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The Role of the Subject "Mathematics" Content in the Learning Motivation

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Abstract--- *The future of any country depends on the quality of education, in particular, mathematics. This paperrepresents an investigation of the possibilities of using motivation, which is one of the main conditions for improving the quality of teaching mathematics.Educational motivation, as a particular type of motivation, is determined by many factors: the educational system, the organization of the learning process, the subjective characteristics of a student and teacher. In our opinion, the factor associated with the very specificity of the subject matter "mathematics" remains insufficiently studied. Experience has shown that practice teachers and beginning teachers underestimate the role of motivation in teaching mathematics.They unconsciously or quite consciously skip the stage of motivation when introducing mathematical concepts, studying theorems, etc., not seeing the potential of the subject matter for the implementation of motivation.The purpose of the study is to identify the capabilities of the subject matter "mathematics" in the implementation of motivation, as well as the pedagogical conditions for preparing future teachers for its implementation. The research methods for this problem are the theoretical analysis of the knowledge of this issue, questionnaires, overt observation. The study showed that students and beginning teachers knowing the general techniques and methods of motivation do not see the potential possibilities of the subject of mathematics and specific topics for its implementation.At the same time, we have established that motivation can be carried out at any stage of training: by introducing mathematical concepts, algorithms, studying methods of action, methods for solving problems and theorems. Improving the training of future mathematics teachers is associated with the development of mathematical, pedagogical and methodological thinking of students, allowing motivation to introduce to study mathematics as a subject.To do this, in the classes on the teaching methodology, it is worth to purposefully teach the methods of motivation for educational activity in all substantive lines of the school course in mathematics to supplement the training content with courses on the choice of "Methods of student motivation", "The role of motivation in teaching mathematics", "Motivation for learning through the content of the subject.*

Keywords---*Teaching Motivation, Subject Matter "Mathematics", Methods Of Teaching Mathematics, Future Mathematics Teachers, The Importance Of Motivation In Teaching Mathematics.*

I. INTRODUCTION

One of the main conditions for improving the quality of teaching mathematics is motivation. It has a significant impact on the internal state of a person, his/her satisfaction with the results of his/her own activities, on the ability to perform certain actions, including educational ones [1].

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The psychological foundations of motivation are disclosed in the scientific research of domestic and foreign scientists A. Maslow, J. Kuhl, L.S. Vygotsky, and K. Levin.Motives are considered by them as stable manifestations of a human personality, stimulating him/her to activity, and motivation is defined as a set of motivating factors that reveal the activity of an individual [2, 3, 4].

Researchers were interested in the personal view of pupils and students on their own motivation [5], motivational factors that influence the increase in academic performance [6, 7].

The pedagogical conditions for the activation of the motivational sphere of students are defined in the works of Russian scientists G.I. Schukin, L.M. Friedman et al.In their opinion, the selection of the educational material content provides an individual educational trajectory of a student, an individual approach to the design of educational activities, the choice of teaching methods at each stage of educational activity and the nature of the interaction between the subjects of the educational process [8].

Educational motivation, as one of the types of motivation, is influenced by the educational system, the organization of the learning process, the subjective characteristics of a student and a teacher, etc.We dwell on one of the little-studied factors based on the specifics of the subject “mathematics”.

Observations and pedagogical experience show that the role of motivation in teaching mathematics is underestimated. Teachers often miss the stage of motivation when introducing mathematical concepts, studying theorems, methods of action, and methods of solving tasks without using the potential features of the subject matter.

The purpose of the study is to identify the role of the content of the educational material in the motivation of learning.

II. METHODS

The research methods of this problem were the theoretical analysis of the knowledge on this issue, questioning, overt observation, analysis of the creative activity products. The study involved students and graduates of the teacher education department of the N.I. LobachevskyInstitute of Mathematics and Mechanics, and also students of the Volga Centre for Advanced Studies and Professional Retraining of Education Workers of Kazan Federal University.

At lectures and practical exercises on the methodology of teaching mathematics, methods, techniques and means of increasing the motivation of students that can be used by future mathematics teachers in their upcoming professional activities are studied. Below are some of them:

- Motivate by example;
- Show interest in the student’s position;
- Demonstration of the practical application of mathematical knowledge [9, 10];
- Emphasize the achievements of students, praise them for successful assumptions, highlight non-standard methods of solution [11];

- Use various forms of an educational organization in lessons [12];
- Offer students feasible study assignments, and clearly articulate homework [13];
- Organize mutual verification and mutual evaluation of written works and answers at the blackboard;
- Encourage students who are faster than others in completing the proposed tasks.

III. RESULTS

The teacher's professional standard defines competencies that increase the motivation for student learning. A teacher must:

K1) promote the formation in students of positive emotions from mathematical activity;

K2) form the idea of students that mathematics will be useful to everyone, regardless of the chosen speciality;

K3) facilitate the preparation of students for participation in mathematical olympiads, contests, research projects, student conferences;

K4) recognize and maintain high motivation, run circles, optional and elective courses;

K5) to achieve that in any lesson in the classroom and when doing homework, each student receives a result in solving at least one problem [14].

Assessment of the listed competencies on a hundred-point scale (%) for students and teachers with various pedagogical experiences is presented in table 1.

Table 1: Competencies Assessment

Competencies	*Bachelors (4-5 courses)*	*Teachers (work experience - 1-3 years)*	*Teachers (work experience - 5 and more years)*
K1	50	50	100
K2	10	50	100
K3	10	10	100
K4	10	10	50
K5	10	50	100

Beginning teachers have difficulties in forming positive emotions in students in mathematics lessons, in forming ideas about the importance of mathematics in life, in ensuring that each task can be correctly solved duringa lesson and at home. They do not know how to properly prepare students for participation in mathematical olympiads and competitions; run circles and elective courses.

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The possibilities of the subject of mathematics for the implementation of motivation were studied. Students studying the methodology of teaching mathematics (28 people) were asked the question: how can you motivate 6th-gradersto study the topic “Proportions”?

Here are some typical student responses:

- show how this concept will be applied;

- compare two relationships;

- rely on the subjective experience of pupils and find out how they understand the word "Proportions";

- offer a feasible task for direct and inverse proportionality;

- start directly with the topic announcement.

It should be noted that a significant part of students intends to study this topic in an abstract-deductive way. A small number of students offer to rely on a practical task. But at the same time, they find it difficult to give an example of a specific problem or situation that necessitates the introduction of a new concept.

To determine the idea of the importance of motivation in teaching mathematics, we conducted a survey of students of 1–5 courses (72 people) and working mathematics teachers (59 people) with various lengths of service.Respondents were asked to indicate the length of service and to rank the following factors affecting the quality improvement for teaching mathematics in decreasing order: timely monitoring; cabinet equipment; the desire of apupil himself; motivation; class discipline; role-playing methods; an individual approach to each student; pupil’s interest in the subject; other factors.

We were interested in answers where respondents give the first three places to the motivation factor. The survey results are shown in Table 2.

Table 2:The motivation ranks

Rank	The number of students of the year (% to total number)					Teachers
	I	II	III	IV	V	
1	15	8	20	30	23	25
2	15	12	25	20	14	31
3	25	20	25	20	14	18
4 and lower	45	60	30	30	49	26

Thus, the significance of these factors undergoes changes as students move from year to year of education. At the same time, leading positions are given to motivation.A third of the teachers surveyed give motivation a second place (which corresponds to methodological expediency), a quarter gives it first place. More than half of the teachers surveyed also assign motivation to one of the leading roles.

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As part of the study, the lessons of trainees and beginning teachers were visited and analysed, their reporting documentation, self-examination sheets, lesson videos, results of control assessments of schoolchildren were studied.

Observations of the lessons showed that trainees and beginning teachers do not fully master the methods of motivation, but, precisely, do not use the possibilities of the content of the subject “mathematics” for its implementation. Here are examples of unrealized learning situations.

In a mathematics lesson in grade 7, the teacher immediately formulates the topic of the lesson: “Linear function” and introduces its definition without preliminary work with pupils. The topic provides an opportunity for pupils to independently formulate it. After constructing several points belonging to this function, pupils see that they are located in one straight line and offer the name of the function. In this case, the teacher “missed” the opportunity to motivate children when they are learning a new concept.

When studying the topic "Actions with fractions" in grade 5, and demonstrating a rational solution to the equation $\frac{1}{7} \cdot x = 11$, the teacher suggests pupils multiply both sides of the equation by 7, without focusing on the need to get a factor equal to unityfor the unknown value: $7 \cdot \frac{1}{7} = 1$. An opportunity to motivate finding a new mode of action was “missed”.

It is worth to motivate the finding of a solution why zeros at the end of a decimal fraction are insignificant, presenting this fraction in the form of an ordinary fraction, which can be reduced, etc.

For our study, the ability to carry out motivation based on the very content of the subject “mathematics” is significant. Teachers do not know how or do not consider it necessary to motivate upon the introduction of new concepts, theorems, methods of action, the choice of a method for solving the problem. Special classes should be given to the formation of appropriate skills.

IV. DISCUSSION

We consider examples of motivation when studying some of the structural elements of mathematics in classes on the methodology of teaching mathematics.

1) *Introduction of new concepts.*

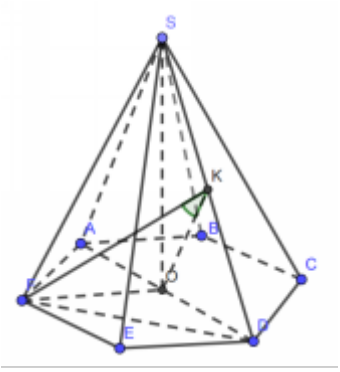
- Introduction of the "Logarithm" concept in the 11th grade. The lesson begins by solving the equation $4^x = 16$.This equation is solved by reducing both sides of the equation to power with the same base equal to 4. Pupils are then asked to solve the equation $4^x = 7$.The considered method cannot solve it. But the equation has a solution, which is shown graphically. We say that the unknown is "an index of power to which you need to raise the number 4 to get 7". You must enter the appropriate term. Thus, the introduction of a new concept is motivated.

- The introduction of a new concept “Proportion” at the 6th grade is useful to start with an expedient task. The teacher offers a situation in which it should be noted that the time of movement and the distance travelled is directly proportional at a constant speed of movement.

- Introduction of a new representation of the quotient *a* and*b* $(a: b)$ in the form of a fraction $(\frac{a}{b})$.We can also start with a task.Thus, it becomes necessary and possible to present the quotient in a new form. Pupils notice that these two characters are combined on the corresponding calculator key (÷).

2) *The solution of geometric problems.*

The problem of finding the angle between straight lines in space is proposed. When determining the angles between crossed straight lines, teachersthen pass to the angles between the lines parallel to the given ones, and then, after considering the corresponding triangles, they rely on the cosine (sine) theorem or use the area formula for the orthogonal projection of a polygon.



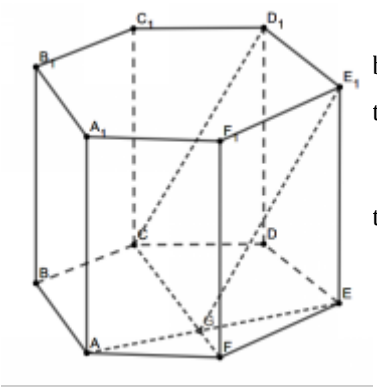
Task 1 In the regular hexagonal pyramid *SABCDEF*, the lengths of the sides of the base of which are 1, and the lengths of the side edges are 2, the point *K* is the middle of the edge SD. Find the cosine of the angle between the straight lines *AS* and *FK*.

Solution. From considering the angle between the straight lines *AS* and *FK*,we move on to considering the angle between KO, the middle line of the triangle ASD (parallel to AS) and the line FK. Since the regular hexagon lies at the base of the pyramid, the segment FO is equal to its side, that is, FO = 1.Hence KO = AS/2=1

To find *FK*, consider the isosceles triangle *FSD*, in which *FS* = *SD* = 2, and *FD* = $\sqrt{3}$(smaller diagonal of a regular hexagon with side 1). Using the formula for the length of the median of a triangle, we find $FK = \frac{1}{2}\sqrt{2FS^2 + 2FD^2 - SD^2} = \frac{\sqrt{10}}{2}$

And then according to the cosine theorem $\cos(\angle FKO) = \frac{FK^2+KO^2-FO^2}{2FK \cdot KO} = \frac{\sqrt{10}}{4}$.

Answer:$\frac{\sqrt{10}}{4}$



Task 2. In the regular hexagonal prism $ABCDEFA_1B_1C_1D_1E_1F_1$, the base side lengths of which are 1 and the lengths of the side ribs are 2, find the angle between the planes BA_1D_1 and AA_1E_1.

Solution. Quadrangles BA_1D_1C and AA_1E_1E are sections of this prism by the planes BA_1D_1 and AA_1E_1.

Let *G* denote the midpoint of the segment *AE*. Since the segments *BA*,D_1E_1 and *CF are* perpendicular to the plane AA_1E_1 (each of them is perpendicular to AA_1 and *AE*), the trapezoid AA_1E_1G will be the orthogonal

projection of the trapezoid BA_1D_1C to the plane of the section AA_1E_1E. In an isosceles trapezoid BA_1D_1C lateral sides $BA_1 = CD_1 = \sqrt{1+4} = \sqrt{5}$, and the bases $A_1D_1 = 2$, $BC = 1$.

In trapezoid BA_1D_1C,height $h = \sqrt{CD_1^2 - \left(\frac{A_1D_1 - BC}{2}\right)^2} = \sqrt{5 - \left(\frac{2-1}{2}\right)^2} = \frac{\sqrt{19}}{2}$, and the area is $S_{BA_1D_1C} = \frac{A_1D_1 + BC}{2} \cdot h = \frac{3 \cdot \sqrt{19}}{4}$.

In a rectangular trapezoid AA_1E_1G bases$A_1E_1 = \sqrt{3}$, $AG = \frac{\sqrt{3}}{2}$, height $AA_1 = 2$, square $S_{AA_1E_1G} = \frac{A_1E_1 + AG}{2} \cdot AA_1 = \frac{3 \cdot \sqrt{3}}{2}$

According to the formula:$\cos\varphi = \frac{S_{\text{пр}}}{S} : \cos\angle\left(BA_1D_1,\ AA_1E_1\right) = \frac{S_{AA_1E_1G}}{S_{BA_1D_1C}} = \frac{3\sqrt{3}}{2} : \frac{3\sqrt{19}}{4} = \sqrt{\frac{12}{19}}$.

Answer:$\arccos\sqrt{\frac{12}{19}}$.

As we can see, the first problem is solved through the cosine theorem and the second through the formula of quadrangle orthogonal projection area. Making a decision, teachers show only “how” to act, without explaining “why”. The solution itself remains “not transparent” to pupils. Until the last step, the pupils do not know why they are doing something: why they look at triangles, find their medians, this or that trapeze, and find their areas, etc.Essentially, all actions taken are not motivated for pupils. Only at the end,the idea of solving the problem becomes clear. And the main thing in the process of solving the problem should be the answer to the question: "how to understand where to start?"

Obviously, the motivation of a particular method of solving the problem is closely related to the need for analysis. Otherwise, pupils are forced to act by trial and error.

V. CONCLUSIONS

The study shows that students and beginning teachers knowing the general techniques and methods of motivation do not pay attention to the motivation of learning mathematics as a subject. They do not see the potential possibilities of specific topics for their implementation. They often build an unmotivated course of solving a problem, while pupils need to master the way to solve this class of problems, rather than the course of solving a specific problem.

It was revealed that the motivation of learning mathematics as a subject can be associated with the introduction of mathematical concepts, algorithms, methods of action, methods for solving problems, and studying theorems.

Improving the training of future mathematics teachers should be aimed at the development of mathematical, pedagogical and methodological thinking of pupils, which allows motivation of mathematics as a subject. In the classes on teaching the methodology, one should purposefully teach methods of motivating educational activity in all the substantive lines of the school course in mathematics and include in the curriculum for training future teachers of mathematics courses on the choice of "Methods of pupil motivation", "The role of motivation in teaching mathematics", "Motivation for learning through the content of the subject", etc.

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