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Improving the Quality of Future Bilingual Mathematics Teachers Knowledge at University Using Digital Education Recourses

Anvar N. Khuziakhmetov* (a), Ramis R. Nasibullov (b), Inar F. Yarullin (c),
Guzel R. Nasibullova (d)

(a), (b), (c), (d) Kazan Federal University, 420008, Kazan (Russia), 18 Kremlyovskaya street,
hanvar9999@mail.ru

Abstract

This study is devoted to the study of improving the quality of knowledge of future bilingual teachers of mathematics in a modern university using digital educational resources. One of the key objects for assessing the quality of education is the quality of students' knowledge. In the framework of this study, we considered the quality of knowledge of future bilingual teachers of mathematics as the ability to use the Russian and Tatar language in pedagogical activity at the same level. The purpose of the study is theoretical substantiation, development and testing of a model for improving the quality of knowledge of future bilingual mathematics teachers using digital educational resources. The results of the study can be used both nationally and internationally, since the study is aimed at the scientific and practical solution of the problems of modernizing society based on strengthening the national-cultural identity of a new generation of citizens, which is a national priority today. And on an international scale, the study is aimed at training modern specialists who can easily integrate into the international community, based on the development of intercultural communication skills with representatives of various ethnic groups and cultures. The developed model for improving the quality of knowledge of future bilingual teachers by means of DER in the educational process is universal in nature, which makes it possible to use it in other universities.

Keywords: bilingual education, education, high school, bilingual teachers, digital educational resources, mathematics teachers.

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* Corresponding author. E-mail: hanvar9999@mail.ru

Introduction

In the condition of globalization, problems of preserving and strengthening national-cultural identity are the most discussed both at the global and national levels. Bilingual education itself is a leading area of educational policy in many countries of the world. It confirms by the emergence of national bilingual education models. Among them, we can name such as the Canadian and American, German, pan-European concept of "Euro School" (Barric, Christ, Sven, A. Turman, H. Hammerli) (Alex, 2002; Anita, 2001; Barik et al, 1975). The modern concept of higher education in Russia is expressed not only in rethinking the content, but also the structural component. Recently, there has been an intensive development of alternative learning technologies that complement traditional forms of learning. The idea of variability of education is one of the priority areas for reforming the entire educational system.

The increased attention to the problem of the quality of higher education in Russia is due to the socio-economic changes which take place in the last two decades. And they have entailed changing the needs of citizens, including educational ones, in the conditions of the emerging market economy and its inherent attitude to work. One of the most important goals of higher education is the mental development of students, the formation of cognitive skills and the practical application of the knowledge gained in life. The result of education should be actually acquired knowledge, personal development, the ability to continue education at a higher level. One of the key objects for assessing the quality of education is the quality of students' knowledge.

Purpose and objectives of the study

The purpose of the study is theoretical substantiation, development and testing of a model for improving the quality of knowledge of future bilingual mathematics teachers using digital educational resources.

Literature review

Numerous studies prove that three factors play an important role in the development of society: these are high technologies, information content and internationalization. It needs to organize the learning process in higher education on the basis of modern information technologies, where digital educational resources (DER) are increasingly being used as sources of information. The psychological and pedagogical foundations of the application of information technology in education are considered in the works of Bepalko (2002), Zimnyaya (2012) and Robert (1994). The introduction of information technologies in the educational system involves both the creation of new teaching aids and the development of the theory and methods of their use in the educational process.

Babansky (1997), Verbitsky (1991) and others and others studied the problem of substantiating the concepts for creating various pedagogical technologies and the general issues that arise during their development. The possibilities and prospects of using electronic textbooks, multimedia, virtual reality, hypertext systems in various fields of education are considered in the works of Alekseeva (2001), Kodzaspirova (2002) and others researched.

The issues of bilingual teaching of natural and mathematical disciplines in schools and universities based on natural (national-Russian) and artificial (e.g. Russian-English) bilingualism are paid special attention in the Russian and Tatar pedagogy (Khuziakhmetov & Valeev 2018; Salimov, Niyazov, Evtugina, & Khuziakhmetov, 2019; Tsvetkova, 2001).

At the present stage it becomes necessary to include DER to the pedagogical process, which will allow future bilingual teachers to improve the quality of knowledge due to the needs of higher education (Amhag, Hellström, & Stigmar, 2019; Mannila, Nordén, & Pears, 2018). The content of pedagogical disciplines is gradually being revised. The didactic problems of selecting the content of pedagogical information are considered in the works of Bezrukova (2008), Krayevsky (1991) and others. The ideas of integrating knowledge, combining them into large blocks, consolidating educational material, establishing dependency and intersubject communications are disclosed in the study by Danilyuk (2000) and others. Based on the technology of modular training, invariant models of educational subjects, and end-to-end courses, interdisciplinary and integrated pedagogical courses are being developed (Vyatkin, 2000; Yutsyavichene, 1990).

In organizing the training of future bilingual teachers of mathematics, the formation of a specialized subject language plays a special role. So, in the educational process of future bilingual teachers, subject language is both an object and a means of obtaining special knowledge (Dominguez, 2011; Karaoglan Yilmaz, Özdemir, & Yasar, 2018; Ji-Yeong, 2019; Campbell, Davis, & Adams, 2007). The ability to use the subject language to obtain additional professional information play the key role, and in the context of the development of integrative relations in Russia there is a need for knowledge of the subject language on a bilingual basis. The need to obtain such knowledge, skills and abilities is determined by modern requirements for specialists of a wide profile, capable of self-education and self-development.

Research methods

The following methods were used in the research process: theoretical methods: systematic analysis of the problem, structural and functional study of the object, modeling of the educational process, generalization;

empirical methods: observation, interviews, questionnaires, testing, analysis of documentation and products of educational activities; pedagogical experiment (stating, formative, control experiments); graphic representation of the results.

Experimental base of research

The experimental base of the research was the N.I. Lobachevsky Institute of Mathematics and Mechanics of Kazan (Volga region) federal university.

Research stages

The study of the problem was carried out in three stages:

- at the first stage, a theoretical analysis of the existing methodological approaches in philosophical, psychological and pedagogical scientific literature, as well as the theory and methodology of pedagogical research, was carried out; the problem, purpose, and research methods are highlighted, an experimental research plan is drawn up;
- at the second stage, in accordance with the goals and objectives of the study, pedagogical conditions were determined aimed at improving the quality of knowledge of future bilingual teachers of mathematics by means of DER;
- at the third stage, experimental work was carried out, the dynamics of the level of formation of knowledge quality indicators using the cognitive, activity and personality criteria, taking into account the use of DER in the educational process of the Kazan (Volga) federal university, was revealed.

Results

The structure and content of the model

A pedagogical experiment was conducted while studying the course "History of Pedagogy and Education", which is part of the system of pedagogical disciplines studied by students of the pedagogical direction. This course is important in teaching the future teacher, for the formation of his analytical thinking, views and beliefs. Studying this academic discipline, students master the knowledge and skills necessary for their self-determination in a variety of educational theories and practical developments, for choosing their own pedagogical path and using the experience of the past in a specific activity as a subject teacher or leader.

In the framework of our study, we proposed a methodology for embedding DER for discipline in the educational process, which is presented in Figure 1.

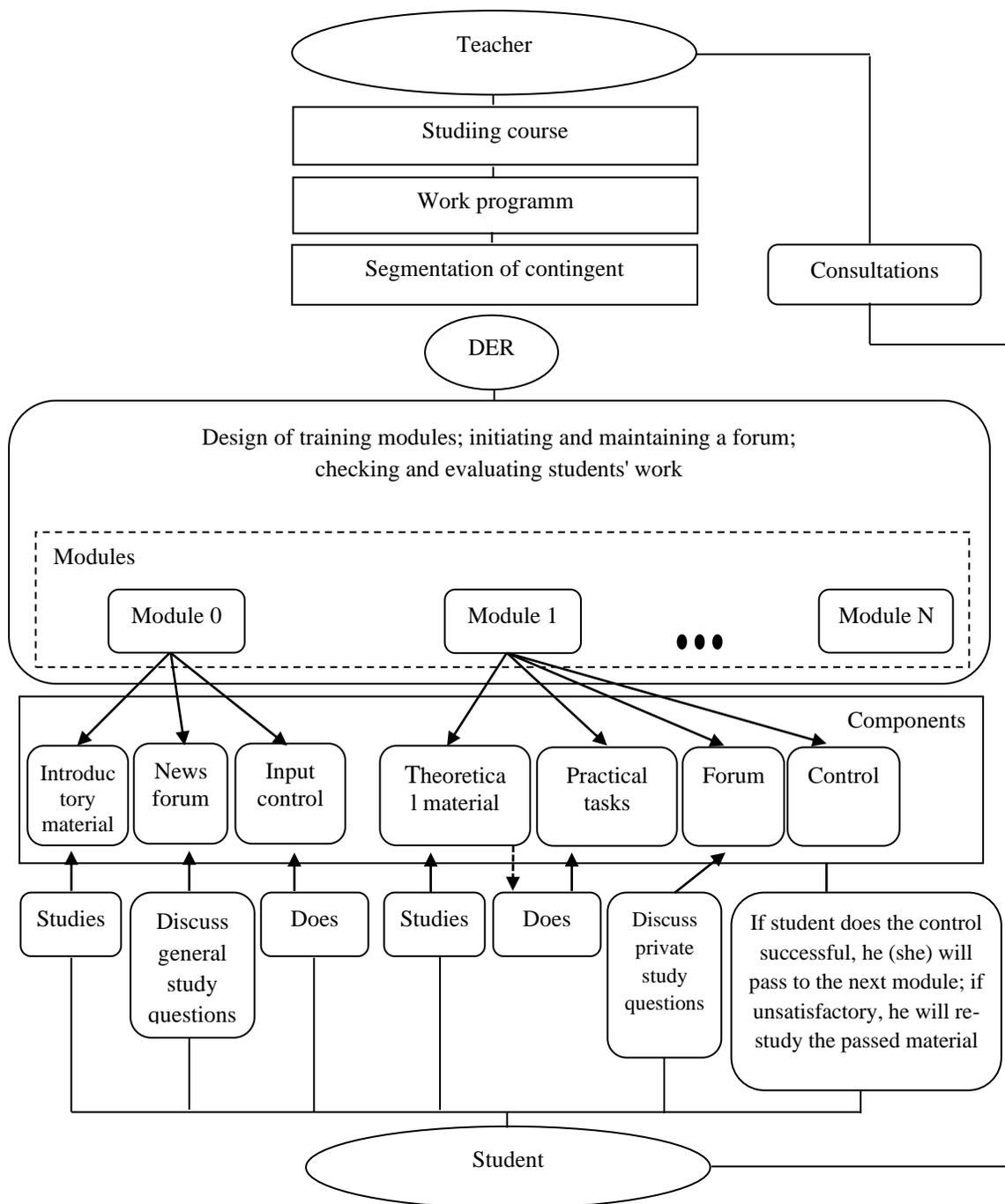


Figure 1. The technique of embedding DER for discipline in the educational process.

The teacher who reads the course "History of Pedagogy and Education" develops a course program or implements the approved. He has the opportunity to advise students in personal meetings.

It is necessary to segment the contingent (who will study with the help of the center: are all students, small groups (skipping classes for one reason or another), students with special educational needs) to use DER in the educational process. Based on the results of segmentation, the teacher can change the content of the modules, because each module is an independent, logically complete part of the learning process.

The teacher designs the training modules; initiates and leads forums; checks and evaluates the completed work of students.

The student masters the material into modules, each module consists of components; studies materials, discusses general and particular tasks on the course, performs control tasks, etc.

The implementation of improving the quality of knowledge of future bilingual teachers of mathematics by means of DER was carried out in the course of a pedagogical experiment, which consisted of three stages:

- determination of the initial level of knowledge quality of future bilingual teachers of mathematics (ascertaining experiment);
- the introduction of a pedagogical system to improve the quality of knowledge of future bilingual teachers of mathematics by means of DER of study and determination of the final level of knowledge quality (formative experiment);
- comparison of the quality levels of knowledge of future bilingual teachers of mathematics by means of DER in the control and experimental groups.

49 students participated in the experiment: 44.03.05 Pedagogical education, profile "Mathematics, Informatics and IT in the bilingual Tatar-Russian environment" of the N.I. Lobachevsky Institute of Mathematics and Mechanics of Kazan (Volga) federal university.

Initial diagnostics of the level of improving the quality of knowledge of future bilingual teachers of mathematics at the stage of a stating experiment was carried out on the basis of established criteria and indicators.

Measurement of indicators of the personal criterion - sociability, responsibility, independence, self-control - was carried out during the testing of students by the method of Cattell's multivariate questionnaire.

Measurement of the indicator “motivation in educational activity” was carried out according T.I. Ilyina's “Methodology of studying the motivation of learning at a university” (Odegov et al, 2010).

By the indicators of the cognitive criterion, we previously determined the volume of acquired knowledge, the speed of doing tasks, and the academic performance rate. The measurement of the amount of acquired knowledge was carried out by the testing method. The amount of acquired knowledge was determined by the number of correct answers in the test.

The speed of doing tasks (V) was calculated by the formula:

$V = N/T$ (1), N – number of asked questions; T – time spent on tasks.

Achievement rate (AR) was calculated by the formula:

$AR = N1/N*100$ (2), N1 – number of correct answers; N – general number of asked questions.

As part of the study, at the stage of the ascertaining experiment, a questionnaire was conducted among students to identify: the functions of DER in the process of studying the disciplines of the pedagogical cycle; degree of utilization and effectiveness of DER; difficulties in implementing DER; attitude to various forms of organization of educational activities with the help of DER. The results of the questionnaire confirmed the objective contradictions between the awareness of the need and the insufficient development of the theoretical, methodological and technological aspects of the use of DER for improving the quality of knowledge of future bilingual teachers of mathematics. At the second stage of the ascertaining part of the experiment, cognitive, activity, and personality criteria were developed for assessing the quality of students' knowledge. The leading indicators of the quality of students' knowledge were: levels of assimilation of knowledge on the subject, students' awareness of the relationship between concepts, ownership of operations, the degree of students' independence in the study of new material.

The quality of knowledge of future bilingual teachers of mathematics was monitored at three levels: low, medium, high.

The results of the stating experiment are presented in table 1.

The experiment data indicates the representativeness of the sample of the experimental and control groups.

Table 1. The quality level of knowledge of future bilingual teachers of mathematics in% (ascertaining experiment)

Criteria	Low level		Middle level		High level	
	Control group	Experimental group	Control group	Experimental group	Control group	Experimental group
Cognitive	30,05	38,37	52,15	47,12	15,42	13,01
Active	48,00	52,76	34,97	32,36	14,23	14,23
Personal	38,47	36,21	48,79	48,00	13,12	13,12

The analysis of the obtained data confirmed the need for the implementation of DER in improving the quality of knowledge of future bilingual teachers of mathematics.

At the stage of the formative experiment, two groups were formed: the experimental group, it consisted of 20 students (Direction: 44.03.05 Pedagogical education, profile “Mathematics, Informatics and IT in the bilingual Tatar-Russian environment”) and the control 29 students (Direction: 44.03.05 Pedagogical education, profile “Mathematics, computer science and IT in the bilingual Tatar-Russian environment”). The experiment was conducted during the study of the course “History of Pedagogy and Education”, which is an integral part of pedagogy, during the 2nd semester of the 2018/2019 academic year. The course is not very large in terms of the volume of material studied, only 72 hours, and difficult to perceive exclusively “by ear”, it involves serious and active work of students.

The formative experiment included the following interrelated areas of activity: testing a model for improving the quality of knowledge of future mathematics teachers using digital educational resources in the educational process of the university; systematic study of the course and results of experimental work in the experimental group; comparison of materials obtained in the experimental and control groups, their comparative analysis; statistical processing, generalization of indicators of the results of experimental work.

Lessons in the control group were conducted according to the traditional form of training, and in the experimental group on the basis of the developed electronic textbook and other types of DER.

At the final stage of the forming experiment, the final level was determined to increase the quality of knowledge of future bilingual teachers of both groups according to the same criteria as in the ascertaining experiment. The results of the formative experiment are presented in table 2.

Table 2. The quality level of knowledge of future bilingual math teachers in% (formative experiment)

Criteria	Low level		Middle level		High level	
	Control group	Experimental group	Control group	Experimental group	Control group	Experimental group
Cognitive	43,85	13,10	40,62	57,31	14,38	28,39
Active	25,63	11,26	54,13	62,82	17,95	26,89
Personal	33,12	20,80	51,76	58,97	14,10	19,12

The data of the formative experiment showed that as a result of the using DER in the preparation of future bilingual teachers of mathematics, the level of knowledge quality increased on average by 12.14%.

Stages of model implementation

With the introduction of DER in the educational process of the university, the task arose of developing a learning model using these resources to improve the learning process and improve the quality of knowledge of future bilingual teachers. This problem was solved using the model we developed, which is formed by three interconnected blocks: informational, practical, and final (Figure 2).

The first stage is preparatory. The student gets acquainted with the outline of the course (watching a video); a program; mastered competencies; methodological recommendations. He can learn the glossary; all the news during the organization of the educational process can be seen in the "news forum"; if students have questions, they can ask the teacher questions on-line, the teacher can be at the computer and initiate a forum; and a prerequisite is the implementation of incoming control.

The second stage is the main, we can say - cyclical, because it is repeated on each module, consists of three blocks.

On the information block the student gets acquainted with the list of questions, guidelines, glossary and literature.

In a practical unit the student studies the theoretical material that is offered in Russian and Tatar; demonstration material (presentation, audio-video, virtual museum, etc.); performs practical tasks; tasks for self-control and all the questions that may arise, can ask and express your wishes in a forum initiated by the teacher, as well as by students

On the final block, the student does a control test for this module. If the result is positive, the student moves to the next module; if the result is negative, the student re-examines the previous blocks of the module. And so, until all the modules of the center are studied and completed.

The third stage is the final one. The student gets acquainted with the methodological recommendations for the implementation of the final control of knowledge and performs the final test task for DER “History of Pedagogy and Education”.

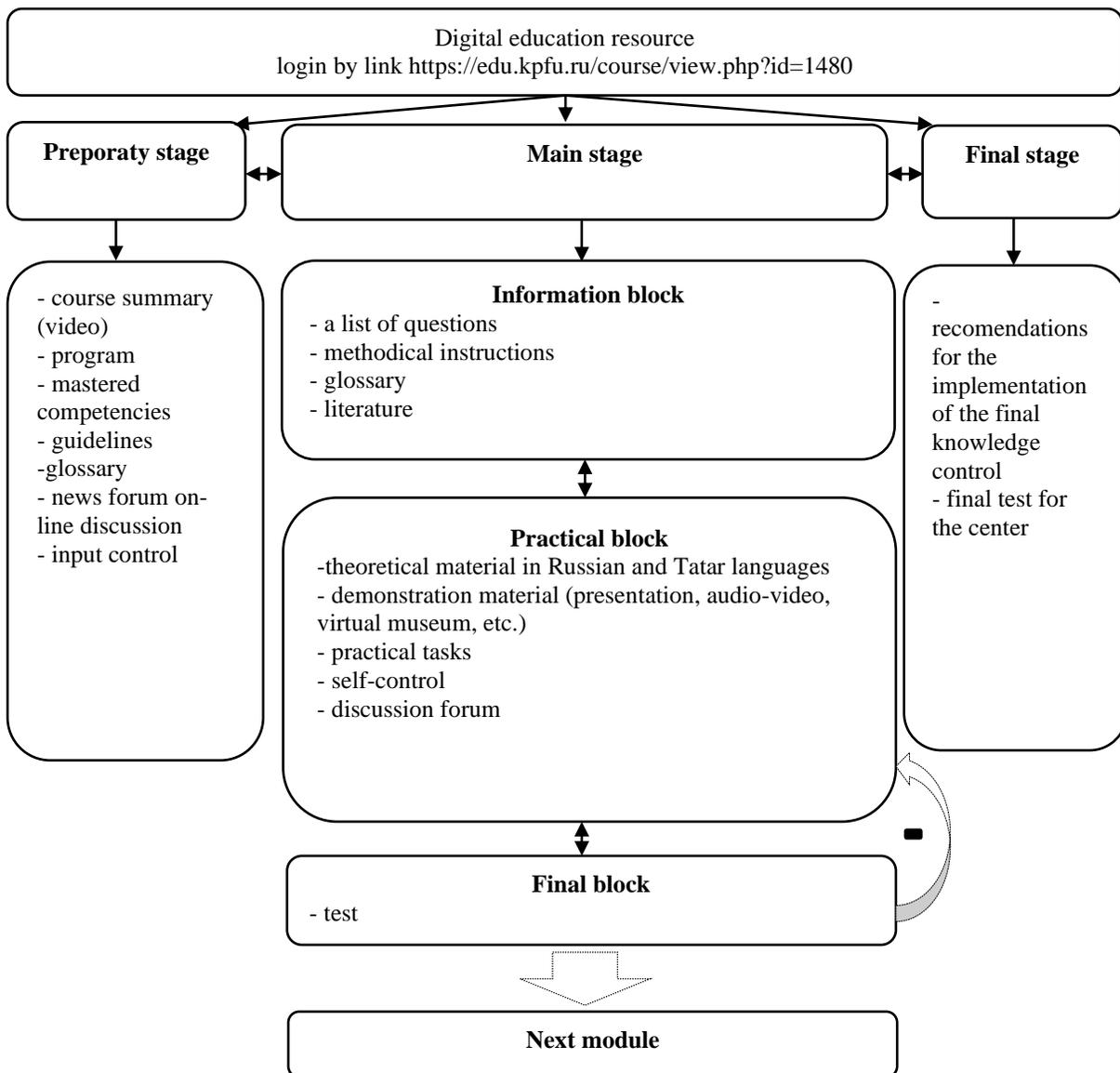


Figure. 2 Model for improving the quality of knowledge of future bilingual teachers of mathematics by means of DER

The educational process in the experimental group was presented as follows: lectures on the main sections of the course "History of Pedagogy and Education" - 18 hours, including in a bilingual educational environment, presentation - 13 (in a bilingual educational environment - 10), video - 19 (own developments - 8, including in a bilingual educational environment - 4), audio - 1, practical lessons - 18 hours, including in a bilingual educational environment, essay - 3, forums - 11, chat - 1, tests - 20, links to external sources - 13, glossary - 10; assessment of DER - 1.

The time taken to study this course with the use of DER was reduced compared to the traditional course study by 18 hours (25%). This became possible due to the optimization of the lecture material, part of which was transferred to the information module of the electronic textbook, as well as to the automated control of students' knowledge by the testing program.

So the use of the center in the educational process of the university: a lecture course taught to students with multimedia support, the use of electronic textbooks, computer business games, web quests, etc. in practical classes, the complexes of control and self-control tests used by DER as a means of increasing the knowledge of future bilingual mathematics teachers provided students with the opportunity to individually, at the highest possible pace, move from one level of learning material to another, higher; contributed to the formation of sustainable educational motivation, stimulation of independent search creative activity, the launch of self-education and self-organization mechanisms.

After the full learning this course using DER, a survey was conducted of future bilingual teachers of mathematics in the experimental group to identify interest in the course "History of Pedagogy and Education". The following questions were given to future bilingual teachers of mathematics for an on-line answer: Please rate the usefulness of the materials for your professional activities on a 10-point rating scale. Evaluate the level of training organization on a 10-point grading scale: 1) course program; 2) the quality of the supply of material; 3) the educational value of the content; 4) the convenience of the forum; 5) the uniformity of the training schedule. The qualification and responsiveness of the teacher: 1) the teacher successfully conducted lectures / presentations; 2) the presentations were understandable and well organized; 3) the teacher effectively used the course time; 4) it was possible to turn to the teacher for help and get it; 5) estimates were put quickly and were accompanied by informative feedback. The content of DER: 1) the learning objectives were clear; 2) the course was well organized and planned; 3) the burden on students was justified; 4) all students could participate in the discussions in full. What was the most valuable and useful thing about this center? Your suggestions for improving the center. Why did you choose this DER? Some results of the questionnaire on a 10-point rating scale are presented in table 3.

Table 3. Assessment of DER through the eyes of students on a 10-point grading scale

Please assess the usefulness of the materials for your professional activity	Assess the level of organization of training				
	Course programm	Quality of presentation of information	Educational value of content	Convenience of forum	Uniformity of a training schedule
9	10	10	9	9	10
9	10	10	10	10	10
10	10	10	10	10	10
10	10	10	10	10	10
10	10	10	10	10	10
10	10	10	9	10	10
10	10	10	10	10	10
10	10	10	9	10	10
8	9	9	9	9	10
9	10	10	10	10	10
10	8	9	9	9	10
9	8	8	8	10	10
9	9	9	9	10	10
10	9	8	9	10	10
10	10	10	10	10	10
10	9	9	9	10	8
10	8	8	10	9	10
9	10	9	10	8	8
10	10	10	10	10	10
10	8	8	9	10	10

The main purpose of studying the section of the course “History of Pedagogy and Education” is to master, first of all, the system of theoretical knowledge, which should create the basis for the formation of further practical pedagogical skills. Therefore, it was the improvement of the quality and level of assimilation of theoretical knowledge of future bilingual teachers of mathematics in this discipline that was of first interest to us in the course of the study.

Discussions

The study of psychological and pedagogical literature allows us to state the absence of special studies devoted to the problem of improving the quality of knowledge of future bilingual teachers by means of DER, in the context of real practical pedagogical activity. However, the study, due to the complexity and multifactorial nature of the studied problem, could not reveal all aspects of this problem, for example, it was necessary to study in more depth the question of the possibility and adequacy of the translation of other sections and directions of pedagogy using DER, using other types of DER and several other issues (Alger, Jordan, & Velegol, 2019). Nevertheless, various systems for assessing the quality of knowledge are considered in the works of Potashnik (2002), Subetto (2000); principles of the practical use of information technology are considered by Trainev (2005), Polat (2009).

Conclusion

Digital educational resources are modern cognitive tools that open up great prospects for improving the learning process and improving the quality of students' knowledge. The implementation of these resources in the pedagogical process implements the principle of visualization at a higher level, generates positive motivation, stimulates cognitive activity and independence of students. The effectiveness of the process of improving the quality of students' knowledge by means of DER was evaluated on the basis of the following criteria: cognitive, active, personal. Leading indicators were the levels of assimilation of knowledge on the subject, students' awareness of the relationship between concepts, knowledge of operations, the degree of students' independence in the study of new material. Experimental work confirmed the effectiveness of DER for improving the quality of knowledge of future bilingual teachers of mathematics in the educational process.

Changes in modern society require new productive approaches to the training of qualified personnel. Nowadays teaching should be considered as helping every student in the organization and rational, efficient implementation of active, independent and effective cognitive activity. In this regard, teachers have a special need for reliable pedagogical technologies that can make education flexible, combined, aimed at enhancing and improving the quality of education.

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