International Journal of Innovation, Creativity and Change. www.ijicc.net
Volume 7, Issue 12, 2019

New Technologies in Professional Mathematics Training of Technical University Students

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The quality of professional training of technical university students has to be improved. This is due to the constant technical, socio-economic development and the growing demand for the engineering profession in the labour market. The purpose of this article is to develop an approach to improving the methodological support of disciplines for the professional mathematics education of technical students. In the course of the study, the main destructive factors of providing high-quality mathematics education for students in domestic technical universities are identified. Such destructive factors are also compared with foreign ones and as a result, ways to eliminate them were proposed. The hierarchy of interdisciplinary connections of the course “Mathematics” and other disciplines in all technical areas is determined. With the use of the method of expert assessments and the method of graphs. By the method of analysing hierarchies, the priority to the formation of students' mathematics competencies is substantiated according to their future professional activities and in the process of obtaining professional mathematics education. The pedagogical conditions for the development of methodological support for technical disciplines are presented based on the following: determined interdisciplinary connections of the mathematics course with other courses; the priority of forming the mathematics competencies of students and the analysis of technical education practices in Germany, the USA, the Great Britain, the Netherlands and Portugal. A pedagogical experiment was conducted to test the developed problem-developmental exercises where such exercises took into account the requirements and priorities of modern education and proved their practical effectiveness. The findings are useful for practical implementation. They can also serve as the basis for the effective use of competency-based and interdisciplinary approaches, which are needed in providing professional mathematics education for technical students in the CIS countries and abroad.

Key words: *Technical education, mathematics training, interdisciplinary communication, conditions for effective mathematics training, modern problems of technical education.*

Introduction

Mathematics literacy is an essential condition of cultural, social and professional competency of the individual. There is the necessity of formation of specialised types and levels of mathematics competency, as universal mathematics literacy. It is relevant for various groups of professionals, including in technical and engineering areas of training. In general, maintaining a high level of mathematics competency, as well as the development of mathematics in higher education ensures the progress of technology and scientific research. It is a necessary component of the socio-economic development of the state, based on the knowledge system. In technical higher educational institutions, mathematics is a basic academic discipline that determines students' progress in mastering other natural sciences, general professional and special disciplines (Boesen et al., 2014; Maher et al., 2018).

Therefore, the quality of teaching and the completeness of the formation of competencies in students directly affects the development of dialectic thinking and the quality of the formation of skills in independent scientific research activities. In the “Concept of the long-term socio-economic development of the Russian Federation for the period up to 2020”, quality of vocational mathematics education improvement is one of the main guidelines for the development of the system of vocational education in technical universities. In pedagogical science, there is an intensive search for effective approaches to the professional mathematics training of future engineers. New educational concepts are being developed, aimed at implementing the competency approach in vocational education (Zagitova, 2013; Heitink et al., 2016; Zaikin et al., 2017; Herppich et al., 2018).

According to the estimates of Top Universities (by criteria: reliability, accessibility and productivity of higher education), Russia in 2018 ranks 15th in the world, after the United States, Great Britain, Canada, Australia, China, Japan, South Korea and leading European countries (QS Higher Education System Strength Rankings, 2018). Therefore, the techniques and experiences of leading countries should be taken into account. For example, the indicator of mathematics anxiety is an important factor in influencing the success of the education process. A study conducted in Germany shows that students might be afraid of studying mathematics due to the prevailing opinion about the complexity of this science. As well as worries about the lack of sufficient intellectual level or the presence of a high probability of learning difficulties. All this reduces the motivation and interest of students in technical professions. Germany's indicators are lower than in the USA, Italy, Poland, but higher than, for example, Iran. Moreover, girls have a higher rate of comparison to boys (Schillinge et al., 2018). It is necessary to take into account the likelihood of mathematics anxiety in the preparation of educational programs. As well as while choosing teaching methods and contributing to a decrease in this indicator. As the productivity of education directly depends on it.

In the course of training, it is important not only to form professional knowledge and skills, but also to increase the level of self-regulated learning and students' self-efficacy, as this is an important base for further growth. The study of Roick and Ringeisen proves that a high level of self-learning and self-efficacy encourages students to apply deeper learning strategies, develops skills in setting goals, planning and identifying their own current level of knowledge. Taken together, these skills contribute to improvement of the effectiveness of training, enhancement of exam results, and development of cognitive and metacognitive strategies (Roick & Ringeisen, 2018).

A quite useful study justifies the use of educational computer games (Ke, 2008). In addition to using this technique in teaching students, it is important to teach them to use games themselves in future educational activities, as well as to involve them in the development of similar games. The three-year experience of using gamification in the Netherlands and Europe shows that the technique can be used to teach technically challenging courses (75% out of 450 students have successfully completed the course on new cloud computing technologies) (Iosup & Epema, 2014). A study from Turkey shows that games increase motivation and interest; improve skills of applying theoretical knowledge in practice. It was found that the use of computer games contributes to higher levels of academic performance and creativity. The only difficulties that may arise are the availability of suitable games and the necessary technical support (Demirbilek & Tamer, 2010). It is also believed that for the introduction of this methodology and its effective use, it is necessary to improve the qualifications of the teaching staff.

The use of blogging in education is also useful. A study in the United States and Britain shows that working with blogs allows the visualisation of information, becoming acquainted with recently published studies and theories, and helps to develop students' pedagogical activities. A blog helps to express one's own views and knowledge, and thus, to educate readers (Garcia et al., 2019). In addition, blogging raises the motivation for one's own development and obtaining new knowledge for presenting this in a blog in order to gain respect, response and a positive assessment from readers and teachers, as well as provoking interesting discussions in comments. A survey of students in the USA and England showed that frequent reading, writing and commenting on blogs contributes to an increase in the level of self-education and increases the volume of perceived material by 20%. It is believed that this technique requires improvements, for example, it should take into account the individual characteristics of students. Someone may not be interested or not have the skills to write educational posts, and be enthusiastic only in reading the new information. In general, this technique is a positive phenomenon and should be adapted to the national education system and tested.

The use of augmented reality technology in higher mathematics education is as well progressive. The experience of Portugal shows that visualisation and practical application of formulas and drawings contributes to a better perception, understanding and more thorough memorisation. The educational courses include programming and development of 3D content for augmented reality and three-dimensional editing of models. A survey of participants showed that augmented reality is indeed an enhancement to the technical learning process. Students recognised that this technique facilitates the understanding of mathematics concepts, because 3D technology provides better visualisation and interaction with the material. The independent creation of 3D models helps to gain practical skills necessary in the modern technological world (Coimbra et al., 2015).

In modern conditions, engineers and technicians represent the most sought-after profession in the global labour market and in Russia as well. Consequently, the issue of improving the quality of mathematics education for students of technical areas of training is becoming increasingly relevant. Therefore, the purpose of the study is to analyse the methods used in technical domestic education and compare them with foreign ones. As a result, develop a methodological approach to improve the quality of mathematics training for technical students.

Methods

The following methods of scientific knowledge serve as the methodological basis for the study: 1) the method of collective expert assessments used to determine the complementarity of the "Mathematics" course with other academic disciplines for technical students based on the opinions of leading university teachers; 2) the method of graphs (a mathematical method of research, a model of a real system, represented as a set of objects and a set of connections between objects), used to define interdisciplinary connections of mathematics with other disciplines.

The hierarchy analysis method by T. Saaty (Aldamak & Zolfaghari, 2017) is a multi-level peer review method used to determine the priority for students to form mathematics competencies. The method of analysing hierarchies is based on decomposing the problem into relatively simple constituent parts with the subsequent processing of the sequence of judgments, by means of pairwise comparison. The system of paired judgments based on the analysis of the hierarchy of T. Saaty leads to a result that is represented as a logical matrix (Table 1).

Table 1: Matrix of paired judgments based on the analysis of the hierarchy of T. Saaty

Factor	1(j factor)	…	n
1 (i factor)	1		a (i,j)
…		1	
n	a (i,j)		1

Matrix element a (i,j) is determined by comparing the importance of the i factor with the j factor on an intensity scale from 1 to 9, where the estimates have the following definition:

9 - equal importance;
3 - moderate dominance of the i factor over the j factor;
5 - a significant advantage of the i factor over the j factor;
7 - a notable advantage of the i factor over the j factor;
9 - a very strong advantage of the i factor over the j factor;
2, 4, 6, 8 - the corresponding intermediate values.

The prioritisation of criteria (main activities of technical university graduates and the type of mathematics competency) is carried out using the formulas (1-2) (Aldamak & Zolfaghari, 2017):

$$w_i = \sqrt[n]{\prod_{i=1}^{n} a_{ij}}$$

(1)

$$w_{norm} = w_i / \sum_{i=1}^{n} w_i$$

(2)

W – matrix vector component (average value of priority estimates);
W_{norm} – normalised matrix of paired judgments (priority vector);
aij – matrix element values.

To assess the consistency of expert assessments, indicators of the consistency index and the consistency ratio are calculated (formulas 3-5) (Aldamak & Zolfaghari, 2017):

$$\lambda = \sum_{i=1}^{n} a_{ij} \cdot w_{norm_i}$$

(3)

$$I_c = (\lambda - n)/(n-1) \leq 0{,}2$$

(4)

$$CR = I_c / I_{ca} \leq 0{,}1$$

(5)

λ – matrix eigenvalue;
Ic – consistency index;
Ica – the average value of the consistency index (table 2) (Aldamak & Zolfaghari, 2017);
CR – consistency ratio;
n – number of criteria (alternatives).

Table 2: The average value of the expert assessments consistency index

Dimension of the matrix	1	2	3	4	5	6	7	8	9	10
The average value of the consistency index (Ica)	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

The global vector of priorities of mathematics competency of students is determined by the formula (6) (Aldamak & Zolfaghari, 2017):

$$A = W^1 \cdot W^2 \cdot \ldots \cdot W^n$$
(6)

W^1 – 1^{st} level priority vector;
W^n – n hierarchy level priority vector.

The reliability of the results of the pedagogical experiment is determined by the sufficiency of the sample, which for a large general totality (> 30 people) is estimated by the formula (Reid, 2015):

$$SS = \frac{Z(\alpha)^2 \cdot p \cdot (1-p)}{\varepsilon^2}$$
(7)

SS – sample size;
Z(α) – normalized deviation;
α – confidence level;
p – sample variation;
ε – acceptable error level.

The effectiveness of the pedagogical experiment for the formation of mathematics competency is determined by the formula (Walder, 2017):

$$E = \frac{E_e}{E_c},$$
(8)

E_e – level of mathematics competency in the experimental group;
E_c – level of mathematics competency in the control group.
The level of mathematics competency (formula 8) corresponds to a certain part of the correct answers to tests, expressed in shares (Berestneva et al., 2015):

$E_e = \frac{X_e}{X_e+Y_e}$,
(9)
$E_c = \frac{X_c}{X_c+Y_c}$,
(10)

X_e – the amount of the correct answers to the tests in the experimental group;
Y_e – the amount of incorrect answers to the tests in the experimental group;
X_c – the amount of correct answers to the tests in the control group;
Y_c – the amount of incorrect answers to tests in the control group.
A pedagogical experiment was conducted, which made it possible to test in practice the effectiveness of the proposed seminar.

The experiment was conducted in the control group during the semester in seminars and as tasks for independent work of students. Pedagogical conditions of study are:
- the use of the same mathematics object in different academic disciplines;
- the use of the same method in different academic disciplines;
- the use of the same theory in different academic disciplines.

There were 300 students in the 4th year of field of study “Oil and gas business” participating in the experiment.

The size of the sample should exceed 273 people in order to ensure the sufficiency of a large sample with a confidence level of 90% and a confidence interval of ± 5% (Reid, 2015). The number of students who took part (300 people) exceeds the minimum sufficiency threshold, which indicates the representativeness of the results of the experiment.

The experiment involves the allocation of experimental (a group of students for whom the experiment was conducted - which participated in interdisciplinary seminars) and the control group (not covered by interdisciplinary seminars). The ratio of experimental and control groups was 70:30. Knowledge examination of the experimental and control groups was carried out by testing, which helps to assess the level of students’ competencies.

Results and Discussions

The main problems of professional mathematics training of technical students

After analysing the methods of technical education in the United States, Germany, Portugal and others, it can be observed that they are aimed at eliminating previously identified gaps in education. They are also aimed at modernisation and improvement of education's efficiency, as well as increasing the interest among young people in technical professions. To apply this approach in Russia, it is needed to identify the problematic issues of technical education, and more specifically, mathematics preparation.

Comparing the volumes of the mathematics study load of engineering students in the modern education system and in the Soviet Union, a significant decrease in the total volume of classroom session by 45% can be noticed. A decrease in the number of lecture hours by 43% and seminars by 48%, which significantly reduces the quality of education of university graduates (Portal of the Federal State Educational Standards, 2018). In addition, such educational disciplines as “Vector analysis” and “Complex numbers; the theory of functions of a complex variable” were removed from the curriculum. The current situation is caused by the inconsistency between the following two indicators. First, the lack of state standards for allowed time for the education of engineers of a particular specialty. Second, the state educational standards of higher education (Portal of Federal State Educational Standards, 2018). On the one hand, this opens up the possibility for students to develop self-study skills and self-regulation of studies, but due to the lack of experience in using this practice, the current situation has provoked the infringement of fundamental disciplines in the preparation of curricula for technical universities.

The other destructive factor is the gap between the level of mathematics preparation of school graduates and the needs of universities (Gerasymenko et al., 2017). The current situation is caused by:

1. Inappropriate level of mathematics training of applicants due to the lack of professional qualifications of teachers, as well as the lack of continuous and convenient system of advanced training. The prevailing number of students in technical universities of Russia have the number of Unified State Examination points in elementary mathematics from 27 to 60 (Gerasymenko et al., 2017).
2. Inconsistency of school mathematics curricula with university ones.
3. Introducing interviews and testing as entrance exams in mathematics instead of solving complex logical problems in writing, which led to a decrease in the level of students' mathematics preparation, the variability of students’ thinking and the seriousness of their preparation.

An essential negative aspect of the mathematics training of engineers is also the theorisation of higher mathematics as a field of study. In most Russian technical universities, students do not receive skills in applying mathematics knowledge (Maheretal., 2018). Interdisciplinary connections between fundamental and special disciplines should be provided for comprehensive mathematics education. The inclusion of main material in general education courses should not lead to a violation of intra-subject relations, the logic of discipline, or turn it into a cycle of separate, unrelated issues. Methodological support for mathematics courses should be developed taking into account the requirements of special disciplines. That is, mathematics training should include coverage of technical and economic issues, natural appearances, reflecting the systematic links of mathematics theories with functional practical tasks.

Definition of interdisciplinary relations of mathematics with other academic disciplines

To determine the interdisciplinary relations of mathematics with other disciplines, studied by students of technical specialties, the branch of Tyumen State University in the city of Noyabrsk was taken as the object of research. The study was conducted based on curricula for field of study “Oil and gas business”, “Technologies of transport processes” and “Electrical power and electrical engineering”. Versatile areas of training are used to provide a comprehensive study of the interdisciplinary relations of mathematics with other disciplines and to identify their features in different areas of professional training. Such an approach will contribute to the development of the general scientific outlook and the formation of integral scientific thinking. The establishment of relations between the disciplines stipulated by the curricula in the above areas of training carried out based on collective assessments.

Collective discussion led to a consensus. On this basis, it was not necessary to assess the degree of consistency of expert opinions. The results of the collective discussion are agreed, and the established system of interdisciplinary relations and the hierarchy of disciplines are significant and reliable. A hierarchy model is built, using the method of directed graphs. This was in order to establish the relations of mathematics with other disciplines, and their priorities. The initial stage of building a hierarchy model is the establishment of relations between disciplines and these form the curriculum in technical faculties.

The purpose of education is to form certain competencies. Hence, interdisciplinary relations are determined based on the competencies that are formed according to the studied academic disciplines. The competency format of education allows realising the principle of individual readiness to solve a clearly defined list of professional tasks. Such tasks are represented by the unity of knowledge, proficiency and skills. In addition, several academic disciplines are needed for the formation of one competency. Such disciplines may relate to different fields of study (Guerrero-Roldán & Noguera, 2018; Herppich et al., 2018).

The following disciplines are used for the determination of interdisciplinary relations. The disciplines, that are able to form interdisciplinary relations with mathematics and their hierarchy were also developed (Table 3).

Table 3: The hierarchy structure of the technical disciplines based on interdisciplinary relations

Level	Disciplines
Field of study "Oil and gas business"	
1	"Mathematics"
2	"Physics", "Mathematics modeling in the tasks of the oil and gas industry", "Management of innovative projects"
3	"Computer science", "Descriptive Geometry", "Problem solving of Mathematics Physics", "Computer Design", "Economics"
4	"Electrical Engineering", "Metrology, Qualimetry and Certification", "Interpretation of the Results of Hydrodynamic Research", "Fundamentals of Engineering Design", "Numerical Methods", "Geological Modeling", "Applied Software Products"
5	"Resistance of Materials", "Theory of Machines and Mechanisms", "Parts of Machines and Design Basics"
Field of study "Technologies of transport processes"	
1	"Mathematics", "Physics"
2	"Information logistics on transport", "Information technologies on transport", "Fundamentals of engineering design", "Metrology, standardization, certification", "Computer science"
3	"Modeling of transport processes", "Logistics of integrated supply chains", "Management of innovative projects", "Economy of the industry"
4	"Logistics of freight traffic", "Logistics of passenger traffic"
5	"Management of technical systems"
Field of study "Power and Electrical Engineering"	
1	"Higher Mathematics", "Special Mathematics", "Mathematical Statistics", "Mathematical Logic"
2	"Computer science", "Physics", "Chemistry", "Numerical analysis", "Economics"
3	"Physical fundamentals of electronics", "Theory of control engineering in electrical systems", "Computer-aided design", "Theoretical and applied mechanics", "Electrical engineering and structural materials science", "Theoretical fundamentals of electrical engineering", "Mathematical modeling of power supply systems", "Fundamentals of engineering design", "Computer modeling", "Project management of innovative development", "Transient processes in electric power systems"
4	"Electrical engineering and structural materials science", "Metrology, standardization and certification", "Mathematical problems in the power industry", "Electronics", "Microprocessor systems"
5	"Physics of electrical materials", "Management of innovative projects"

6	"Engineering graphics"
7	Technological processes of oil industry objects, Technological processes of gas industry objects

Based on the results obtained in Table 3, the following can be stated. Mathematical disciplines (in particular, "Mathematics") are at a basic level for technical students, regardless of the field of study. Mathematical disciplines also form the framework for mastering competencies in other disciplines. The methodological support of professional mathematical training of students was analysed. In the process of learning, students acquire constructive-computational, diagnostic-design, communicative-managerial, constructive-creative competencies. The hierarchy analysis method by T. Saaty (Aldamak & Zolfaghari, 2017) is used to determine the priority of mathematical competency formation among students. In this method, groups of mathematical competencies serve as alternatives. The possible activities of the graduate represent the criteria for ranking competencies by priority. Such activities include main (by technical specialty), scientific (research work), pedagogical (work at the university).

Thus, the key mathematical competencies for the implementation of professional activities after graduating are identified. According to the Saaty method using formulas 1–2, the following priority values are achieved for the relevant criteria: "Main activity" 0.65; "Scientific activity" 0.28; "Pedagogical activity" 0.07 (table 4). The hierarchy shows the priority of mathematical competencies' formation. It can be assumed that the main activity is predominant for university graduates.

Table 4: Priority criteria for the formation of mathematical competency of technical students

	Main activity	Scientific activity	Pedagogical activity	W_i	W_{norm}
Main activity	1	3	7	2.76	0.65
Scientific activity	1/3	1	5	1.19	0.28
Pedagogical activity	1/7	1/5	1	0.31	0.07
$\sum$	1.48	4.20	13.00	4.25	1.00
λ	3.06				
Ic	0.03				
CR	0.06				

Similarly, using the hierarchy method and formulas 1-2, calculations were made of the priority formation of mathematical competencies for each type of students' professional activity. The priority values of alternatives according to the criteria of mathematical competency are presented in Tables 5-7.

Table 5: Priority of mathematical competencies by the criteria of main activity

Alternatives	Constructive-computational competency	Diagnostic-design competency	Communicative-managerial competency	Constructive-creative competency	Wi	W_{norm}
Constructive-computational competency	1	3	9	5	3.41	0.55
Diagnostic-design competency	1/3	1	7	5	1.85	0.30
Communicative-managerial competency	1/9	1/7	1	1/5	0.24	0.04
Constructive-creative competency	1/5	1/5	5	1	0.67	0.11
∑	1.64	4.34	22.00	11.20	6.16	1.00
λ	4.27					
Ic	0.09					
CR	0.10					

Table 6: Priority of mathematical competencies by the criteria of scientific activity

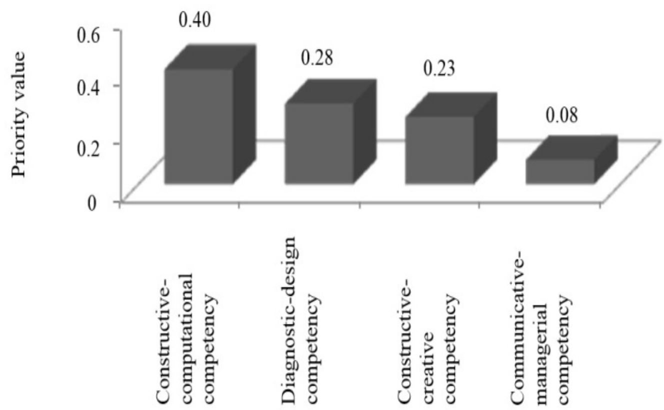
Alternatives	Constructive-computational competency	Diagnostic-design competency	Communicative-managerial competency	Constructive-creative competency	Wi	W_{norm}
Constructive-computational competency	1	1/3	3	1/5	0.67	0.12
Diagnostic-design competency	3	1	5	1/3	1.50	0.26
Communicative-managerial competency	1/3	1/5	1	1/7	0.31	0.06
Constructive-creative competency	5	3	7	1	3.20	0.56
∑	9.33	4.53	16.00	1.68	5.68	1.00
λ	4.12					
Ic	0.04					
CR	0.04					

Table 7: Priority of mathematical competencies by the criteria of pedagogical activity

Alternatives	Constructive-computational competency	Diagnostic-design competency	Communicative-managerial competency	Constructive-creative competency	Wi	W_{norm}
Constructive-computational competency	1	1/2	1/5	2	0.67	0.12
Diagnostic-design competency	2	1	1/5	2	0.95	0.17
Communicative-managerial competency	5	5	1	5	3.34	0.62
Constructive-creative competency	1/2	1/2	1/5	1	0.47	0.09
∑	8.50	7.00	1.60	10.00	5.43	1.00
λ	4.12					
Ic	0.04					
CR	0.04					

Based on the data in Tables 5–7, the following can be concluded. In the process of mathematical preparation of students for main activities, the following should be emphasised. The development of general analysis, perception of information, use of the basic laws of mathematical disciplines in professional activities. As well as integration of knowledge from different sections and disciplines, ability to apply analytical, computational methods in the course of professional activities etc. For future scientific activities in the field of engineering, taking into account the greatest importance of competency, it is necessary to actualise the possession of the following skills. Cognitive activity, understanding of a holistic picture of the world, using information to solve vital problems, developing the capacity for productive, reproductive cognition and independent cognitive activity. For the implementation of professional pedagogical activity, the formation of the following skills is a priority. The ability to work with various sources of information, mastering ways to transform information effectively. As well as the ability to create motivation to learn, ability to present the results of scientific and methodological activities. The global vector of competency priorities in the process of professional mathematical training was calculated. The integral levels of significance of mathematical competencies are obtained, based on the results of the calculation (Figure 1).

Figure 1. The value of the global vector of students' mathematical competency priorities, in terms of professional activities



The hierarchy of global mathematical competencies priority, taking into account the priority of activities, constitutes the following values. 0.40 - for constructive-computational competency; 0.28 - for diagnostic-design competency; 0.23 - for constructive-creative competency; 0.08 - for communicative-managerial competency. The study showed that the most significant and decisive mathematical competency is constructive-computational, ensuring a high level of professional and scientific activities of university graduates. Based on the obtained data, a material was developed and an experiment was conducted to test the effectiveness of the developed material. The result showed that the material contributes to the development of constructive-computational, diagnostic-design, constructive-creative, communicative-managerial competencies. According to the results of the semester work, as a result of testing, it was determined that the performance indicator for the control group of students in the “Oil and Gas Business” field of study is 1.4. Values bigger than 1.0 indicate the effectiveness of the proposed interdisciplinary approach. Since the level of mathematical competency of the experimental group for all fields of study exceeds the level of competency of the control group (Walder, 2017). The dispersion coefficient of the results of evaluating the effectiveness is 4.88%. Since the value of the coefficient does not exceed 10%, this indicates a weak variability of the efficiency indicator. Thus, the statistical significance of the experimental results (Rousseau et al., 2018). The hypothesis about the random nature of the obtained results is rejected. The proposed approach to providing high-quality professional mathematics education will have the same effect for students of all technical specialties.

The proposed approach has shown its overall effectiveness for providing professional mathematical training. It is also appropriate for developing methodological support for the Mathematics course, taking into account other academic disciplines for technical students, although it requires some modifications. Prospects for further research could be in the adaptation of practices mentioned above. For example, there is an urgent need to assess the level of mathematical anxiety. There must be a revision of the methods, forms of training based on the results obtained and the creation of conditions for reducing anxiety, as the effectiveness of education directly depends on it. Ways to motivate self-education should also be considered. An attempt to assess the effectiveness of using a blog and the function of augmented reality will be quite innovative. In case of positive results, this will take the Russian education system to a new level.

Conclusion

The main problems of improving the quality of professional mathematical training of students in technical universities of Russia in modern conditions are as follows: the tendency to reduce classroom hours in mathematics; the lack of state standards for time allotted for the training of engineers in various specialties; the inappropriate level of school mathematics training; the widening gap between the level of mathematical preparation of school graduates and the needs of Russian universities; the theorisation of the higher mathematics as a training course; interdisciplinary relations were determined; and their hierarchical structure was formed for mathematical training of technical students. Based on this, it can be stated that mathematical disciplines serve as the basis for the formation of competencies in other complementary training courses. Students' mathematical competencies hierarchy has been developed, according to the global priority vector: 0.40 - for constructive-computational competency; 0.28 - for diagnostic-design competency; 0.23 - for constructive-creative competency; 0.08 - for communicative-managerial competency. These results should be taken into account in the development of methodological support for academic disciplines of technical specialties. The methodological approach is presented for the formation of interdisciplinary connections of the Mathematics course and other courses. Which is based on the following: intensification of the formed concepts; familiarising with scientific methods and the scope of use. As well as usage of theories and laws to explain various appearances. Also taking into account the priority of forming students' mathematical competencies.

The approach used in the study is characterised by universality and efficiency of practical use. Hence, the data presented in the study will be useful to all educational institutions. As they might improve the quality of professional mathematical training in all technical specialties. Scientists might apply this approach in practice, compare the obtained results with those presented in the study, as well as assess and revise the effectiveness of the technique in their conditions.

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