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Educational and developmental goals are important component for mathematics teaching process

This article presents the goal-setting problem of teaching. Modern research shows that in the real learning process the goal has the fundamental place, so called «core» around which the teacher combines all the pedagogical means into the system locating each of them. Humanization of Education promoted the educational and developmental goals to the foreground, but few knows the differences in goals of education and development. The authors propose a model of educational and developmental learning, where the teacher comes to goal-setting process with the responsibility. The attention of teacher in the learning process is aimed at identifying the individual capabilities and interests of each student.

Key words: Educational and developmental goals, learning process, education, development, personality, interest, educational and developing model, educational activity.

The problem of education goals is relevant at all times, and deserves close attention. After all, the goal is a fundamental element of the learning process.

The value of the goal from a psychological and pedagogical point of view is that it organizes and mobilizes the creative power of the teacher. The goal provides assistance in the selection and choice of the most effective content, methods and forms of work.

It is possible to see the different approaches to defining the goals of teaching mathematics in the methodological and pedagogical literature. Teachers, scientists and relevant education authorities are defining a system of mathematics teaching goals that guided by the specifics of the discipline, as well as their views on the need to study mathematics in the conditions of modern society.

The purpose of the learning process is always connected with education, development, learning of a student, with his improvement.

Education and development is an ongoing process that happens regardless of whether the teacher is making efforts or not. It depends on the teacher how manageable the process will be.

In most cases the teacher wants to form the new developmental and educational aspects for each lesson, forgetting that the development and education of the child is much slower than the process of learning, that the independence of education and development is relative and that they are carried out to a large extent as a result of properly organized learning.

This implies that the same educational and especially developing aspect of the lesson goal can be formulated for a few lessons, and sometimes for the whole section.

Many teachers unconsciously remain in the content of their subject forgetting that the educational and developmental goals are the backbone to the goals and tasks of education.

Humanization of the school education involves a different hierarchy of the educational process goals at the lesson. Humanization requires different choices preferred by the students themselves and realization of their needs and their chances to succeed in the chosen directions. The focus of the teacher is to identify individual capabilities and interests of each particular student. The teacher relying on humanistic position in the process of learning must provide a complete education and development of the student, in accordance with their capabilities and needs. With this construction of the educational process the main role is given to the student, the teacher acts as a kind of consultant, a man ready to help at any moment. The teacher should pay special attention to the identification of individual capabilities and interests of each student. In the past first priority was always given to the educational goals, but today the foreground occupied by the educational and developmental goals, thus the educational content is enhanced with the moral and ethical aspects.

Therefore, humanization of education predetermined the primary importance of the educational and developmental goals in learning. We will consider them in the unity of both educational and developmental learning goals.

Professional experience and the study of psycho-pedagogical and methodological literature allowed us to build a model of the learning process that implements the educational and developmental function of the

mathematics in school. This model includes the following: didactic conditions, actualizing educational and developmental teaching mathematics functions; learning goals, with a priority to educational and developmental functions of the educational process; learning content, adequate leading types of mathematical activity, describing the essence of the mathematics subject, its leading ideas and methods of reality cognition, revealing the structure of mathematical objects; educational methods and modes for the promotion of students cognitive-motivational activities, forming the basic mental operations and student reflective activity; learning aids, organically included in the structure of the educational and developmental process, providing search and creative activity of students in the educational process.

Therefore, educational and developmental education is characterized by the stress not on the learning knowledge, skills and experience, but on the development of the personality, achieved by means of learning mathematics. For these purposes, it is necessary to overcome the contradiction between the declaration of educational and developmental learning and practical knowledge and skills learning. It is known that the implementation of any goal occurs only as a result of activities. This being said, fulfillment of goal for each student should dominate on every lesson, and this should distinguish each mathematics lesson in educational and developing learning.

The lesson has a unique chance to impact upon the formation of many personality qualities. Educational and developmental aspect should include the use of the educational material content, learning technologies, forms of cognitive activities organization in their interaction for the formation and development of moral, labor, aesthetic, patriotic, environmental, and other student personality qualities. It should be aimed at learning the correct attitude to human values, and a high sense of civic duty.

The terms of these relations are quite wide. Therefore, educational and developmental goal of mathematics lesson will simultaneously cover a variety of these relations. But these relations are mobile enough: from lesson to lesson, referring to one of educational and developmental goals, the teacher solves various educational and developmental tasks.

Mathematics as a subject in school is promoting this to a greater extent. It promotes the development of imagination and logical methods, which are the basis for the justification of the truth or falsity of observation.

The mathematics and mathematical language are necessary for student as in the study of related subjects, as well as for continuing education, because without mathematics skills it is almost impossible to plan and organize their activities. On the other hand, when the student mastering certain mechanisms of thinking (logical, deductive, abstract, critical thinking, divergent and convergent thinking), developing qualities, that are used in any mathematical operations, such as attentiveness, accuracy, precise wording, validity of assumptions and conclusions, he/she forms the foundation for his mathematical culture. Furthermore, for integrating into society and ensure social mobility graduates need the flexibility of thinking, the ability to implement a mental experiment and skills of conducting research.

The thinking development is one of the most important goals for teacher. It is known, that the development of student's thinking can only be based on a thorough analysis of mathematical concepts origin and theory and practice mutual impact. Teacher should always take care that the spoken and written language of students reflects a deep understanding of the concepts, terminology and symbols. Moreover, work on the development of mathematical thinking and speech of students should be according to their ability and age characteristics. For example, in the IV–V form on the basis of specific examples consideration, students should be able to apply the definitions and rules for the common cases, and in VI–VIII form students should understand the role of definitions, axioms and theorems, and be able to prove the statements that are available to this age. Many mathematical problems can be used as a tool for the development of student's thinking.

Learning to solve problems of increased difficulty or finding yourself theorem prove depends primarily on the art of the teacher, as well as the content of the material, as the desire to learn, as a rule, is inherented by all children. The only thing necessary is to organize learning in such a way so that students will learn willingly.

However, there are few ways in a methodical science to spark interest in learning. There are few children who are interested in mathematics. To increase their number, it is necessary to make the mathematic problems more attractive for students to read and solve. Who can find interest in traditional boring problems such as «pedestrian walked from point A to point B?»; «Two tubes are filling a swimming pool?»; «Find», «Calculate» and so forth. More effective way of learning process makes the student experience deep emotions for the events set forth in the text of the new material. The material that is emotionally presented will be absorbed and reproduced better. Due to insufficient balanced organization of educational process the stu-

dents lost interest in learning. It is necessary to pay attention to the feasibility of the material. The new material must be presented so that the students hear it and see the formula. This requires the provision of mathematical interest to the material, so that the student will not deviate from the goal and remember to achieve it.

An important characteristic of the personality is the personality cognitive interest. Cognitive interest is a steady condition of a person, expressed in its targeted active-cognitive activity in relation to any object of importance. The issue of cognitive interest is one of the central problems in modern teaching technologies. A. Leontiev [1], analyzing the structure of educational activity, showed the necessity of education for specific attitude towards knowledge and motives, due to which the knowledge and skills acquired for student's personal meaning, become their inner property. The particular material of school mathematics does not always stimulate cognitive interest. To do this, the teacher must find materials that enhance interest of students in mathematics. The materials that show the novelty of the subject being studied; practicability and the necessity to introduce new theoretical material to solve a particular problem; the history of the mathematical concepts and laws; practical importance of mathematical knowledge, etc.

Among all subjects Mathematics occupies a special place in the logical reasoning formation, mathematics has a great potential for the development of mental operations: comparison, analogy, classification, specification, generalization. It should be noted that the operations mentioned above are interrelated in a certain sense.

One should take into account the peculiarities of mathematical knowledge. Remarkable qualities of the personality, emerging in the process of learning mathematics, are mastering the ability to simulate real processes, which are described by means of mathematics: theories, concepts, attitudes, and language. Also mathematics has excellent opportunity to demonstrate the role of theoretical knowledge.

The study of mathematics helps to simulate real processes through the use of language and conceptual instrument of the discipline itself. The Goals of school mathematics course, which are aimed at the development of thinking and education of the student in the learning process, must fully comply with the course content. Thus, when the goals are achieved the important principles for the selection of the material content of and structuring should be followed. This issue is addressed in the article by G. Dorofeev «On the principles of the content selection in school mathematics education» [2], in which the author named two leading socio-conditioned principles: the information capacity and social efficiency. The principle of information capacity involves getting all the students the necessary knowledge, sufficient for the realization of the mathematics education goals. The principle of social efficiency suggests that learning in school should provide workforce for the society in all areas that require mathematical knowledge and intellectual culture. Moreover, a combination of two of these principles, that reflects the relationship «school – society» has a distinct character of optimization.

Lomonosov also noted the importance of mathematics education in mental development: «One should learn mathematics only because it puts the mind in order». And this depends on the orientation of education, teaching method. It is possible to teach mathematics so that, even at the optimum content, the students head filled with a large number of formulas and calculations without understanding their meaning and purpose. As a result of such teaching the students do not get the basic components of mathematical knowledge. And will not form their personality. At best, the children will gain knowledge without adequate mental development. Only by learning cognitive activity of students we will realize the possibility of mathematics to educate thinking personality.

The main device of thinking culture formation in the context of mathematics education is the educational activity, adequate and creative mathematical activity. A necessary development condition is the student activity in the learning and cognitive process, the inside activity, making the student the subject of activity. This requires, first and foremost, ensuring the proper interest in mastering mathematical material, and it must be feasible for the student, and the digestion of the material should be properly organized through the work of students with a new knowledge. As L. Vygotsky [3] rightly confirms, the knowledge can only be digested if the student work with that knowledge. The Learning process, according to L. Vygotsky, creates the zone of immediate development, it brings to life the internal processes of development: that the child at this stage of learning will do under the guidance and with the help of an adult, he will do it himself. After the problem is introduced to the child, it moves from the zone of immediate development in the actual development zone. Thus, the learning should lead the development, and be «ahead» of development. «Pedagogics should focus not on yesterday, but on the next day of the child development. Only then we will be able to bring in the developmental processes that are currently lying in the zone of immediate development» [3; 381].

It is established by psychology and methods of teaching mathematics that in the study of Mathematics, the student must learn not only the content of knowledge, but also the methods of knowledge reception. Psychologists say that the education and learning forms the developing person, including, if the teacher is organizing the student activities for digestion of new knowledge. To do this, the teacher must create during the learning process the pedagogical situations that stimulate the opening of students. The importance of this educational process organization is confirmed by V. Davydov, «The student performs cogitative activities that are appropriate by the historically developed products of spiritual culture» [4; 147].

Thus, the activity approach promotes learning not only for prepared knowledge but also the acquisition of a new mathematical knowledge, methods of reasoning used in mathematics to prove theorems and solve problems. Speaking about the importance of the independent activity of students, professor I. Depman noted: «The power of mathematics is not only in memorizing theorem proof, but also in heuristic rediscovery of the facts. Realization of the fact that these truths are not only an exercise in logic, but they also represent the true tools for nature study, that gives lessons in mathematics high educational character» [5; 150].

Students who are able to independently acquire a minimum of knowledge on the level of the active creative application will always be in a better position than the students that superficially mastered a large volume of learning material. Therefore, there are still problems with the student personality education, such as cognitive independence, the development of interest, etc.

Knowledge of the students, as a rule, is directly dependent on the volume and regularity of independent cognitive activity. In this regard, A. Disterveg wrote: «The development and education cannot be given or conveyed to a person. Anyone who wants to develop his personality should achieve this by his own activities, their own strain. A person can only get the excitement from outside... So independent activity is an instrument and at the same time the result of education» [6; 118]. To make the student search the knowledge, we need to organize these search, manage and develop their cognitive activity. School Mathematics provides a great opportunity for the organization of such activities.

The student activity organization is more important for the student's personality than mathematical knowledge acquired in the course of this activity.

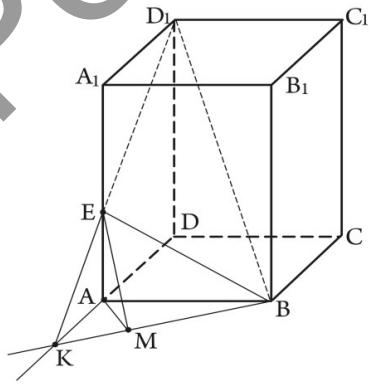
Therefore, from the point of view of educating and developing mathematics teaching in the aspect of «Mathematics for Everyone», the mathematical knowledge is the basis for the organization of full developing activities.

Implementation in practice of the stated position is justified by a significant shift in focus from «Mathematical Education» to «development with the help of mathematics», which allows to form the student personality more efficiently, his moral and intellectual potential, and prepare creative thinking member of society.

Psychologists proved that the children are not developing with the same type of easy tasks; they develop with overcomable difficulty tasks because too easy and too difficult tasks have no developmental effect. In addition, the easy tasks create imaginary impression of easy learning, and difficult tasks are frustrating, and in the end the student loses interest in learning.

Experience of many teachers, including our experience, shows that finding different ways of solving the problems is the most important thing to develop the creative thinking of students. Ability to solve problems in different ways is one of the hallmarks of a good mathematical training.

For example, the following task designed to differentiate the level of preparation was proposed to the students: «In the regular shaped quadrangular prism $ABCDA_1B_1C_1D_1$ the side of the base is equal to 3, and the lateral edges are equal to 4. On the edge AA_1 point E is marked, so that $AE:EA_1=1:3$. Find the angle between the planes ABC and BED_1». This problem was solved in 3 ways. We will not keep the strict record of solving the problem.



Method I

Line D_1E crosses line AD in the point K. The planes ABC and BED_1 cross at the line KB. From E we drop a perpendicular EM on the line KB, then segment AM (projection EM) is perpendicular to the line KB. Angle AME is the linear angle of the dihedral angle, created by planes ABC and BED_1.

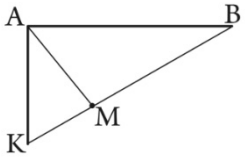
Let $\angle AME=\alpha$. Let's find α from rectangular ΔAEM $(AE\perp AM)$.

$$tg\alpha=\frac{AE}{AM}.$$

By condition $AA_1 = 4;\ AE : EA_1 = 1:3,$ then $AE = 1$; Let us consider the rectangular ΔKD_1D and ΔKEA.

ΔKD_1D is similar to ΔKEA with acute angle D_1KD. $\frac{D_1D}{AE} = \frac{DK}{AK};\ \frac{4}{1} = \frac{AK+3}{AK};\ AK = 1$

From rectangular ΔKAB let us calculate hypotenuse KB by the Pythagor theorem.



$KB = \sqrt{AK^2 + AB^2} = \sqrt{1^2 + 3^2} = \sqrt{10};\quad AM = \frac{AK \cdot AB}{BK};\quad AM = \frac{1 \cdot 3}{\sqrt{10}} = \frac{3}{\sqrt{10}};$

$tg\alpha = \frac{1}{\frac{3}{\sqrt{10}}};\ tg\alpha = \frac{\sqrt{10}}{3}.$ Answer: $arctg\frac{\sqrt{10}}{3}.$

Method II

Let us use the following statement: the area of the polygon orthogonal projection onto the plane is equal to the product of the area of a polygon on the cosine of the angle between the planes of the polygon and its projection.

ΔABD is orthogonal projection ΔBED_1 on the plane ABC.

$S_{ABD} = S_{BED_1} \cdot \cos\alpha,$ where α – te angle between ΔABD и ΔBED_1

ΔABD — rectangular ($AD \perp AB$); $S_{ABD} = \frac{1}{2} \cdot AD \cdot AB = \frac{1}{2} \cdot 3 \cdot 3 = \frac{9}{2}.$

Let us find S_{BED_1}. From rectangular ΔAEB: $BE = \sqrt{AE^2 + AB^2} = \sqrt{1^2 + 3^2} = \sqrt{10}.$

From rectangular ΔEA_1D_1

$D_1E = \sqrt{EA_1{}^2 + A_1D_1{}^2} = \sqrt{3^2 + 3^2} = \sqrt{18};\quad BD_1 = \sqrt{3^2 + 3^2 + 4^2} = \sqrt{9 + 9 + 16} = \sqrt{34};$

$S_{BED_1} = \frac{1}{2} \cdot BE \cdot ED_1 \cdot \sin\angle E;\quad S_{BED_1} = \frac{1}{2} \cdot \sqrt{10} \cdot \sqrt{18} \cdot \sin\angle E\ .$

Let us calculate by the cosine theorem $\cos\angle E$ from ΔBED_1: $\cos\angle E = \frac{18 + 10 - 34}{2\sqrt{18} \cdot \sqrt{10}} = \frac{3}{\sqrt{180}}.$

$\sin\angle E = \sqrt{1 - \frac{9}{180}} = \sqrt{\frac{171}{180}} = \sqrt{\frac{19}{20}}$

$S_{BED_1} = \frac{1}{2} \cdot \sqrt{10} \cdot \sqrt{18} \cdot \frac{\sqrt{19}}{\sqrt{20}} = \frac{3}{2} \cdot \sqrt{19}$

$\cos\alpha = \frac{S_{ABD}}{S_{BED_1}} = \frac{9}{2} \cdot \frac{2}{3\sqrt{19}} = \frac{3}{\sqrt{19}};\ \alpha = \arccos\frac{3}{\sqrt{19}}$

Note, that if $\cos\alpha = \frac{3}{\sqrt{19}},$ then $tg\alpha = \frac{\sqrt{10}}{3}.$ Answer: $\arccos\frac{3}{\sqrt{19}}$

Method III

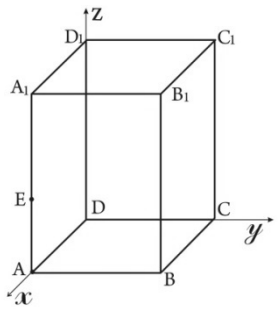
Let us use the vector-coordinate method, which allows us to reduce the solution of the problem by finding the angle between normal vector s of these planes. Any nonzero vector that is perpendicular to the plane is the normal vector.

Every linear equation $px + qy + rz + d = 0$ upon condition $p^2 + q^2 + r^2 \neq 0$ sets in a rectangular coordinate system the only plane, with vector $\overline{n}\{p;q;z\}$ is the normal vector.

The problem of finding the angle between the planes α and $\beta,$ given by the equation $p_1x + q_1y + r_1z + d_1 = 0$ and $p_2x + q_2y + r_2z + d_2 = 0$ accordingly, it is convenient to narrow down the problem about finding angle between vectors and their normals $\overline{n}_1\{p_1;q_1;r_1\};\ \overline{n}_2\{p_2;q_2;r_2\},$

Using the formula $\cos\gamma = \frac{|\vec{n}_1 \cdot \vec{n}_2|}{|\vec{n}_1| \cdot |\vec{n}_2|} = \frac{|p_1p_2 + q_1q_2 + r_1r_2|}{\sqrt{p_1^2 + q_1^2 + r_1^2} \cdot \sqrt{p_2^2 + q_2^2 + r_2^2}}$, where $\gamma -$ angle between the planes α and β.

In the problems for the calculation of the angle between the crossing planes, usually it is not required to find the equation of plane. Coordinates of the normal vector can be derived, if we know the coordinates of three points on a plane, which do not lie on a straight line. For this we should find the coordinates of two plane vectors $\overline{a}\{a_1;a_2;a_3\}$; $\overline{b}\{b_1;b_2;b_3\}$.



We assume, that the vector with coordinates $\overline{n}\{p;q;r\}$ (where p,q,r unknown figures, which we should find) is perpendicular to any plane vector α, i.e. $\overline{a}$ and $\overline{b}$. The coordinates is found from the dot product condition of null equality $\overline{n}$ with vectors $\overline{a}$ and $\overline{b}$ from the following equations $\begin{cases}\overline{n}\cdot\overline{a}=0,\\ \overline{n}\cdot\overline{b}=0;\end{cases}$

$$\begin{cases}a_1p + a_2q + a_3r = 0,\\ b_1p + b_2q + b_3r = 0.\end{cases}$$

This system has an infinitely many solutions, since there are uncountable perpendicular vectors of plane α. Let us express, for example, from coordinate system p and q through r, we choose nonzero vector, $\overline{n}\{p(r);q(r);r\}$, for r we take some figure (normally we take the figure without any fraction or radicals in coordinates). Then, we introduce rectangular axes with the beginning in the point D.

$B(3;3;0)$; $E(3;0;1)$; $D_1(0;0;4)$.

$\overline{BD_1}\{-3;-3;4\}$; $\overline{BE}\{0;-3;1\}$

Let $\overline{n}_1\{p;q;r\}$ — normal vector to the plane BED_1

$$\begin{cases}\overline{n}\cdot\overline{BE}=0\\ \overline{n}\cdot\overline{BD_1}=0;\end{cases}\quad\begin{cases}p\cdot0+q\cdot(-3)+r\cdot1=0,\\ p\cdot(-3)+q\cdot(-3)+r\cdot4=0;\end{cases}\quad\begin{cases}-3q+r=0,\\ -3p-3q+4r=0;\end{cases}$$

$r = 3q$; $p = 3q$; $\overline{n}_1\{3q;q;3q\}$.

Let $q = 1$, то $\overline{n}_1\{3;1;3\}$.

Normal vector (vector, perpendicular planes ABC) $\overline{n}_2\{0;0;1\}$

$$\cos\alpha = \frac{3\cdot0+1\cdot0+3\cdot1}{\sqrt{3^2+1^2+3^2}\sqrt{0^2+0^2+1^2}} = \frac{3}{\sqrt{19}};\ \alpha = \arccos\frac{3}{\sqrt{19}};\ \text{Answer: } \arccos\frac{3}{\sqrt{19}}.$$

Of course, the entire set of proposed solutions was submitted by more than one student, but each of them has found the solution without any assistance from the teacher.

An analysis of the personal-oriented learning theory has shown the need to leave many of the usual pedagogical habits, which interfere with the successful education of children. One of those habits is the tendency to compare the "failure" of some students to other students' success. It turns out that such a comparison does not always produce the desired effect for some students. As a result of this comparison, weak students develop a sense of insecurity in their abilities, and the strong students develop a sense of pride in their activity.

Japan is demonstrating the antipode for this comparison in all spheres of human activity. Experience of the teachers in Japan shows that one of the basic principles for learning and educating is the inculcation of the idea that the person should always compare himself with himself, not with others, and strive to become better than he was yesterday. Such approach is essential in Japanese adult life too. «Nobody says there»: Look at Misha, he behaves himself well» or «He is good at solving problems». Instead they say: «Yesterday you were better than today», «Today you do better than yesterday and tomorrow you will manage to make it even more successful». Studies have shown that, using this approach, the Japanese did not suffer from coro-

nary heart diseases, and especially heart attacks. This principle is aimed at quite attainable goal of improving themselves, this will reduce the number of internal and external conflicts and promote good health» [7; 16–17].

The technology of person-oriented learning as much as possible helps to ensure that the teacher had no reason to oppose the progress of one student to the success of other.

The study of this problem allowed us to identify the following objectives in the implementation of educational and developmental mathematics learning, and reveal the activities of teachers:

– Methodically ensure the learning activities of students on understanding, disclosing educational and developmental opportunities generated for the new concepts;
– Teach students to analyze the stages of their activities during the implementation of proposed mathematical problems;
– Provide and develop the interest to study the lesson;
– Consider and develop the activities of the students on interpreting the teacher's guidance (during the lesson) in the conscious, subjective actions of the students;
– Develop the skills of control and self-control of the students in educational activities and communication;
– Define the content and form of control for all stages of the learning process.

Thus, the success in the education and development of students can be achieved by the teacher who will provide various ways for the intellectual and spiritual development, taking into account the interests and abilities of every student.

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Қ.Ғ.Қожабаев, Р.С.Ғабдуллин

Тәрбиелеу мен дамытудың мақсаттары — математиканы оқыту үрдісінің маңызды компоненті

Мақалада педагогикалық мақсат қою мәселесі қарастырылды. Заманауи зерттеулер нақты оқыту үрдісінде мақсат негізгі фактор, мұғалімнің барлық педагогикалық тәсілдерді бір жүйеге біріктіретін, әркайсысының орнын анықтайтын негіз болатыны айқындалды. Білім беруді ізгілендіру тәрбиелік және дамытушылық мақсатты бірінші кезекке қояды, бірақ кейбірі тәрбиелік пен дамытушылық мақсаттардың айырмашылығын сезінеді. Авторлар педагог мақсат қою үрдісіне барлық жауапкершілікпен қарайтын оқытудың тәрбиелей-дамыту моделін ұсынып отыр. Оқыту үрдісі барысында мұғалімнің барлық ынтасы әрбір оқушының жеке мүмкіндіктері мен қызығушылығын анықтауға бағытталды.