On the Problem of Values Formation in the Context of Informatization of Mathematical Education

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Abstract. The article discusses the possibility of the formation of various types of values in the process of teaching mathematics in the context of informatization of education. It is shown that under the conditions of traditional education, the enormous educational potential of mathematics is mainly used to solve cognitive problems, and the problem of forming values is left without attention. What opportunities does informatization of education create to solve this problem? The issue is discussed for the cognitive, aesthetic, moral, mental, universal and national values. It is shown that mathematics has great potential in the formation of all these values, and the purposeful use of IC tools can increase the efficiency of solving the problem. The idea of value-oriented teaching of mathematics is put forward as an important mean of forming values, which acquires special significance in the conditions of informatization of education.

Keywords: Mathematical education, informatization of education, cognition, value, value orientation, value-oriented teaching.

Introduction. Values are the most important components of the human inner world. Preferences, beliefs, goals, needs, choices, behavior, human actions in many respects depend on values and value orientations. Family, surroundings, church and school are the main links in the formation of values. The school is crucial in terms of the commonality of values, value orientations, and the value system of students, inclusion of national and universal components in them, solution of common problems of moral and aesthetic education, formation of a single system of cognitive values. For this reason, the formation of values is one of the main problems of general education.

For life activity, a person needs knowledge of the world, its objects and phenomena. Together with cognition, it is no less important for a person to evaluate these objects and phenomena, which basically becomes the stimulus or cause of human activity. It follows from what has been said that a comprehensive school should deal with not only cognitive, but also axiological problems, along with the knowledge of various objects and phenomena, it should also teach students and evaluate them.

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From this point of view, adopted in some circles, the approach of conveying a solution to this important problem is puzzling [1]. On the contrary, it is a school subject that is able to compare the cognition of an object and its value, which will give the object, its knowledge new shades, motivate the need for its knowledge.

It should be noted that each school subject has a special potential for the formation of values, and it solves the raised problem in its own way. What is the educational potential of mathematics in this direction?

Mathematical education is capable to perfectly fulfill the functions of the formation of cognitive, aesthetic, moral, national, universal and other values which also makes it possible to give a real content and a new charge to the modern trend of humanization of mathematical education [2, 3].

But how computerization of mathematical education create in this direction is reflected in the problem of the formation of values, which are its opportunities? Having carried out a comprehensive analysis of the available scientific and methodological works on the use of ICT in the process of teaching mathematics, L. Martirosyan notes: "Modern studies in the field of ICT use do not pay due attention to the specifics of teaching a subject of mathematics, the development of a student's personality, and its socialization in a modern information society" [4, p. 24-25].

IC tools and training sites, specialized software products are mainly used as a means of increasing the effectiveness of teaching mathematical material. But the issues of education, the formation of values, value orientations of students mainly go beyond the tasks.

It is clear that informatization as an educational tool is multi-layered, and the capabilities of ICT in the educational process and the formation of values are primarily determined by the choice of tools. I note that one of the extreme cases of such a toolkit - distance learning – which has been imposed on the general educational and university system in the last two to three months. The issues of education, the formation of values, value orientations of students mainly go beyond the scope of the tasks of distance learning. On the platform of the FB for Teachers "Mathematical Education" I organized a discussion on the topic "Distance Learning: Advantages and Disadvantages". Interesting results were obtained that are worthy of further detailed study. But today it is already obvious that distance learning, in fact, does not carry out the educational function and a function forming of values. It follows that in the conditions of informatization of mathematical education, the solution to the problem of forming values is determined by the choice of IC tools.

The solution to the problem is largely due to the age and individual characteristics of students, which affects both the formation of levels of values and value orientations, as well as the possibility of mastering and using ICT tools [5].

As noted above, mathematical education has great potential for the formation of various types of values. Let us consider the corresponding process for some of them in the context of informatization of education.

1. Cognitive values. Cognition or knowledge is the most important value without which it is impossible to imagine the existence of the human species. At the same time, cognition is the kind of human value where mathematics is manifested in all its

glory: mathematics is designed to “read the golden book of nature”, cognition, expression, understanding, justification and application of forms and quantitative relations of objects of the surrounding world. At the general education level this task is carried out through the process of teaching mathematics.

Computerization of education can affect the implementation of these functions in different ways and on the formation of levels of mathematical knowledge [6]. If we are talking about the accumulation of knowledge, then IC tools best serve this purpose. They also make it possible not to load memory with an "extra" supply of mathematical knowledge, which has both positive and negative consequences. It is difficult to assess the role of IC tools in mathematical cognition, in formation of a level of understanding. It is well known that pure knowledge, just possession of it, being is the lowest level of knowledge in terms of the mathematical education can have a negative value, if not accompanied by processes of understanding and application. In that case in the educational process, the phenomenon of cramming is remarked with its negative consequences, which are well known.

IC tools can influence this phenomenon in different ways. While teaching geometry, they make the representations of planimetric figures and, especially, spatial figures, their various transformations and sections more visual and figurative, and also contribute to the understanding of the questions posed. The same applies to graphical representations of individual algebraic formulas. However, when it comes to the structure of the algebraic material, the logical interconnection of its parts, which provide the process of understanding, IC tools do not play a special role. They are here keeping the external side of objects and phenomena in the spotlight, do not give an opportunity to stop, get into their essence, to understand, justify, argue and show the main charm or “art” of the mathematical approach, which is called “proof”.

Nevertheless, in the learning process, one can find forms of evidence presentation, for which IC tools create additional opportunities to increase the effectiveness of training. A similar interesting example is the tree-like proof method proposed by Gerhard Gentzen [7].

To present the proof in the usual way, we sequentially mark the steps of the proof, their justification, and come to the proof. Here, the process is delayed, the proof does not receive a uniform and explicit form, which complicates perception. Gentzen proposes to present the proof in the form of a tree, where both the complete proof and the steps to its reduction are clearly visible. For educational purposes, we propose, in parallel with the proof, to bring also the names of the steps leading to the proof, which will serve as a justification or argumentation of the proof.

This technique successfully contributes to the development of both logical thinking and speech culture of students. It is especially effective in organizing the repetition of training topics. Indeed, the systematic and consistent application of the steps of argumentation, the marking of their names, achieves serious success in the direction of mastering and consolidating the educational material. The only difficulty lies in memorizing these properties, especially at the initial stage of learning the material. In the conditions of traditional teaching, the student must resort to the textbook every time, which technically contains some difficulty and, therefore, becomes boring. IC

tools make it possible to put the appropriate link next to each property and immediately, without unnecessary effort, just by pressing a button, get its formulation. A similar technique is used in the textbooks [8], And its effectiveness is shown in [9]. For example, here is illustration (Fig. 1) for the proof of the property of equality of expressions equal to the same expressions from the textbook [8, 2006].

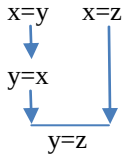
Proof	Argumentation
	conditions symmetry of equality, link transitivity of equality, link

Fig. 1

We also add that the usual representation of proof in the form of a Gentsen tree presents some difficulties in terms of illustration and ensuring their external aesthetics, which can also be successfully overcome through the use of IC tools.

2. Aesthetic values. Generally, the process of teaching mathematics makes it possible throughout the entire educational process to cover the aesthetic aspect of development of students. At the lower educational levels of education aesthetic in mathematics manifests itself in its applications, in the external form of subjects. Subsequently, parallel to increasing the educational level at other levels of instruction visualization gradually gives way to abstract mathematical material, revealing in it signs of mathematical beauty, its internal aesthetics.

IC tools provide ample opportunity to present both the external aesthetics of mathematical objects and a number of objective signs of mathematical beauty [10]. In this framework you can with great success include images of geometric figures and bodies, graphs and various properties of functions, part and percent of number, symmetry, comparisons, rhythm, unity of manifolds and some other objective signs of mathematical beauty. But the internal aesthetics of mathematical objects and subjective signs of mathematical beauty [3] would seem to remain outside the possibilities of presentation by tools of IC.

As a representation of the external aesthetics of mathematical objects, we can cite the well-known example of Archimedes about the connection between the volumes of a regular cylinder, a sphere inscribed in it, and a cone, for an aesthetic illustration of which, an excellent opportunity is created by IC tools.

IC means also provide ample opportunity to illustrate symmetry. Moreover, the research framework can include objects and phenomena that occur both in nature and in mathematics courses and other academic disciplines. It also increases the possibilities of organizing independent and creative work of students. And the presence of an aesthetic element, in conjunction with the means of IC, makes it possible for the teacher to record serious successes. The same applies to comparison and especially to the golden ratio. IC means make it possible to consider from these

positions, for example, an important and significant figure such as the five-pointed star, to reveal that its individual parts are golden triangles, to turn to Pythagoras and get acquainted with the numerous applications of a five-pointed star.

IC tools can also be successfully used in illustrating the aesthetic appeal of other properties of scientific beauty, which makes the learning process more interesting and effective.

IC tools also provide ample opportunities for expressing the aesthetic appeal of concepts, theorems, problems, their proofs, solutions and other mathematical objects. Let us discuss, for example, an illustration of the Pythagorean theorem using IC tools.

Consider the connection between the sum of squares $a^2 + b^2$ of sides a and b adjacent to any angle α of an arbitrary triangle with the square c^2 of the side opposite to this angle. The comparison conducted using IC means allows the student to clearly see that if the angle is acute, then $a^2 + b^2$ > if obtuse, then $a^2 + b^2$ <, and only if the angle is right then $a^2 + b^2$ =.

3. Moral values. Mathematics, its teaching process also have great potential for formation of both positive and negative moral values [2]. Among the school subjects mathematics is perhaps more distinguished than others by the multilevel student attitude to the teacher, to the textbook, and specifically to mathematics. It must be admitted that most math teachers also show unequal attitudes towards different layers of students.

In the bilateral relationship of teacher-student the principles of love, kindness, duty, tolerance and other moral principles often are violated, the most obvious being violation of the principle of justice. Here equalizing and distributive principles of justice are basically interchanged, the principle of Schopenhauer's double injustice appears [11]. In the student community cheating is being accepted as friendliness or mutual assistance. As a result, envy, intolerance, an inferiority complex, and other moral defects prevail in the educational environment [2].

What can change in this case the informatization of mathematical education? On the one hand, it can deepen the injustice in the educational sphere due to the inaccessibility of expensive IC tools for some groups of students. A math teacher can smooth this out by focusing on the IC tools available in the classroom. On the other hand, new accents appear in the question of assessing knowledge of mathematics.

I remember when in Soviet schools they started teaching the logarithmic rulers, the performance indicators of students changed dramatically. Therefore, in the new conditions the ideas about knowledge of mathematics also significantly change. It may be including and making significant the use of IC tools. And in the conditions of informatization of all public life this trend can become significant and also contribute to increasing interest in mathematical education. It is easy to understand that the use of IC tools can smooth out the above tendencies of violation of the roles of distributive and equalizing types of justice and the manifestation of double injustice on the part of teachers.

4. Mental values. It is well known that the role of the process of teaching mathematics in the formation and development of thinking, attention, memory, volitional qualities, imagination and other mental phenomena [9] is important. What opportunities does informatization create in the field of the implementation of this role of mathematical education?

The role of IC tools in the formation and development of spatial thinking seems indisputable. It can manifest itself at all levels of education and not only increase the effectiveness of instruction, but also significantly increase students' interest in mathematics, especially in geometry.

It will not be easy to attract IC tools into the field of logical thinking. It may be possible to use IC capabilities to create schematic images of proofs mechanisms, reasoning, and other logical receptions that will make it obvious to students how the mechanism of deductive conclusions used in proofs of theorems work. This can best be used by, for example, in Gencen evidence schemes which unfortunately remained out of the attention of specialists [9].

It seems that IC tools can open up new possibilities for imagination. However, human thought, imagination is radiant in conditions of freedom. They work much faster than the fastest tools of IC, which can often interfere with freedom of thought and imagination.

Above, connection of IC tools with memory was noted. It should also be noted that their presence can significantly weaken efforts aimed at developing memory, as well as attention and different volitional qualities which are a natural result of the process of traditional teaching of mathematics. However, it must be admitted that one of the basic educational services of mathematics, its charm, which is characterized as "training of thought" and is carried out through periodic processes of mental voltage, is associated with the virtual nature of mathematical knowledge and seems to disappear in the conditions of informatization of education.

The aforementioned is also confirmed by education specialists who consider the main difficulty in the process of informatization of the educational environment "to be inaction in the process of mastering the data, since the creators of the programs have a desire to make their material ordinary and not requiring much effort" [12].

5. Universal human values. Mathematics and mathematical education are the most important sources of the formation of universal human values. The highest universal human value of mathematics is mathematics itself. With its huge role in development of science and technology, in formation of the human psyche, in cognition, in the search and substantiation of truth, in the compilation of beauty and harmony, mathematics has proved the universal nature of its values. It has unrivaled value as a "language created for reading the golden book of nature" and, therefore, as an indispensable means of studying nature. This language is understood by all peoples and is passed down from generation to generation as an essential element of universal human culture, and is taught in the educational systems of all countries. The point, straight line, plane, number, size, and other heroes of school mathematics, mathematical speech are familiar to all students of world. They give new qualities to

knowledge, the culture of speech, fill the spiritual world of a student with the light of truth.

Informatization significantly increases the possibility of representing the universal nature of mathematics and mathematical education. A variety of specialized software, electronic resources and training sites make it possible to quickly get answers to various mathematical questions, communicate with various events related to mathematics, the life and work of famous mathematicians, use scientific and methodological literature, native and foreign literature related to the teaching of mathematics, thereby giving a new charge to the universal essence of the process of teaching mathematics.

6. National values. Mathematics, being a transnational, universal phenomenon, has great potential for the formation of national values, the expression of the national through the educational process. The main opportunities for representing the national are created by building an applied environment of teaching mathematics based on national culture. Both in the presentation of theoretical materials of school mathematics, and in the system of tasks, one can successfully include materials on history, historical and modern territories, geography, national achievements of a given country, known people, what will form in students a feeling of national dignity, love for the homeland.

Here IC tools can play an indispensable role. They provide an opportunity to quickly and effectively present not only quantitative data on national values, but also to saturate the lesson with the presentation of valuable material of a qualitative nature about objects having these quantitative relations.

7. Value-orientation teaching. IC tools provide a wonderful opportunity for the implementation of training aimed at the formation of marked and other values through the value-orientation teaching mathematics [13]. This approach involves not only consideration of the value of a particular object in separate educational mathematical materials. It establishes existence of an appropriate value, emphasizes the value of an object, compares it with other similar objects, and, thus, also actually solves the issue of forming a value orientation.

The 13th Congress of Mathematical Education was held in Hamburg in 2016. The sections were varied the reports were fascinating. While reviewing the materials for the current day, I noticed an interesting talk that should have been presented by an influential multinational group of authors: "Algebra in Arithmetic". I chose this report and at the end I asked the speaker a question: "What can you say about algebra in a natural language, say, in English?" The speaker looked at me in surprise and ater consulting with the co-authors, said that the question was not clear. After some clarification, I realized that the issue was outside the scope of the authors' interests. In fact, it is very interesting and has both pedagogical and epistemological and value significance. Let's give an example.

In the textbook [8, 2006], for example, in the lesson's on constants and variables, Tigran the Great and Tigran Petrosyan are noted as examples of constants used in the natural language. Value-oriented training requires taking advantage of the opportunity

and, as national values, to focus on the achievements of two famous Armenians - the powerful Armenian king and the world chess champion which can be done best by using IC tools.

The approach deepends on consideration of problems on the concept of a variable of the following nature: How many values can the pronoun “he” take in the next sentence? "He was the Armenian marshal of the USSR". Using IC tools, we can easily find the necessary data on the respective marshals and provide the students /or simply entrust the action to the students themselves.

It is just as interesting to learn about variables or unknowns within the framework of the same lesson, where personal pronouns and nouns are considered as unknowns used in natural language. Value-based learning allows you to give students some idea of the formation of concepts in natural language and their meaning and to consider from the same point of view two most important concepts of the mathematical language - a number and an unknown or a variable.

In essence, this comparison of the processes of the emergence or formation of concepts, in general, includes a great aesthetic potential, since it satisfies the condition of such an important sign of scientific beauty as the unification of diversity or the sign of Francis Hutcheson. Perhaps the corresponding aesthetic influence on students here occurs subconsciously. But value-based learning allows you to deepen it. You can give students some idea of the aesthetics of mathematics and note that here we are dealing with the beautiful, since the union expresses strength, solidarity, unity, knowledge and, therefore, it is beautiful. Doing all this without IC means is difficult and can be ineffective. And with IC tools, you can also provide some information about the aesthetics of mathematics, its history, and about Hutcheson.

In the end, we add that IC means make it possible to make the issue of the formation of values and value orientations the subject of the educational content of future mathematics teacher and for university education in general [9, 14, 15, 16].

8. Conclusions. Summarizing, we note that the process of teaching mathematics has great potential for the formation of various types of values, which acquires special nuances in the conditions of informatization of education, linking the solution to the problem with IC tools, age and individual characteristics of students, etc. The role of informatization of education in the formation of cognitive values is twofold. IC tools provide ample opportunity to present both the external aesthetics of mathematical objects and a number of objective signs of mathematical beauty. If we do not take into account the moral side of access to ICT resources, then their use can have a significantly positive effect on the formation of moral values. And in the case of mental values, the solution to the problem is due to the types of specific values. In the case of spatial thinking the role of ICT is certainly positive, and in the case of other mental processes there are both positive and negative consequences of the use of ICT. Mathematics education also has great potential for the formation of national and universal values, the implementation of which depends on the use of IC tools. The IC resources provide a wonderful opportunity for the value-oriented teaching through the mathematics learning process.

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