mentioned transformations totally changed the quality requirements to the higher professional education, focusing not on the knowledge of subject, but the development of professional competence. The modernization program of the Russian education determined the competence approach to the quality of education as the main goal of study. Nowadays, the issue of professional competence development has been sufficiently analyzed by science at the general psychological and educational level, but there are no specific methods for the competence training, applicable for university students who study different subjects, including mathematics.

The article reviews aspects of teaching techniques for logical competence development in humanities students who take a course in math: structure of logical competence of humanities students; didactical conditions of logical competence development in humanities students at university; requirements (principles) to the teaching techniques for development of the logical competence in humanities students; educational goals, which help develop the logical competence of humanities students; choice of the mathematical content aimed at formation of the logical competence of humanities students; the concept of the point rating system for evaluation of students' knowledge, which contributes to formation of the logical competence.

So, we defined the logical competence as a part of the professional competence, which university students can develop through studying mathematics, and which is one of the general (key) competences. Let us introduce the structural elements of the logical competence [1]. Logical competence involves the following skills: a student knows certain notions and laws of logic, necessary for the further education, maintaining interpersonal relationships and solving life problems; a student can think logically, and use his knowledge of logic and logical thinking to study successfully and handle problems in the everyday life; knows the symbols of mathematical logic used for logical operations, understands the meaning of logical and mathematical symbols and mathematical formulas, used to describe general laws of science and practice, uses logical symbols appropriately and can explain the

meaning of notions and symbols; has an idea of mathematical research methods, peculiarities of mathematical language and can correlate it with the Russian language; can apply algorithmic orders and instructions on mathematical and non-mathematical matters; possess abilities of mathematical thinking, which requires to be abstract, conclusive and exact; can argue and draw logical conclusions; can differentiate the proven and not-proven statements, reasoned opinions and emotionally convincing ones; can summarize and discover laws via analysis of concrete examples and experiments, can hypothesize and understands they need to be proved; can build and study the mathematical models when solving applied and interdisciplinary tasks; knows the difference between the scientific and practical requirements to proofs in mathematics, natural and human sciences; can express his thoughts clearly and exactly, both orally and in writing, understands the logic of oral and written information; has a notion of axiomatic building of mathematical theories, logical status of axioms, defined and undefined notions, definitions and theorems; understands that the logic laws of mathematical inference are universal and applicable in all spheres of human activities; has experience in using the learned knowledge and skills in own activities: study, communication, social and etc.; has a personal and valuable attitude to the acquired knowledge, skills and experience. This educational construction of the logical competence includes all elements of competence: cognitive, active and value-oriented.

Didactical conditions of the logical competence development in humanities students are determined by the active approach to management of learning and cognitive activities of students [5] and goals of the developing education, its requirements to the choice of content, methods and forms of education [3]. We have distinguished the following didactical conditions: the content of mathematical education should correspond with the Federal State Educational Standards of Higher Professional Education, the goals and principles of the logical competence development in humanities students of universities; students' educational aims should be clarified during studying mathematics, they should focus on development of personal traits; participation in learning cognitive activities, stimulation of internal study motives, including, self-learning; teachers should use special educational methods, which help students to value learning mathematics [1]. The revealed didactical conditions clearly determine the main requirements (principles) to techniques of the logical competence formation: principle of compliance with the aims of mathematical training of humanities students; principle of compliance with the structure of the logical competence of humanities students; principle of activation of self-control and self-evaluation of students' learning cognitive activities; comfort principle; principle of providing values and evaluation [1].

We believe that teaching logical competence to humanities students should focus on achieving the goals that are equally important for personality development: explain the humanities students notions and laws of logic that are necessary for the development of their logical thinking and further education; teach skills of using the knowledge of logic and logical thinking in solving mathematical and other tasks, problems in interpersonal relationships; motivate to study, including self-study, and to evaluate the study activities; teach to compare the job offers with the actual level of skills and personal values; teach to

value the acquired knowledge, skills, personality traits and personal experience [1].

The choice of mathematical program, forming logical competence of humanities students, is determined, first of all, by the state standards. The federal state standards for higher professional education for humanities majors are rather brief: «Axiomatic method, basic structures, compound structures, probabilities …» [4]. The standard is a frame, which can be build up with mathematical content, resulting in the course program. Currently, the humanity has accumulated an immense amount of knowledge on mathematics. Therefore, determining the content, we followed the federal state standards for higher professional education, designed for different faculties and majors, as well as the aims and principles of the logical competence development in humanities students at university. Let us present the program of mathematical studies for humanities students as part of the techniques for the formation of their logical competence [2].

Topic 1. Axiomatic method of science development. History and philosophy of mathematics as part of human culture. The main periods and the most important discoveries. The main and composite mathematical structures, their development due to scientific and practical needs. Application of mathematics in human sciences.

Topic 2. Theory of sets. Set definition. Universe. Subsets. Set operations and their properties. Venn diagram. Boolean sets. Cartesian product. Notion of correspondence. Potency of set.

Topic 3. Relations. Basic definitions. Properties of relations. Equivalence and tolerance relations. Graphs as visual method of presenting finite anti-reflexive symmetric relations. Relation of order. Relation of strict order. Completely ordered sets. Partially ordered sets. Hess diagrams showing relations of partial order.

Topic 4. Theory of graphs. The history of the graph theory and its applications. Graphs. Basic definitions. The main types of graphs. Degree of a node. Main theories. Subgraph. Path. Simple path. Cycle. Simple cycle. Directed graphs. Main types of orgraphs. Oriented path and its length. Paths and Euler's cycles. Euler theory. Hamiltonian path. Trees as graphs without cycles. Forest. Directed trees. Properties. The degree of a vertex. Tree depth. Rooted directed tree. Algorithms as tree of decisions or choices.

Topic 5. Logic, truth table and proof. Propositions. Types of propositions. Logical connectives. Value of a proposition. Proof or disproof of proposition's truth. Truth table. Conditional statements or implications. Implication truth table. Equivalent statements. Conversion. Inversion. Contraposition. Basic laws of logic. Proof using truth tables.

Topic 6. Axiomatic systems. Axiomatic systems: inference and proof. Inference rule. Proof of inference using truth table and proof by contradiction.

Topic 7. Elements of probability theory and mathematical statistics. Probabilities and their calculation. Some of the combinatorial formulas to calculate probabilities. Types of events. Classic definition of probability. Casual events. Full group of independent events. Addition and multiplication theorems for events. Generalized theorem of event addition. Distribution law for a discrete random variable. Normal distribution. Event frequency. Sample. Representativeness of sample. Numerical characteristics.

In order to understand the course, students need to have knowledge of the basic school math. After learning the above presented program on math, the students:

Will have an idea of: common human and cultural role of mathematics as science in the human history, and its role in the development of other sciences; main stages of the historic development of mathematics, fundamental mathematical discoveries and famous mathematicians; basic mathematical structures and their development due to the scientific and practical interests; mathematical language and application of math in human sciences; main laws of logic and inference rules; probability of accidental events and certain combinatorial formulas to determine probabilities;

will know: basic definitions of set theory; relations, their properties and types; key notions of the graph theory; the Euler theorem; main notions of statement logic; basic logical connectives and their truth table; axiomatic method of theory building; axiomatic systems of inference and proof; inference rules during proof; probability to win a lottery or make profit in a financial pyramid and etc.;

will be able to: perform operations on sets, including the use of the Venn diagram; visually present relation with the help of graphs and the Hess diagrams; determine the degree of a node, simple path and cycle; determine the Euler path in a graph; prove using the truth tables for logical connectives, the laws of logic and rules of inference; make conscious decisions on gambling or investing in financial pyramids and etc.

During several years, students have been achieving high results on the federal tests, proving that the content of mathematical education was chosen properly.

One of the most important parts of the competence approach to education is formation of an independent educational cognitive activity of students. Elements of such activities are [3]: study-cognitive interest, definition of objectives, study activities, control and self-control, self-evaluation of own activities, reflection over own activities. While learning the subject, they should reach levels V and VI. Let review some of the aspects of students' abilities for self-evaluation of their learning and cognitive activities, which they develop through studying mathematics. The analysis is based on the point-rating system of knowledge evaluation.

The effectively used point rating system of knowledge evaluation should motivate students to take an active part in managing their educational-cognitive out-of-school activities. This could be definitely enhanced by development of evaluation skills of level VI («actual adequate forecast evaluation»). Modern educational science defines six levels of evaluation skills [3]. Work experience shows that the majority of school graduates entering the university have evaluation skills of the III level: students criticize grades given by teachers, but cannot and do not try to evaluate their own abilities before working on a new study project. And only the minority of students are able to estimate their own abilities freely and reasoned, and with teacher's help, can prove their ability or disability to solve a task, basing on analysis of the known plan. During studying mathematics at the university, students should learn to prove in advance whether they have enough knowledge to solve a task; they should develop an ability of self-reflection: what I know and what I do not know in order to solve the assigned task; learn to compensate the lack of knowledge and gain additional knowledge by themselves.

The above discussed aspects of the techniques for development of the logical competence of students, let us clearly determine that main rules of an effective use

of the point rating system for knowledge evaluation in the frameworks of the competence approach to education, follow the essential requirements to techniques for the logical competence development.

Principle of compliance with the aims of mathematical training of university students means that the goals of the effectively used point rating system of evaluation of students' knowledge on math should correspond with the aims of the mathematical education of university students, set by the current standards of higher professional education, including the subject programs.

Principle of openness. Students should have an open access to standards, program of subject, flow sheet. Each module of the flow sheet should contain reasoned criteria for giving minimal and maximal number of points.

Principle of continuity means such organization of study in classes and at home, when the results at every stage of activities are included in activities at the next stage.

Activation principle for self-control and self-evaluation of study and cognitive activities of students. Through learning mathematics, students develop ability, readiness and solid skills to control and evaluate own activities.

Comfort principle says to take into account the individual abilities of students. The given material is of high complexity, but students' success in learning is controlled basing on their individual abilities and requirements of standard; an ultimate focus is set on creative work at the university and at home, and on gaining own experience.

Principle of providing values and evaluation of activity. Students should learn to compare the offered algorithm of activities with their actual abilities and values; they should be permanently confronted with alternatives, develop an ability to analyze the possible options, evaluate them and make the best choice; develop positive personal needs, motives and values.

Diagnostics prove that the developed method provides the essential level of the logical competence in university humanities students through learning mathematics, and can be used to elaborate the methods of key competence development, during learning mathematical subjects at the university.

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