Ways and models of providing integration of information technology science with mathematical sciences

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Abstract. The results of scientific research on the application of information technologies to the educational system show that one of the most important problems in the educational process of higher educational institutions is the integration and classification of knowledge, with the aim of studying its theoretical, scientific and methodological aspects. If integration serves to strengthen the structural connection between different knowledge systems, to generalize them, to further enrich students' holistic perceptions of nature and society, then differentiated education provides students with in-depth knowledge according to their abilities and opportunities, and creates the basis of a project-based model of teaching.

1 Introduction

Reforms in the field of higher education in our society and informatization of the educational system require deep knowledge of the basics of computer science, revision of traditional teaching content, effective use of new pedagogical technologies. So, now it is appropriate to adapt the traditional forms and methods of teaching to computer capabilities.

One of the most important problems in the process of secondary special education is the integration and differentiation of knowledge. If integration serves to strengthen the structural connection between different knowledge systems, to generalize them, to further enrich students' holistic perceptions of nature and society, then differentiated education provides students with in-depth knowledge according to their abilities and opportunities, and creates the basis of a project-based model of teaching.

As it is known, secondary special education implies mastering of the fundamentals of general education subjects along with professional knowledge, skills and abilities. It is necessary to regularly develop critical thinking, logical memory and creative imagination in students for thorough assimilation of knowledge. In this regard, the science of information technology has great potential. Therefore, studying information technology science in a consistent, step-by-step manner and in connection with other subjects helps students to develop independent thinking skills.

In the secondary special education system of our country, a lot of scientific and research works dedicated to the improvement of information technology teaching have been

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conducted and are being conducted. In addition to studies on the integration of educational content (Yu.A.Kustov, M.N.Berulava, V.D.Semenov, L.D.Fedotova), a certain place has been allocated to this issue in studies not related to pedagogical integration (G.I.Ibragimov, I. Ya. Kuramshin, Yu. A. Kustov, Yu. S. Tyunnikov, R. Safarova, P. Musaev, H. Nazarova, R. Ahlidinov, I. Makukhina). During the following years, a number of monographs, scientific articles, educational programs related to this issue were published (V.S. Bezrukova, M.N. Berulava, V.D. Semenov, G.F. Fedorets, N.K. Chapaev, R. .Safarova, P. Musaev, H. Nazarova, R. Ahlidinov). A lot of attention is paid to this issue, especially abroad. An example of this is the research of American A. Blum, Jerome Bruner, G. Winthrop, R. Gagne, James Rutherford, R. Slavin, R. Stevenson and others. German V. Bretsinka, R. Winkel. H. Deppe Wolfinger, L. Klinberg, G. Neuner, K. G. Tamashevsky, French F. Best, Bulgarian M. Andreev, D. Lazerev, I. Santulov, Czech C. Mazyaj, V. Roglichek, Hungarian O. Mihai, A. Horvat and others also addressed the problem of pedagogical integration. It also shows that the integration of educational content is one of the most interesting, socio-pedagogical and practical issues.

With the change of the educational system and its content, the problem of ensuring consistency between the stages and types of education, applying it to the educational process, that is, considering it as a single integrated system, arises.

The following factors should be taken into account when solving this problem:

The first factor - the final stage of general secondary education - clarifying the content of mathematics in the 9th grade and justifying the purpose of its teaching (improvement of DTS).

The second factor is to show the relevance of mathematics in academic lyceums and technical schools to the mathematics course of general secondary education institutions, to show the criteria on which coherence is based, and to ensure coherence (at this stage, the extent to which coherence is ensured in secondary special education is analyzed).

The third factor is to determine the degree to which inter-subject and inter-disciplinary connections are reflected in the content of mathematics studied in secondary special education and to ensure inter-subject coherence (analysis of the connections of mathematics between types of education and ensuring its coherence with other subjects).

These factors include psychological, pedagogical, methodical and didactic issues that are important and need to be resolved in order to ensure consistency in mathematics education.

At the modern stage of scientific and technical development, special attention is paid to the promotion of mathematical knowledge. After all, mathematics is the theoretical basis of all scientific sciences and the practical basis of production in various fields. Therefore, development of students' mathematical abilities is one of the most important tasks of modern education.

In order to properly manage the continuous process of teaching mathematics, the teacher must know the laws, organizational elements, and sequence of actions of this process. To achieve this, it is necessary to understand the psychological characteristics of the emergence of knowledge, including mathematical knowledge.

Therefore, the content and process of education depends primarily on the age characteristics, level of knowledge, abilities and interests of the students, because these principles determine what kind of knowledge, at what level, and with what form, method and means of teaching is imparted at this or that age. [2,5,7].

2 Materials and methods

The continuous education system is based on the continuity of education, as a result of which a certain consistency is ensured among all types of education. The implementation of this process implies the provision of internal (intersubject, inter-chapter) and external

(interdisciplinary) coherence of subjects taught in each type of education, not only between types of education.

With the adoption of State educational standards for general secondary and secondary special education in the republic, the problem of coherence between these types of education was officially resolved, and on this basis, curricula and basic (model) curricula were developed for each subject.

It is known that these curricula not only express the content of the educational process and the topics of newly created textbooks of general secondary schools and academic lyceums, vocational colleges, which are the main links of continuous education, but also the knowledge that future young professionals need to acquire, taking into account the specific characteristics of educational institutions. , also determines the size and level of skills and qualifications. Therefore, it is not possible to separate the educational programs of mathematics in general secondary and secondary special, professional education. Several studies have been conducted in this regard. For example, P.I. Samoilenko stated that in post-school education, it is necessary to expand and deepen the knowledge, skills and abilities acquired in mathematics, as well as to further develop specific concepts and ideas. This shows that each student can easily transition from one type of education to another type of education, based on the provision of sequence, tracking, systematicity, interrelationship and coherence between the content, form and methods of education [96,189-194].

S.D. Bordyakova emphasized that the process of mathematical education is integral, the teaching of each subject should be completed and that it should not be returned to in higher education, and the successful implementation of educational programs in practice:

1. Training of mathematics teachers in pedagogical universities.
2. Quality textbooks.
3. Believes that it depends on person-centered education [14].

In our opinion, one of the most important indicators determining the consistency between the curriculum of general education subjects in general secondary education and secondary special education is their compatibility with the specialized curriculum. Therefore, ensuring the integrity of educational programs in each type of education is considered from the point of view of the integrity and continuity of the educational system, the integrity of the types and stages of education, interdisciplinary, interdisciplinary, and the integrity of theory and practice.

The concept of curriculum integrity is related to the concept of educational integrity and systematicity (Figure 1).

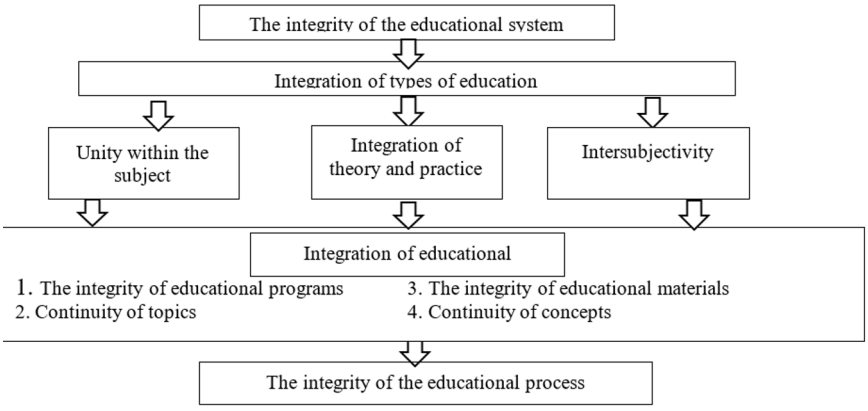


Fig. 1. Components of the educational system.

The principle of continuity and continuity of education noted in the picture allows us to show the types of the concept of continuity from the point of view of mathematics.

From the overall scheme of the education system's integrity and continuity, it is possible to comment on the organic links that apply to individual subjects, such as mathematics. In our opinion, the content of the curriculum for general mathematics subjects of special secondary educational institutions does not reflect the coherence shown in the above scheme. This has a negative effect on the teacher conducting the educational process organically and the student mastering the educational material as a whole. Therefore, the educational programs of mathematics subjects of secondary special education institutions do not fully meet the current requirements. Because in the curriculum: firstly, the age characteristics of the students are not taken into account (for example, the topics of mathematical induction, mathematical statistics and probability theory), and secondly, the lack of sequence and coherence of the topics (for example, the inclusion of a trigonometry chapter between the function derivative and function integral chapters or combinatorics, the lack of connection between the elements of probability theory and mathematical statistics), thirdly, the possibilities of vocational education were not taken into account (for example, both agriculture and medicine are taught on the basis of the same program). Therefore, taking into account the best practices, the development of science and technology, to review the sequence and content of the basic curriculum in mathematics, and to justify it pedagogically, and to create invariant curricula for each educational field based on that program and to test it in practice. the need to see has arisen.

The listed shortcomings indicate that the educational content is not selected correctly;

that the age of learners is not taken into account;

failure to organically place the selected (if correctly selected) educational content;

it was caused by not taking into account the need to teach the existing educational content with other similar, neighboring subjects.

It is known that the process of learning this subject will be complicated if the content of each subject is not coherent. Therefore, first of all, the coherence of the educational content, that is, choosing the set of knowledge that the student needs to learn, and placing it correctly (it is necessary to ensure that each new topic is logically related to the previous topics). Only then will it be possible to form a comprehensive, integrated system of knowledge in the student's memory. The factor that determines the result of this process is the model of logical connections that must be formed in the mind of the student.

Creating logical models that ensure the integrity of educational content and process, firstly, how science teachers approach the issue; secondly, it depends on the level of formation of the knowledge system in the minds of students.

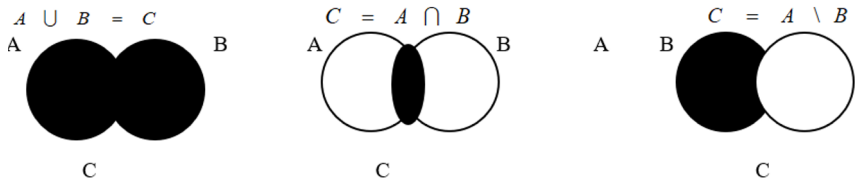
Logical models should be considered not only as a means of determining, showing and causing the relationship between the teaching materials of a certain subject, but also as a means of showing the degree of connection with other subjects. In addition, logical models show the logical unity of the educational subject, as well as the coherence of human activity, natural phenomena, and processes, and are a contributing factor to the improvement of the educational subject in accordance with the development of science and the requirements of the time. Accordingly, logical models serve as a basis for new logical models as a product of human creative activity.

Cohesive logic models are fundamentally different from other models, depending on the types, characteristics, and levels of logical connections, and the components of logic models are important in providing coherence between learning types.

Below is a discussion of the logical models used in the research to ensure the coherence of mathematics in general secondary and secondary special education:

1) MMM (Content-logical model). Students are presented with the following eight-coordinate axis scheme. The name of the subject is written in the center of the scheme, and properties, characteristics, their history, elements, types, etc., which fully reveal the subject, are written on the eight coordinates.

2) Euler-Venn circles model (on the topic of elements of set theory).



Such frameworks can be used to provide interdisciplinary coherence. Because it is the correct model when taking into account the general, specific and all characteristics of a certain educational material.

3) Block - scheme or "Cluster" model. Block diagram (on the subject of real numbers).

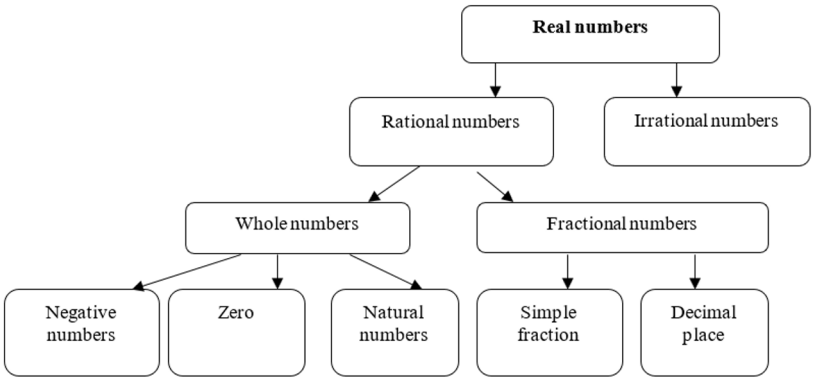


Fig. 2. "Real numbers" cluster.

Models in the form of a block diagram belong to the group of models that are used by students to study the educational material in a certain sequence by classes and to imagine them as a whole in memory.

"Clusters" are considered to be a convenient model for monitoring the extent to which knowledge has been mastered by students. With their help, it is possible to see the connection between the voluntary concept and other concepts that are closely related to it.

There is an opportunity to use models that provide integration in generalization and repetition lessons, as well as in the design of the educational process.

A number of clusters were used to provide students with mathematical knowledge and control their knowledge in the process of organizing experimental work. In particular, the following cluster represents the relationship between mathematical disciplines:

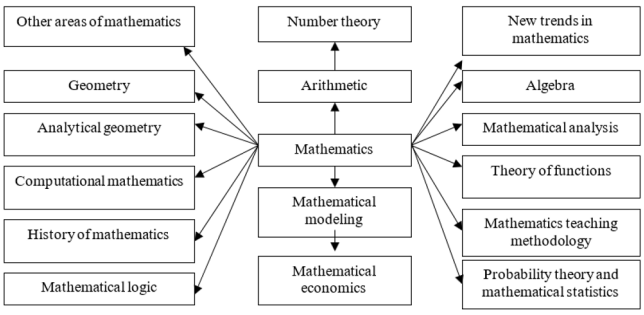


Fig. 3. Mathematical Sciences Affinity Cluster.

Thus, the use of models in the educational process is one of the main means of ensuring the coherence of mathematics.

The advantages of models that provide coherence are that when they are used in the educational process, the relationship between topics (or chapters) is clearly shown and forms a whole view of the topic (learning material) or chapter in the minds of students.

3 Results

The main goal of the emphasis experiment was to determine to what extent the integrity of mathematics taught in general secondary and secondary special educational institutions is ensured.

Depending on the purpose, the emphasis is on experimental work:

- study and analysis of DTSs, curricula and manuals, textbooks on mathematics in general secondary and secondary special education;
- to study the work experience of teachers teaching mathematics in general secondary and secondary special educational institutions and to determine their opinions about the problem of coherence;
- determination of knowledge, skills and qualifications of 5-9 grade students and students of academic lyceum in mathematics;
- the tasks of determining the achievements and shortcomings of mathematics teaching in general secondary and secondary special educational institutions were determined.

Emphasis on the analysis of experimental work**:**

1. To determine the achievements and shortcomings of DTSs, curricula, textbooks and manuals in the field of mathematics in general secondary and secondary special education.

2. Summarizing the opinions of teachers teaching mathematics in general secondary and secondary special education institutions about the problem of coherence and answering the following main questions:

What are the shortcomings and achievements of the current curriculum in mathematics?

a) Which chapters of the current mathematics textbook can be updated?

b) What should a modern mathematics textbook be?

c) What topics are not sufficiently covered in mathematics textbooks?

g) Which topics are difficult to convey to students?

d) What should be the sequence of topics in textbooks?

3. The level of formation of knowledge, skills and qualifications of students of 5-9 grades of general secondary schools and academic lyceum in mathematics was determined on the basis of specially developed criteria. They are:

High level:

- highly developed interest in mathematics;
- to have a complete and clear understanding of the topics covered;
- to be able to apply acquired knowledge in non-traditional situations;
- creative application of theoretical knowledge in practice;
- to be able to use various methods in solving examples and problems;
- able to work independently with literature;
- to be able to complete the assigned tasks independently, that is, without the help of the teacher.

Intermediate level:

- students' interest in science is limited only to solving examples and problems;
- able to apply acquired knowledge, skills and qualifications in practice;

- use only the methods taught by the teacher when solving examples and problems;
- to have a general understanding of the topics covered;
- lack of desire to solve additional mathematical examples and problems outside the textbook;
- to be able to correctly complete the assigned tasks with the help of the teacher.

Lower level:
- the student's interest in mathematics is not sufficiently formed;
- lack of continuity in the student's knowledge, skills and qualifications;
- lack of theoretical knowledge, skills and qualifications;
- making gross mistakes when solving examples and problems;
- inability to work independently with the textbook;
- inability to independently complete assigned tasks.

4. Based on the above conclusions, to determine to what extent coherence in mathematics is ensured in general secondary and secondary special education institutions and to draw a general conclusion.

The level of acquisition of mathematical knowledge, skills and abilities of academic lyceum students is shown in the table below.

At the end of the experiment, we record the results of the mastering presented in Table 1 in the form of the following table for the purpose of analysis.

Table 1.

Groups	Number of students	Grades			
		2	3	4	5
Experimental groups	n=128	n_1=1	n_2=49	n_3=49	n_4=29
Control groups	m=130	m_1=5	m_2=79	m_3=35	m_4=11

Its diagram looks like this (Fig. 4).

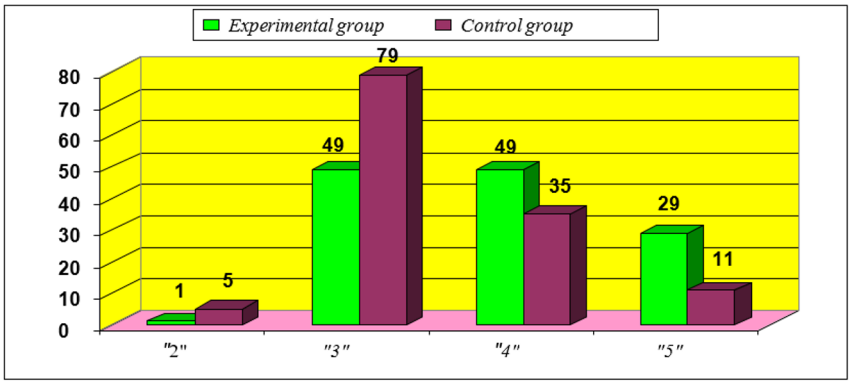


Fig. 4. Experiment - diagram of test results.

The numerical data in Table 1 were analyzed using the Student and Pearson methods of mathematical statistics.

The conducted statistical analysis consists of a mutual comparison of the learning results obtained in the experimental and control groups. For this purpose, initially the average absorption indicators and their corresponding standard deviation values were calculated using the following formulas:

$$\overline{x} = \frac{1}{n} \cdot \sum_{i=1}^{4} n_i \cdot x_i \qquad \overline{y} = \frac{1}{m} \cdot \sum_{i=1}^{4} m_i \cdot y_i$$

$$S_1^2 = \frac{1}{n} \cdot \sum_{i=1}^{4} n_i \cdot (x_i - \overline{x})^2 , \qquad S_1 = \sqrt{S_1^2}$$

$$S_2^2 = \frac{1}{m} \cdot \sum_{i=1}^{4} m_i \cdot (y_i - \overline{y})^2 , \qquad S_2 = \sqrt{S_2^2}$$

Here x_i and y_i are the acquisition rates of the experimental and control groups, respectively.

For experimental groups:

$$\overline{x} = \frac{1}{128} \cdot (1 \cdot 2 + 49 \cdot 3 + 49 \cdot 4 + 29 \cdot 5) = 3{,}8 \ ;$$

in percent $$\overline{x_0} = \frac{3{,}8}{5} \cdot 100\% = 76\%$$

$$S_1^2 = \frac{1}{128} \cdot \left[1 \cdot (2-3{,}8)^2 + 49 \cdot (3-3{,}8)^2 + 49 \cdot (4-3{,}8)^2 + 29 \cdot (5-3{,}8)^2\right] = 0{,}6$$

$$S_1 = \sqrt{0{,}6} = 0{,}78$$

For control groups:

$$\overline{y} = \frac{1}{130} \cdot (5 \cdot 2 + 79 \cdot 3 + 35 \cdot 4 + 11 \cdot 5) = 3{,}4$$

in percent $$\overline{y_0} = \frac{3{,}4}{5} \cdot 100\% = 68\%$$

$$S_2^2 = \frac{1}{130} \cdot \left[5 \cdot (2-3{,}4)^2 + 79 \cdot (3-3{,}4)^2 + 35 \cdot (4-3{,}4)^2 + 11 \cdot (5-3{,}4)^2\right] = 0{,}55$$

$$S_2 = \sqrt{0{,}55} = 0{,}74$$

So, the average mastery rate in the experimental groups is higher than in the control groups, ie:

$$\overline{x_0} = 76\% > 68\% = \overline{y_0} \ .$$

Now we calculate the accuracy levels of the mean values for both groups.

$$C_1 = \frac{S_1}{\overline{x} \cdot \sqrt{n}} \cdot 100\% = 1{,}8\%;$$

$$C_2 = \frac{S_2}{\overline{y} \cdot \sqrt{m}} \cdot 100\% = 1{,}9\%$$

So, for both groups, these values are less than 3%, which, in turn, means that the calculated mean values correctly reflect the unknown mean values of the main sets from which the sample sets in the table above are taken, and this indicator is higher in the experimental groups.

(because, $C_1 = 1{,}8\% < 1{,}9\% = C_2$). We average the values corresponding to the main sets μ_x and μ_y are the by specifying that they overlap $H_0 : \mu_x = \mu_y$ We will advance the hypothesis and check whether it is correct or incorrect using the following Student's statistics:

$$T_{x,y} = \frac{\overline{x} - \overline{y}}{\sqrt{\frac{S_1^2}{n} + \frac{S_2^2}{m}}} = 4{,}26$$

$P = 0{,}95$ if we determine the critical point corresponding to the confidence probability from the table: $t_{0,95} = 1{,}96$ will be like. Apparently, $T_{x,y} = 4{,}26 > 1{,}96 = t_{0,95}$.

So we are H_0 we reject the hypothesis and admit that the corresponding mean values differ from each other. Now the following about the equality of the distribution patterns corresponding to the experimental and control groups

$$K_1 : F_x = F_y$$

we test the hypothesis of homogeneity using Pearson statistics:

$$X_T^2 = \frac{1}{n \cdot m} \cdot \sum_{i=1}^{4} \frac{(nm_i - mn_i)^2}{n_i + m_i} = 20{,}117$$

$P = 0{,}95$ confidence probability, and degree of freedom $\nu = 4 - 1 = 3$ ra if we determine the corresponding critical point from the table $Z_{0,95}(3) = 7{,}815$ will be.

Even in this case, $X_t^2 = 20{,}117 > 7{,}815 = Z_{0,95}(3)$,

ie K_1 the hypothesis is rejected. The above statistical analysis confirmed that the teaching methods used in the experimental and control groups were fundamentally different from each other, and that in the experimental groups was more effective.

4 Conclusion

It is known that as society and science progress, the demands and needs of the society for education also change. It is natural that educational programs based on the principle of continuity and continuity of education also become obsolete, that is, they are renewed based on the emerging social need.

In the article, this problem was considered in the example of mathematical education, several directions of ensuring the continuity of education were studied in a comprehensive manner, an author's curriculum serving to ensure the continuity of mathematical education in general secondary and secondary special education institutions was developed and a special methodology was based.

The methodology differs from traditional teaching methods, consists of interactive methods, lesson developments based on technological projects, and covers topics suitable for repetition and generalization lessons held in academic lyceums. This methodology has been successfully tested by experienced teachers on test sites.

According to the results of experimental work, it was considered appropriate to pay attention to the following:

- to determine the internal and external integrity of the given subject in preparation for each subject and pay special attention to ensure the integrity of the educational process when introducing it into the educational process;
- determining the goals and tasks of each lesson in a coherent way, taking into account the students' mathematical knowledge, skills and abilities;
- when developing a lesson plan for each topic, taking into account the age and personal characteristics of students, choosing the most effective elements of pedagogical technology and developing methods of using them in the lesson;
- in the technological design of the lesson, the method, form, tools and methods needed in accordance with the predetermined goal are determined and implemented in a certain sequence;
- in the practical part of the lesson, the use of examples and issues related to interdisciplinary relations that shape the worldview of the student;
- it is necessary to envisage the control and stimulation of the level of mastery of the student at each stage of the educational process.

Based on the results of experimental work and the opinions of practicing teachers, it can be said that the development and implementation of lesson plans based on pedagogical technologies ensures the integrity of the educational content and process, increases the activity of students, mastering knowledge in a holistic way, increases the mathematical thinking of students, independent creates the necessary conditions for increasing interest in thinking and mathematics.

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