Hermeneutical Approach to the Design Process Interactive Learning Environment Technologies*

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Abstract. In the period of digitalization of education, the creation of interactive learning environments is one of the most urgent tasks of this system. However, education is still dominated by the use of theoretical and concrete-practical texts, in which the hermeneutical potential of the studied science, embedded in reflexive teaching methods, is poorly manifested. In this regard, the study aimed to provide theoretical and methodological support for the design of interactive learning environments that include innovative educational technologies in mathematics, created in the course of the hermeneutical approach. In this case, methods are used that develop students 'and students' self-awareness, as well as humanitarianization of their thinking. Relying on this approach can provide the creation of new educational technologies for reflexive work with scientific and practical texts, their integration into electronic educational resources posted on the Internet, the intensification of innovative activities of teachers by combining them in creative educational clusters. As a result of the research, the following conclusions were made: reliance on the hermeneutical approach to the educational process will create conditions for the transition from the existing attitude to "ready knowledge" in education to the attitude to independent and active mental activity of students, which will stimulate the reflexive process of mastering the studied theories; the use of models and technologies of innovative computer didactics based on the HTML software platform provides electronic resources with the properties required by GOST R 53620-2009: interactivity, multi-media, the ability to modify content and software components, functionality, independence from the computer operating systems used. Thanks to these properties, it is possible to optimize the process of designing computer didactics technologies following the tasks of digitalization of the education system.

Keywords: Educational Technologies, Interactive Learning Environment, Innovative Computer Didactics, the Hermeneutic Approach, the Educational Process.

1 Introduction

The new technological era is inevitably the reason for cardinal changes in all areas of human society. There are a lot of changes in the educational process at all levels of education since the innovative type of educational process must also correspond to an innovative economy [13]. At the same time, its methodological support should be transformed from a traditional type into an innovative one. This task can be solved provided that the majority of practicing teachers are involved in innovative activities, which corresponds to the paradigm of the state program for the digitalization of the education system [1, 4]. The creative teachers' activity means using modern digital technologies integrated into subject inter-active environments with the use of cluster technologies based on the ICT competence of teachers [11].

The creation of interactive training environments caused changes in the teaching methodology of many disciplines. It led to forming a new teaching system with its own specific theoretical and methodological basis - computer didactics. It is the field of modern didactics. It explores the theoretical aspects and practice of e-learning and creates the means for digital full-time and distance learning [18, 19] with a skillful combination of technical, software, and didactic teaching aids for both schoolchildren and students of various specialties and areas [22]. At the same time, a teacher designs digital educational courses with interactive tools [9]. Computer didactics uses the factors of national cultural heritage, i.e. the concept «culturally enriched environment».

The concept «computer technology» has not yet received a clear definition, but is widely used in the theory of distance education. The authors of many scientific works use various terms as synonyms of this concept: electronic educational environment, virtual learning environment, digital educational environment, but these structures are different from interactive educational environments (IEE).

Many authors also refer to interactive educational environments as various types of electronic educational materials: electronic educational resources, electronic laboratory and task workshops, electronic supplements to training courses, electronic libraries, etc.

Others consider that interactive educational environments also are social networks and social repositories, network offices and diaries, social media and databases, mental maps as a technique for visualizing thinking, etc. However, the above-mentioned electronic constructions have different aims and perform different functions in the educational space [10].

There are different approaches to describe the IEE structure. For example, I.K. Sirotina, S.I. Berezyuk, A.V. Faley teaching mathematics to point out the following components: interactive content, presented by interactive texts, reference material, workshop, and tests; interactive text with dialogical interaction with the student through comments, tips, pictures, diagrams, and animation; an interactive workshop that includes key tasks and tabs «Knowledge Update» and «Solution»; an interactive online reference book with a base of theoretical material; a test component with two modes of operation: control and interact with material for self-study [16].

This structure is typical for most of the subject educational environments presented on the Internet. There is no unified IEE classification; we cannot refer to a unified definition of this concept.

That's why we use ready-made software components in the structure of IEE, and the functions of teachers are in developing educational content (this is the way «from a computer to the content of education»).

Our research follows a different way, it is «from the content of learning to the computer», i.e. we create the software component of interactive technologies IEE independently. We define IEE as a subject software-content structure for studying scientific theory with the help of digital interactive technologies which can be individual and implemented in line with the hermeneutic approach to creating IEE.

2 Methodology and Materials

2.1 A Hermeneutic Approach to Designing IEE Technologies

The term «hermeneutics» comes from the Greek «Hermeneuo». It means «I explain, interpret» [3], therefore the art of interpretation and interpretation of texts in Ancient Greece was called «hermeneutics» (on behalf of the god of eloquence Hermes). In the Renaissance, a philosophical hermeneutics, in the center of which is the theory of understanding, developed by the works of Schleiermacher, who substantiated the method of the hermeneutic circle, since understanding takes place in a circle as a result of returning from the whole to the parts and vice versa; Dilthey, who defined the role of deduction and analysis in the process of identifying the meaning of a text, and induction in hermeneutic synthesis. In modern hermeneutics, G. Gadamer, M. Heidegger, G.G. Shpet used logical, semiotic, and phenomenological methods to study the objective meaning of the text, which is considered as a sign-symbolic information system [14].

At present, hermeneutics is in demand as a certain methodology for mastering the phenomena of modern knowledge, based on the idea of influencing a person's consciousness to obtain various information, on his thinking and types of activity, including forecasting, modeling, design, diagnostics.

Pedagogical hermeneutics is the theory and practice of interpreting and interpretation pedagogical knowledge. The key idea of this science is in developing the self-consciousness of students in the process of reading and interpreting scientific texts, the humanization of their world outlook and thinking. The urgency of this problem is emphasized by the majority of school teachers and university teachers, believing that many students do not have the ability of formal logical and dialectical thinking [3]. Teachers see the reason for this problem as the fact that many computer technologies orient students to assimilate ready-made schemes and patterns, which leads, according to A.F. Zakirova, to «format-ting thinking and stereotyping personality» [6]. The solution to this global problem, according to G.I. Bogin, is oriented towards the hermeneutic approach, which directs towards understanding how «the organization of reflection».

The process of understanding the studied text must be accompanied by the transformation of knowledge into the mental experience of the learner. Therefore, it is important to rely on the hermeneutic potential of scientific texts when designing IEE, which is usually ignored in teaching physical and mathematical disciplines, where computational and practical methods dominate. At the same time, by hermeneutic potential we mean those properties of the text, based on which it is possible to organize the mental activity of pupils and students, formulating a hermeneutic task for its study and the subsequent development of a didactic (textual) version of educational technology, as well as the creation of computer programs [8, 12].

There are three groups of IEE technologies: technologies for mastering the content and analysis of theoretical educational texts, technologies for forming practical skills, recreational technologies focused on preventing mental fatigue, for example, computer educational games. Fig. 1 shows the components of the design process for an interactive educational environment. Each component has its characteristics and is invariant for any subject area (see Fig. 1).

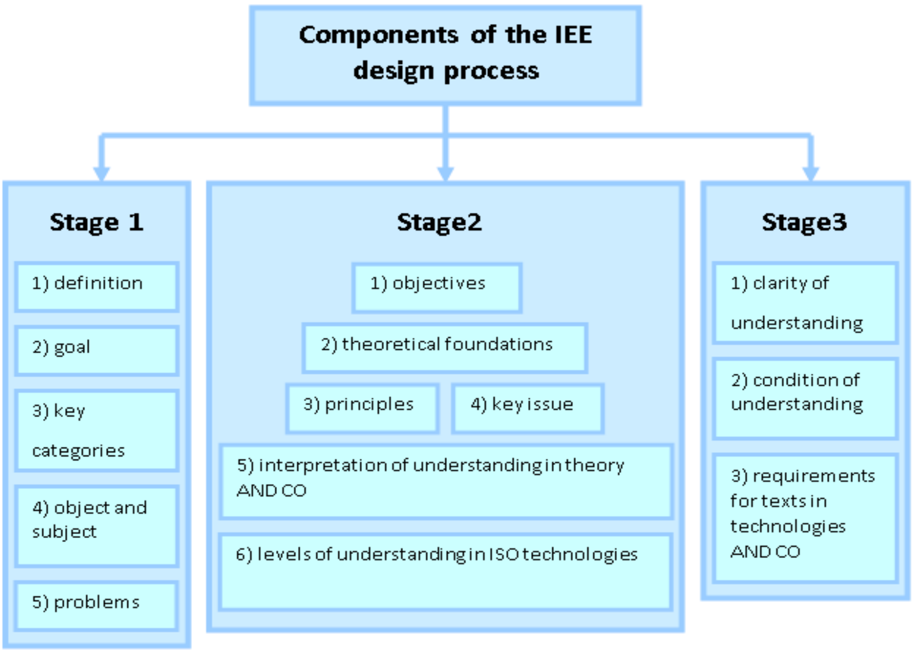

Fig. 1. Components of the process of designing an interactive educational.

2.2 Implementation of the hermeneutic approach in IEE technologies

Extrapolating the ideas of hermeneutics to the field of didactics, interactive digital technologies for processing scientific text were created in the structure of IEE. For example, at the first level of understanding, the following items were used:

- «SLD» (structural and logical diagram), preliminary analysis of the entire topic as a whole; the method of the hermeneutic circle is implemented («from the whole text to separate parts, from parts to the whole»);
- «Blind scheme», the establishment of a sequence and connection within the studied theory and self-filling of the scheme [15];
- text analysis and synthesis is used in many IEE technologies, for example, in the Internet technology «Formula of knowledge» using symbols of the algebra logic, a definition of a concept is made from elementary statements; Internet technology «Disappearing text» («Fast reading» or «Visual dictation») is also based on the analysis of the text and its correlation with the studied didactic objects [15].

Understanding scientific texts involve the step-by-step implementation of a complex system of cognitive operations: defining keywords, highlighting the main thing, proposing to continue the thought, find the cause and establish a consequence, draw conclusions, draw up abstracts, find an analogy, choose an adequate pictogram, establish a sequence of events, or algorithm of actions, correlate text with a picture, etc.

Technologies were created that reveal the internal structure of concepts: «Reconstruction»; «Insert symbol», «Find meaning», etc. They implement the principle of «didactic iteration», multiple variable repetitions.

The second level of understanding is syntactic, reflecting the understanding of sentences in the generalizing Internet technology «Matrix of knowledge».

The third level - semantic (contextual) - forms an understanding of the meaningful parts of the text, as well as the text as a whole - the technology «Synopsisscroll» (with a gradual unfolding the synopsis), «Concepts-meaning» (concepts are revealed by interactive modules), «Synopsis-meaning», (symbolic designations of concepts and their lexical meanings) [15].

The peculiarity of IEE technologies is that their aims are not to percept in-formation directly, but the logical and dialectical understanding of information. In our opinion, the phenomenon of understanding arises at the moment when it becomes possible to connect a new information object with subject relations that are already presented in the individual experience of the student. This provision of pedagogical hermeneutics was implemented in the text-component IEE, in training blocks, for example, in the Textbookcom program (textbook + computer) [2].

The use of game situations in the IEE texts is essential for developing concepts since intellectual games involve the transformation of texts into various operations with concept elements that are absent in scientific texts [7, 17].

3 Research Results

The stated theoretical provisions were implemented through a complex of innovative technologies using the Power of Knowledge Internet constructor on the site of the same name http://ya-znau.ru/ [15]. We give examples of some technologies in mathematics: «Test of knowledge» (choice of interpretation of the meaning for individual fragments of the text); «Facet test» (making up a test task from the elements of the frame structure, generalizing the study of the topic); «Knowledge field» (choice from alternative answers, graphical representation of the amount of knowledge based on the selected text features); «Matrix of knowledge» (correlation of text fragments with key questions of the studied topic); «Formula of knowledge» (understanding the structure of concepts and rules by compiling them using logical connectives); «Knowledge dictionary» (correlation of terms and their lexical meanings); «Knowledge gaps» (step-by-step deployment of a complex text or complex task); «Cross-word of knowledge» (concentration of text information up to the size of one word); «Relay race of knowledge» (transfer of a number, symbol, word from one piece of text to another, checking the relay by one last answer); «In search of knowledge» (implementation of a game situation with the aim of multiple variable repetition of educational information).

The process of monitoring the didactic efficiency of IEE digital technologies took place parallel with the study. So, during 2017-2019 years to identify the effectiveness of using interactive technologies of IEE, an experiment was carried out based on the study of the section of mathematics «Elements of linear algebra» for 2nd-year students of the Faculty of Continuing Education of training judicial system specialists of the SCF FSBEI HE «Russian State University of Justice». The control and experimental groups were selected by random sampling. The topic «Matrixes and actions on them» was studied using the interactive technologies of IEE, created in the program of the Internet constructor «Power of Knowledge» (see Fig. 2).

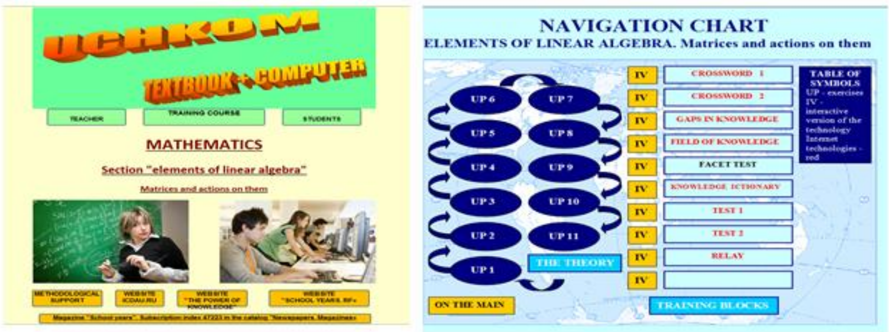

Fig. 2. The title page and navigation map of the "Power of Knowledge".

Algorithm of the experiment and statistical processing of the data obtained during the experiment.

1. Students of the experimental group were provided with a lecture course in the form of a web presence for self-study (see Fig. 3). Lectures were held traditionally for the students of the control group.

2. For the experimental group, various interactive tasks were organized through the corresponding web-forms on «the Power of Knowledge» website (see Fig.4 and see Fig. 5), namely: technologies for working with text, hermeneutic techniques (the concept of understanding), local learning technologies. Interactive exercises are aimed at the practical application of the knowledge gained during the study of the corresponding

educational text and are equipped with operational verification of the results. The control group students performed the tasks presented in the methodological manual, traditionally on paper.

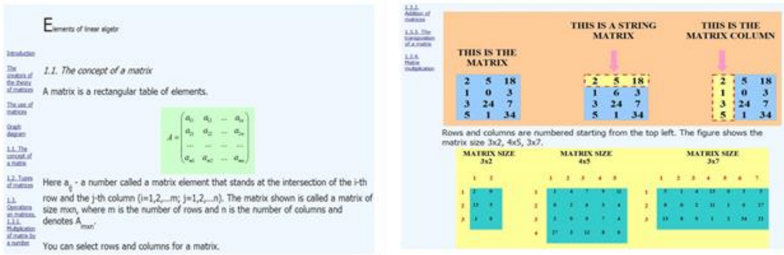

Fig. 3. Pages of web-presentation “Matrix concept”.

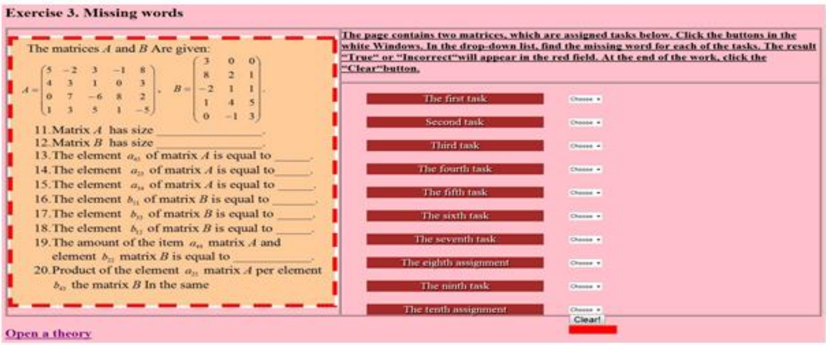

Fig. 4. View of the web page of the technology “Missing Words”.

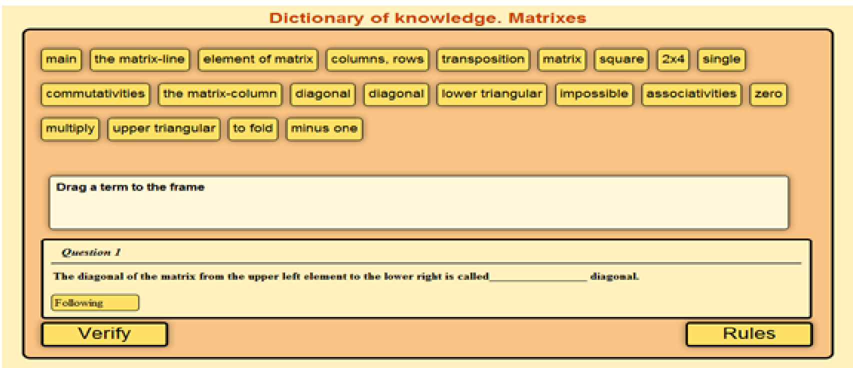

Fig. 5. View of the web page of the technology «KnowledgeDictionary»

Fig. 5. View of the web page of the technology “Knowledge Dictionary”.

3. The study of the topic in the computer program «Textbookcom» is allocated to voluminous, complex educational tasks (in one task there can be up to 36 questions-tasks). Each such question-task is evaluated by a certain number of points. In our case, the maximum number of points is 141. When completing the tasks, the students' answers were recorded in the assessment tables, the number of points scored was calculated, the assessment scale was built, and, using the rating system, the mark was set (Table 1).

Table 1. A fragment of the intermediate results of the experimental group.

Correct answer, %	Number of points	Evaluation
90 – 100	127 – 141	Excellent
70 – 89	99– 126	Good
50 – 69	71 – 98	Satisfactory
Less than 50	Lessthan70	Unsatisfactory

The rating system may be changed depending on the complexity of the tasks. Table 2 presents the data of the experimental group (students are encoded with serial numbers) on the topic «Matrixes and manipulations with them», performed using the computer shell of the Textbookcom program.

Table 2. Data of the experimental group.

№	Tasks							Homeindependentwork	Sumof points	Points in %	Evaluation
	1					9	10				
Max. score	8	8	10	…	10	9	21	30	141	100%	5
1	8	7	8	…	8	8	17	28	126	89,36	4
2	7	8	8	…	8	9	16	28	125	88,65	4
3	8	8	10	…	10	9	21	30	141	100,0	5
…	…	…	…	…	…	…	…	…	…	…	…
29	6	6	6	…	8	6	20	20	106	75,18	4
30	8	8	9	…	9	8	21	28	127	90,07	5
32	8	8	7	…	7	9	18	18	114	80,85	4
Averages Core	7,28	7,13	8,03	…	8,69	8,28	18,16	25.34	22,12	86,61	4,31

4. For each group, bar graphs were constructed, illustrating the average score for each of the tasks of interactive technologies. Graphically, the data in Table 2 are presented in the form of a diagram (see fig. 6).
5. At the end of the experiment, a final control work was carried out to generalize and systematize knowledge about the main issues of the section with the use of innovative didactic technologies for the experimental group. The final work was carried out in the traditional form in the control group. The tasks were arranged in ascending order of

difficulty; each was evaluated by a point corresponding to its ordinal number in the task (from one to five).

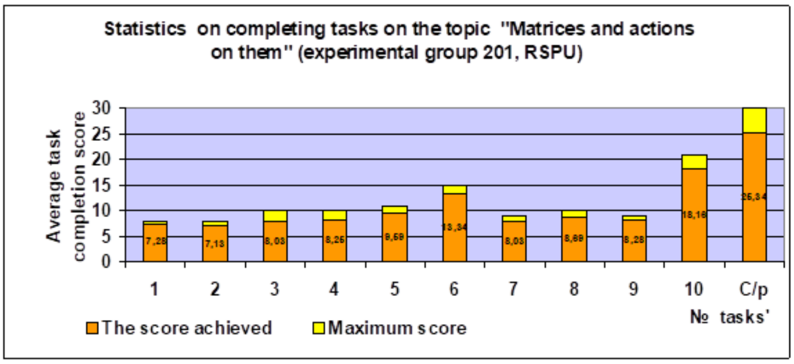

Fig. 6. Statistics of the tasks performed on the topic "Matrixes and manipulations with them".

Tasks 1 and 3 contain two tasks, so the total number of points for the work is 19. The results of the final work for the experimental and control groups are shown in Table 1 and Table 1, respectively, where the number of students who solved each of the tasks is calculated, the total percentage of the task is shown, as the ratio of the number of completed tasks to the total number of tasks.

Table 3. Performing the final control task by the experimental group 201.

Students 201 groups (exp. gr.)	Numbers of solved problems							Out of 7 problems solved	Com-pleted in%	Points scored	Points in %
	1		2	3		4	5				
	а	б		а	б						
Number of students who solved the task	32	32	28	28	27	28	23				
			Average					6,19	88,39	16,0	84,21

Table 4. Performing the final control task by the control group 202.

Students 201 groups (control.)	Numbers of solved problems							Out of 7 problems solved	Com-pleted in%	Points scored	Points in %
	1		2	3		4	5				
	а	б		а	б						
Number of students who solved the task	28	26	27	23	22	15	9				
			Average					4,69	66,96	10,88	57,24

A graphical interpretation of the statistics of the control task performance is given in the comparative diagram in Fig. 7. The diagram is based on the data in Table 1 and Table 1. The average score for the control task in the experimental group (201 g.) is 16.0, in the control group (202 g.) is 10.88, and it means that the experimental group coped with the task more successfully.

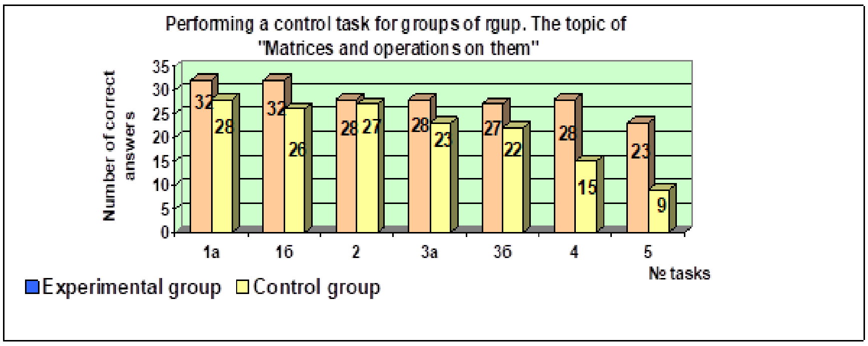

Fig. 7. Comparative diagram of the success of control tasks in the experimental and control groups.

As a result of statistical processing of the data of the pedagogical experiment according to the Fisher slope method, conducted in groups of students when studying the topic «Matrixes and manipulations with them», during the period of training a positive effect was observed in the experimental group using technologies integrated into an interactive environment learning and using the author's program «Texbookcom» [2] with the help of Internet support through five sites [5, 7, 15, 20, 21].

The results of our research can be used both in full-time education and in distance learning, as well as in the independent work of students (pupils). New digital teaching means are being created within the framework of the scientific direction - innovative computer didactics - at the Kuban State University (KubSU), where dozens of dissertations in this direction have been done. Published 75 issues of the scientific and methodological journal «School Years» with electronic applications [20], sites with interactive materials are actively working: «Innovative Computer Didactics» [7], «Electronic Educational Resources» [21], «The Power of Knowledge» [15], «Virtual cluster of innovative computer didactics» [5].

4 Discussion

IEE innovative technologies have been created over a long period, therefore, their discussion was held many times and in various forms: at international conferences (Moscow - 2016, 2018; Derbent - 2017, 2018; Yalta - 2017, 2018 2019; Krasnodar - 2018), at the regional seminars of mathematics teachers held by the Regional Institute of the

Development of Education (Krasnodar, Armavir, Tikhoretsk, Yeisk, Primorsko-Akhtarsk 2016-2020), in the process of performing dissertation research by graduate students of KubSU (2000-2018). Initially, IEE technologies were created to be included in a new model of the textbook, which was the winner of federal competitions of projects: «Informatization of the education system», Moscow - 2006; «The best IT solution for distance learning», Yalta - 2017. The textbook is named technological because 80% of its volume is innovative technologies of IEE. For creating a new model of the textbook, its author, Professor A.I. Arkhipova, was awarded the medal of K. D. Ushinsky. But it is practically impossible to introduce new models of textbooks into schools, therefore IEE technologies began to develop autonomously, entering the structures of other types of electronic resources, in particular, into interactive learning environments. Since 2014, 12 of these technologies have been created on the Internet using the Power of Knowledge constructor on the popular site of the same name [15].

The results of the discussion by teachers of innovative technologies for teaching mathematics (2016-2020) are reflected in the questionnaires, their numerical and graphic interpretation are displayed on the KubSU portal.

5 Conclusion

The study confirmed the legitimacy and productivity of the authors' initial position that a hermeneutic approach to the process of designing digital technologies for an interactive educational environment can create favorable conditions for teaching and educating not just literate, but an intelligent and highly moral person. It is this scientific and pedagogical foundation that we consider as an incentive for the positive development of the digitalization process in Russian education.

In conclusion, the authors express their gratitude to the administration of the Kuban State University, which created a comfortable environment for the scientific and pedagogical activities of the university teachers; Dean of the Faculty of Mathematics and Computer Science, Doctor of Pedagogical Sciences, Professor S.P. Grushevsky, who created conditions for the productive activity of students; software engineer, Ph.D., R.I. Zolotarev, who created four sites with high traffic free of charge; teachers I.G. Knyazeva and S. B. Nuzhnova, actively introducing IEE technology into school practice.

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