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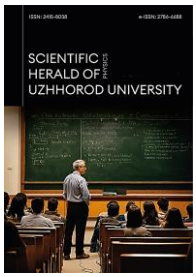

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Development of professional competencies of future technical university specialists through professionally-oriented teaching of mathematics

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Abstract

Relevance. In modern conditions of globalisation, the issue of the prospects for the organisation of professionally oriented mathematics education in the Republic of Kazakhstan is one of the most important problems for improving the quality of technical education in the state.

Purpose. The purpose of the study is the analysis and practical implementation of the methodological component to increase the levels of readiness of future specialists of a technical university for the development of professional competencies, as a guarantee of the education of a competent specialist ready to carry out professional activities.

Methodology. The following methods are used: analysis, comparison, systematisation, classification, generalisation and experiment, and methods of mathematical statistics.

Results. The study conducted at Korkyt Ata Kyzylorda University developed a methodological toolkit aimed at enhancing the professional competencies of future technical university specialists through professionally-oriented mathematics education. Key findings include the identification of effective pedagogical conditions, such as diverse educational activities, the activation of independent cognitive work, the integration of digital technologies in mathematics education, and the use of professionally-oriented tasks, which collectively contribute to higher levels of readiness among students.

Conclusions. The research underscores the importance of a structured approach to professionally-oriented mathematics education in technical universities. By implementing a methodological system that incorporates components and criteria of readiness, educational institutions can significantly improve the professional competencies of future specialists. The study suggests that further refinement of these methodologies can continue to elevate the quality of technical education in the Republic of Kazakhstan, ensuring that graduates are well-prepared for professional activities.

Keywords: higher education; teaching methods; components of readiness; pedagogical conditions of training; digital technologies.

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Introduction

Higher education in Kazakhstan in the 21st century requires the restoration of approaches to the implementation of professionally oriented education. This approach is conditioned upon the active process of informatisation of society. Ensuring the implementation of these areas requires the search for new ways to improve the educational process, the development and implementation of modern innovative methods, forms and technologies for the organisation of professionally oriented mathematics education [1, 2].

The relevance of this issue is conditioned to the insufficiency of theoretical and methodological development of modern methods of organising professionally oriented training of future specialists of a technical university on the way to the development of professional competencies. There is a need to introduce computer technologies into the educational process of training future specialists of a technical university, the widespread introduction of advanced information technologies in the process of professionally oriented mathematics education in the Republic of Kazakhstan [3, 4].

According to M. O'Sullivan [5], the construction of a high-quality training system for future specialists of a technical university should be implemented through the development of a system of professional competencies. A higher educational institution, in particular a technical one, should be focused on professionally oriented teaching of mathematics as a fundamental discipline in the professional training of highly qualified specialists who are competitive in the labour market. However, the method of development of professional competencies has not been considered by researchers. The issue of building a clear structure of the methodological system of teaching mathematics needs to be resolved.

Exploring the issues of the development of professional competencies of future specialists of the technical university, Z.M. Ozhybaeva and N.N. Nurmukhanbetova [6], identified the mathematical skills that future specialists should possess, namely: mathematical thinking, argumentation, communication and modelling, effective solution of mathematical problems, the ability to represent data, operate with mathematical constructions and actively use mathematical tools. The researchers propose to combine the designated components into three classes of competencies: reproduction, definitions, calculations, the ability to reproduce mathematical constructions, the ability to master the definitions of mathematical objects; ensuring the structuring and integration of material for solving problems; providing mathematical thinking, generalisation and insight, but do not provide methods for their development.

A.B. Aitbaeva and Zh.N. Shaihozova [3] consider that teaching mathematics should be carried out by fulfilling two main tasks, namely: the presentation of mathematics as a basic science and the active use of mathematical techniques in the development of professional competencies. However, the study supports the opinion of researchers that one of the main problems of the quality of technical education is the insufficient practical implementation of the principle of professionally oriented teaching mathematics, which can be improved by strengthening the components of the methodological system used in practice. It is necessary to specify the components of the methodological system that are not considered by scientists.

The modern methodological system of teaching mathematics in higher technical educational institutions of the Republic of Kazakhstan requires teachers to actively use professionally oriented training based on the use of a technical and research approach. Ensuring a high level of motivation to study mathematics according to A. Marougkas et al. [7] should be implemented by solving professional-oriented tasks aimed at increasing interest in the study of professional disciplines and the development of professional competencies. Since researchers do not provide specific examples of the use of professionally directed tasks, there is a need to develop them.

The use of professionally oriented mathematics education, in particular the use of professional tasks, occupies an extremely important place in the educational process of higher educational institutions of a technical profile. According to researchers, the use of such training is aimed at activating the educational process, ensuring an increase in the level of mathematics education, and establishing close ties with future professional activities. However, the researchers do not consider a specific model of professionally oriented mathematics education.

According to R.S. Palais [8], the solution to the problem of the development of professional competencies of future specialists is becoming relevant and needs to be solved. The researcher considers the opinion that the professional direction and motivation for fruitful work allow a specialist to ensure their realisation in line with professional activity and self-improvement. That is why the priority area of improving the quality of professional training of future specialists of a technical university is the development of professional competencies, which has not been fully considered. The problem of studying professionally oriented mathematics education is complex and requires an immediate solution.

The purpose of the study is the practical implementation of the components of the readiness of future specialists of higher education of the Republic of Kazakhstan to develop professional competencies in technical universities based on the use of professionally oriented mathematics education. The following tasks that need to be solved in the process of conducting the study are highlighted:

– to analyse the experience of the development of professional competencies of future specialists in technical universities in Kazakhstan;

– to develop and verify the components of the readiness of future specialists in technical universities of the Republic of Kazakhstan for the development of professional competencies;

– to select the necessary methodological tools for the development of the readiness of future specialists in technical universities of the Republic of Kazakhstan to form professional competencies in the context of the use of professionally oriented learning in the process of teaching mathematics;

– to approbate methodological tools aimed at developing the readiness of future specialists in technical universities of the Republic of Kazakhstan to develop

professional competencies through professionally oriented training.

The solution of the problem outlined above will contribute to the effective development of a complex of professional competencies of future specialists in technical universities as a guarantee of their competitiveness in the labour market, and solving urgent tasks and problems of implementing professionally oriented training in the process of teaching mathematics.

Materials and Methods

The research process consisted of theoretical (analysis, comparison, systematisation, classification, generalisation) and practical (experiment: ascertaining, formative, and control) stages.

A theoretical study of the problems of methodology of organisation of professionally-oriented teaching of mathematics in higher technical educational institutions of Kazakhstan in the development of professional competencies of future specialists was carried out. The following methods were used at this stage: analysis, comparison, systematisation, classification and generalisation of theoretical data on the development of professional competencies in universities of the Republic of Kazakhstan. Additionally, modelling of the process of diagnosing the levels of organisation of professionally oriented mathematics education for future specialists of a technical university using the developed components of readiness of future specialists of a technical university to develop professional competencies. Moreover, the investigation of the existing methodology for the organisation of professionally oriented training of future specialists of technical education in universities of the Republic of Kazakhstan. These methods were used at the stage of determining the existing level of readiness of future specialists of a technical university to develop professional competencies.

The practical stage consisted of the implementation of a methodology for the organisation of professionally oriented mathematics education with outlined readiness components. The implementation of the selected methodology was carried out at the Korkyt Ata Kyzylorda University (Kyzylorda). To ensure the representativeness and reliability of the sample, the features of group formation, age and gender of respondents were determined. The establishment of the research array was carried out by pairwise selection. The sample consisted of 86 respondents whose age category is in the range from 18 to 21 years. The control group included 62 respondents, and the experimental group included 24 participants. There were no significant differences between the experimental and control groups before the experiment. The established groups included respondents who studied in the same course and educational training programme. The establishment groups – experimental and control – was carried out by analogy with one another for all the studied signs, which allowed for comparative observation. The results of experimental studies were evaluated at high, average, and low levels. The experiment was conducted during the 2022-2023 academic years.

To increase the level of readiness of future specialists of a technical university for the development of professional competencies at the ascertaining stage of the experiment, the following components of readiness were identified, namely: motivational, cognitive and operational, and reflexive. The levels of readiness of future technical university specialists for the development of professional competencies through professionally oriented training were determined.

Using a competence-based approach, the necessary methodological tools were selected to ensure the high-quality implementation of professionally oriented training of future specialists of a technical university for the outlined components of the readiness. Pedagogical conditions have been created; technological models have been developed; concepts of the information educational environment of technical universities have been used; the necessary methodological tools have been selected to ensure the high-quality implementation of professionally oriented training.

At the ascertaining stage of the experiment, to determine the levels of development of the motivational component, the methodology for determining the motivation to study at a university according to T. Ilyina [9] was used; the level of development of the cognitive and operational component was carried out using testing in the discipline "Mathematics"; testing of the reflective component was carried out by students solving individual tasks aimed at developing self-reflection. Based on the results obtained at the ascertaining stage of the experiment, conclusions were drawn about the need to select methodological tools to increase the levels of development of professional competencies of future specialists of a technical university.

At the formative stage of the experiment, a test of the selected methodological system aimed at the development of professional competencies of future specialists of a technical university was carried out, which was introduced in the author's special course "Methods for solving professionally directed problems in mathematics". The special course is a course of choice, which consists of two modules designed for two semesters of study for students at the 4th year of bachelor's degree.

The content of the first module includes topics that reveal the essence of professionally directed tasks and their role in the development of professional competencies. For example, it was proposed on the topic of "Differential calculation" such topics as "Gradient, directional derivative", "Extremum and the largest, smallest value of a function of several variables" the following tasks: to calculate the gradient and derivative for a given function; to solve a technical problem with an explanation in terms of applying knowledge on the topic "Differential calculation". Next, the task is checked and evaluated. In order to avoid cheating in the test paper, some questions of independent assignments were included. The second module was devoted to a variety of methodological components aimed at the high-quality organisation of professionally oriented training.

After receiving the results of the study, a control stage was carried out at the ascertaining and formative stages. The analysis of the obtained results, which were processed according to the Pearson x^2 criterion, was carried out, their generalisation was carried out, conclusions were drawn and prospects for further research were outlined.

Results

According to the present requirement in the labour market, a graduate of a technical university must have technical thinking, be focused on self-improvement, and self-organise own activities aimed at creating an innovative product. The integration of the components of the professional orientation of educational activities, the harmonious construction of this synergy can become a mechanism not only for intellectual, emotional-behavioural, and motivational, but also for the professional development of future specialists of a new generation [10].

At the current level of development of the higher technical education system in the Republic of Kazakhstan, the state's entry into the global educational space is becoming important. The educational component is changing dynamically today. In order to implement the updated goals of higher technical education, it is necessary to educate a specialist who must possess mathematical knowledge and be able to apply it in professional activity. In modern conditions, the issue of organising professionally oriented training of future specialists of a technical university in the process of developing professional competencies is becoming relevant in an information and educational environment. Future specialists studying in such an environment should develop professional competencies at a high level [11, 12].

The system of mathematical training of future specialists in higher educational institutions of Kazakhstan is undergoing reorganisation by differentiating the content of the disciplines of the mathematical cycle, changing the sequence of studying material from mathematics, introducing the latest teaching methods and technologies into the educational process. Mathematics, which is a basic discipline in the curricula for the training of technical specialists, plays an important role in their professional development.

The implementation of high-quality training of future university specialists in technical profile in higher educational institutions of Kazakhstan based on professionally oriented training is the newest educational direction that is on the path of active development [13]. The development of professional competencies of future specialists of a technical university in the higher education system is a prerequisite and an indicator of the readiness of specialists for professional activity. In particular, the introduction of professionally oriented mathematics education into the practice of training a future specialist of a technical university, the content of which is based on a competence-based approach plays an important role in general education training [14].

The process of developing professional competence acts as an effective tool for the future professional activity of specialists, ensures the activation of educational and cognitive activities, and strengthens the motivation for studying mathematics. The use of professionally oriented education in the study of mathematics provides immersion in aspects of future professional activity, namely: the inclusion in the content of professional knowledge expressed through the connection of mathematical concepts, theorems, and methods with the future profession. Such knowledge forms the psychological readiness of a specialist to apply mathematical knowledge in professional activities, mathematical modelling skills in the aspect of future activities. The development of such skills is aimed at the ability to solve professionally oriented mathematical problems, which can be obtained only under the condition of professionally directed training (consideration of such tasks in the classroom, problem situations, business games) [15].

The educational course "Mathematics" in technical universities of the Republic of Kazakhstan is designed to ensure stable possession of a system of mathematical knowledge. It aimed primarily at: general development of students, practical activities, acquisition of competencies in disciplines of a related cycle. Namely: physics, chemistry, technology, continuation of specialised education.

The general educational goals of mathematics include familiarisation of students with scientific research methods such as analysis, synthesis, induction, analogy. Students at the Korkyt Ata Kyzylorda University do not study numerous sections of mathematics in full, which are not related to the disciplines of the professional cycle, including: theory of differential equations, functional analysis, applied statistics, decision theory [16]. At the request of the present, the use of digital learning technologies in the context of professionally oriented mathematics education is becoming important in the field of technical education. That is why the solution to this problem should be considered as one of the necessary conditions for the development of professional competencies of future specialists of technical universities.

In the process of studying the special course "Methods for solving professionally oriented problems in mathematics", pedagogical conditions have been implemented that most effectively affect the process of providing professionally oriented mathematics education in the process of forming the professional competence of future specialists of a technical university, namely:

- variety of forms of educational activity;
- activation of independent cognitive activity;
- use of digital technologies in the process of studying mathematics;
- use of professionally oriented tasks.

The system of mathematical training of future specialists of a technical university based on professionally oriented education in the Republic of Kazakhstan is undergoing reorganisation by differentiating the content of disciplines, changing the sequence of studying the material, introducing the latest teaching methods and technologies into the educational process.

The components and criteria of its organisation, namely: motivational (value criterion), cognitive and operational (knowledge-operational), and reflexive (subjective), have been identified for the implementation of readiness of future specialists of higher education institutions of technical profile to form professional competencies.

Motivational (value criterion) – consists of goals, motives, needs, values, and professional interests; The essence of the motivational component is to implement a system of motives and needs in organising the process of professionally oriented training of future specialists of a technical university, encouraging them to study on the basis of autonomy, stimulating and supporting the activity of students at a certain level. The motivational criterion is

designed to reflect the attitude of students to the learning process, to use technologies that promote the assimilation of knowledge, using digital learning tools, increasing the degree of motivation to perform professional tasks, striving for self-development and self-improvement. The motivation of students is accompanied by utilitarian and practical motives, acquires personal significance, which is able to turn the goals and objectives outlined by the teacher into internal needs.

Cognitive and operational (knowledge-operational) manifests itself in the presence of knowledge: general professional, special, methodical; mathematical skills and abilities for their implementation in practice. A certain criterion reflects didactic and methodological knowledge of mathematics, and forms, methods, types of digital technologies and patterns of their use in the educational process when training future specialists of a technical university. The criterion involves the development of professional competencies and the definition of ways to manage such processes.

Subjective (reflexive) – manifests in the ability to analyse psychological characteristics and professional inclinations, predict and control the results of their activities; the ability to mobilise their own potential, mobilise creative energy, the ability to express themselves, self-development, and self-improvement. The criterion reflects the level of professional competencies of future specialists of a technical university using professionally oriented training, the ability to carry out reflection.

To determine the levels of development of the components of the studied readiness, the ascertaining stage of the experiment was carried out. In the control group, which was trained according to the conventional method, readiness for the development of professional competencies was checked for three components of readiness during the study of the subject "Mathematics". To obtain the level of development of the motivational component, the method of investigating motivation for studying at a university according to T. Ilyina [9] was used; cognitive and activity – by conducting multi-level testing in the discipline "Mathematics" to assess the professional competencies of students. The development of the reflexive component was checked by students solving individual tasks aimed at developing self-reflection.

The results obtained at the ascertaining stage of the experiment in the control group were processed and presented in Figure 1. Several other results obtained at the ascertaining stage of the experiment in the experimental group and presented in Figure 2.

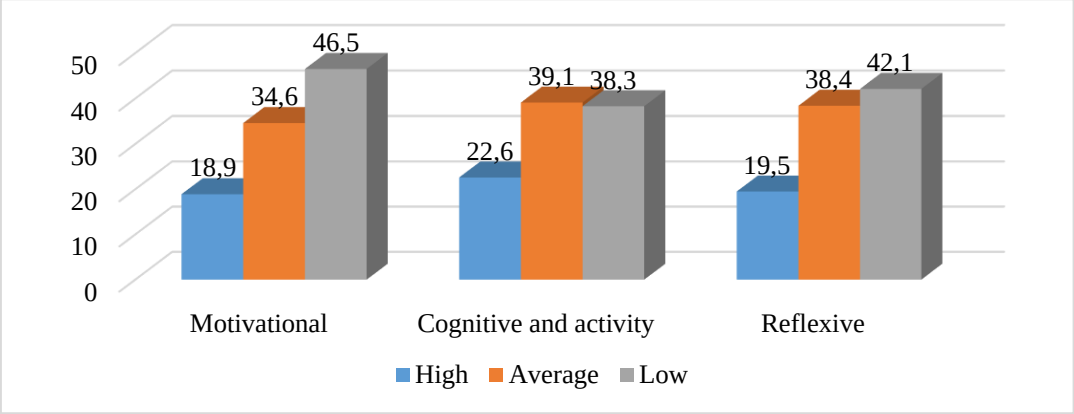

Figure 1. Results of checking the readiness level at the ascertaining stage of the experiment in the control group

Source: compiled by the authors.

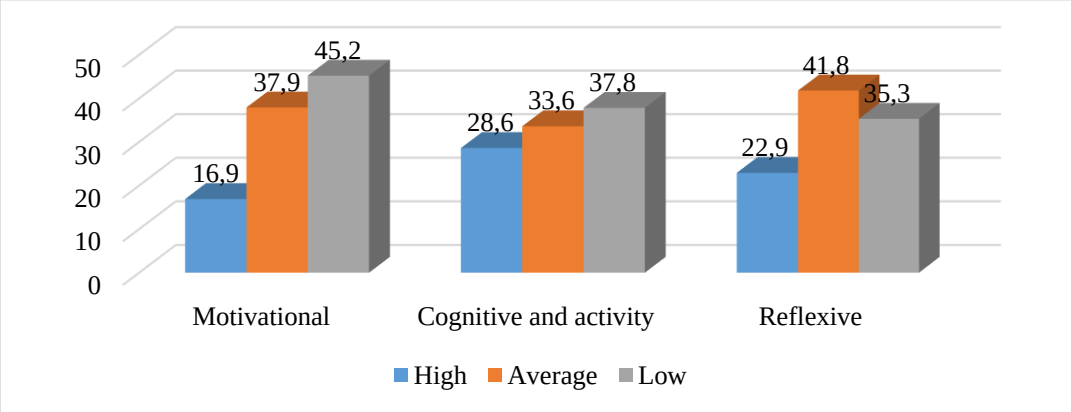

Figure 2. Results of checking the readiness level at the ascertaining stage of the experiment in the experimental group

Source: compiled by the authors.

Based on the data obtained at the ascertaining stage of the experiment, it was concluded that the respondents of the control and experimental groups are at a low and average level of readiness for the development of

professional competencies through professionally oriented mathematics training for all components. Such results indicate the need to develop a methodological system for teaching mathematics based on professionally oriented learning. In the course of the experiment, the features of the theoretical and practical foundations for the implementation of professionally oriented training of future specialists of a technical university and the corresponding methodological techniques reflected in the current teaching programme of the "Mathematics" course and the author's special course "Methods for solving professionally oriented problems in mathematics" at Korkyt Ata Kyzylorda University were highlighted.

The following criteria were used in the selection process:

– general didactic – aimed at ensuring scientific, professional, consistency, connection of theory with practice, computer and "traditional" visualisation of educational information, awareness, activity and independence of students in the assimilation of knowledge;

– general psychological – is designed to ensure proper motivation of students in the organisation and implementation of professionally oriented study of mathematics, conducting pedagogical and computer support of the educational process;

– methodical – ensuring the regularity, algorithmicity, phasing and consistency in the assimilation of educational information with the provision of feedback between teachers and students, a unified approach to the implementation of professionally oriented teaching mathematics;

– technical – qualitative use of technical means of education in the implementation of professionally oriented mathematics education;

– ergonomic – focused on providing functional comfort at work.

In order to implement the developed special course, the formative stage of the experiment was carried out. The paper proposes the solution of professionally oriented tasks for the development of motivation to study mathematics, namely:

1. The auditorium has lighting, the devices of which consume 300 watts in the complex. Would costs be reduced by 30% if lighting was replaced with energy efficient fixtures? How many watts can be saved during the day by using energy-saving devices? Students are offered to solve the problem in several ways and submit them in writing.
2. It is necessary to manufacture a closed cylindrical tank, the total surface of which is S. Specify the height of the tank if its volume was the largest.

In general, the study proposes 44 author-developed professionally-oriented tasks. The implementation of the meaningful criterion consists in determining the available knowledge, including the types, methods, and techniques that affect the organisation of the process of professionally directed learning in teaching mathematics, the implementation of ways to optimise and intensify them using digital technologies. It is proposed to increase and diagnose the levels of organisation of the readiness of future specialists of a technical university to develop professional competencies with the help of professionally-oriented mathematics training according to a meaningful criterion according to the methodology of posing problematic issues and professionally-oriented tasks during the study of mathematics.

The implementation of the operational criterion is to instil in future specialists the skills of using techniques and methods of professionally oriented training on the way to the development of professional competencies. The methodology for diagnosing the content and operational criteria consists in the development of the author's special course "Methods for solving professionally directed problems in mathematics", which included:

– interactive techniques;
– digital and multimedia technologies;
– hypertext and Internet technologies;
– virtual information space technologies;
– cloud technologies;
– Web technologies;
– telecommunication technologies;
– SMART technologies.

It is also proposed to perform author's tasks. The development of the content of the tasks took place considering the principle of complex differentiation for groups of students and is based on the implementation of indicators for the development of readiness of future specialists of the technical university to develop professional competencies through professionally oriented mathematics lessons.

The study proves that mastering mathematics in technical universities should develop intellectual abilities, analytical and technical thinking, intuition, mathematical culture; assimilation of mathematical knowledge and skills necessary for the study of related professional disciplines; apply basic mathematical methods for the analysis and modelling of processes and phenomena of professional activity. The reflexive component is manifested in the ability to analyse psychological features and professional abilities, to predict and control the results of activity; the ability to mobilise own potential, creative energy, the ability to self-expression, self-development, and self-improvement. The criterion reflects the level of development of respondents' skills to solve professionally oriented tasks and carry out self-assessment of their own activities.

When determining the levels of readiness of future specialists of a technical university for the development of professional competencies with the help of professionally oriented mathematics training, attention is focused on the levels, namely: high, average, and low. The results obtained at the formative stage of the experiment after the implementation of the outlined methodological system in the control group are presented in Figure 3.

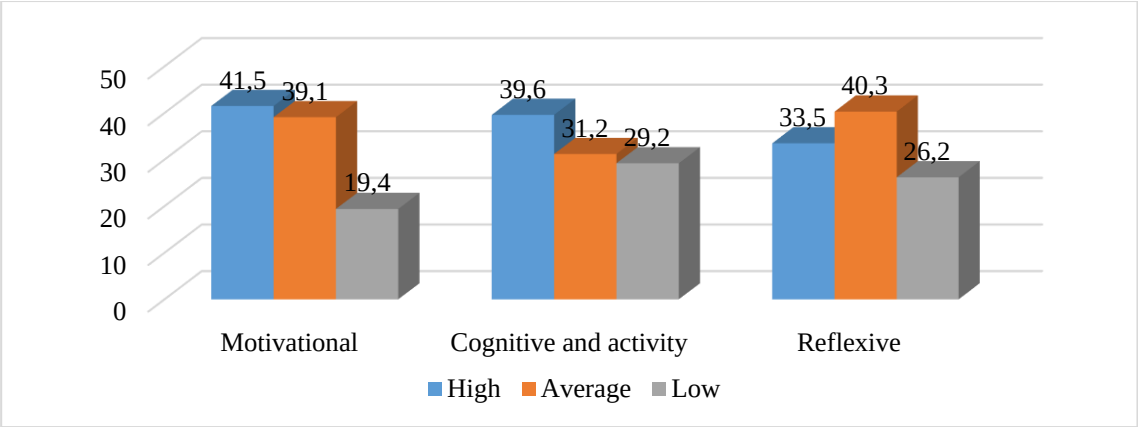

Figure 3. Results of checking the readiness level at the formative stage of the experiment in the control group

The results of the implementation of the outlined methodological system at the formative stage of the experiment in the experimental group are presented in Figure 4.

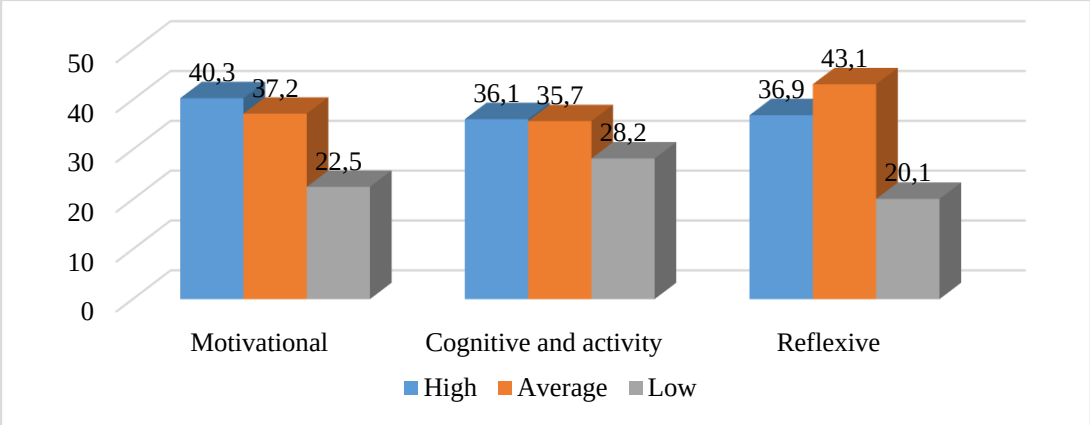

Figure 4. Results of checking the readiness level at the formative stage of the experiment in the experimental group

According to the data obtained during the analysis of the results of the implementation of the author's special course "Methods for solving professionally oriented problems in mathematics" in the experimental group, it was found that in order to ensure the development of professional competencies of future specialists of technical universities of the Republic of Kazakhstan, it is extremely important to solve the issue of professionally oriented teaching mathematics, which was solved during the experiment.

The control stage of the experiment was carried out, at which the analysis of the results of the conducted experimental research was carried out, and the effectiveness of the proposed methodology for the development of professional competencies was assessed. The use of parallel computing in solving problems of numerical methods was carried out using methods of mathematical statistics. In the study, the samples are random, independent and subject to the normal distribution law. The experimental data were processed according to the Pearson x^2 criterion. During the processing of experimental data, no significant differences were revealed in the experimental and control samples at the stage of the ascertaining experiment. However, there were differences in the experimental and control samples, and differences in the control sample before and after the formative experiment.

In the course of the research, it was found that the active work of students in the process of studying mathematics plays an important role in their educational activities and creates the necessary stock of professional competencies necessary for future specialists in professional activities. Given the demands of today's labour market, the specialists are capable of active thinking, self-criticism, and creativity. The use of modern methods of organising professionally oriented training of future specialists of a technical university requires specialists not only to be active and able to find new solutions, but also to develop the skills to independently set and perform new professional and social tasks, to be able to quickly adapt and work in changing conditions.

Discussion

The development of a modern dynamic society dictates updated requirements for a person who must have technical and innovative thinking, and be able to solve professionally oriented tasks in professional activity. That is why the high-quality organisation of professionally guided mathematics education is one of the most pressing issues widely discussed by scientists around the world.

Higher technical education in Kazakhstan should be aimed at training competent specialists capable of reacting in a changing socio-economic society, searching for non-standard solutions. Ensuring the development of a high level of professional competence of future mathematics

specialists is the key to their competitiveness in the labour market [17].

In the context of the definition of the concept of "professionally oriented learning", the study understands the content of mathematics and the organisation of its study in logical forms and types of activities that ensure the implementation of cognitive and practical tasks of the professional activity of a future specialist. Exploring the issues of the relationship between the fundamental and professional orientation of teaching mathematics, K. Stokking et al. [18] concluded that such a task is extremely difficult. The researchers believe that ensuring students' interest in studying mathematics and determining its role in technical education depends on the teacher's experience, and the availability of professionally-oriented textbooks and problem books in mathematics, which are currently lacking. All this affects the content of education, which is based on a formal and logical presentation of scientific knowledge isolated from technical activities. The expressed approach is considered correct and requires diversity in the training of future specialists of a technical university by solving the issue of the process of forming a graduate's readiness to apply professional competencies, namely, in the process of studying the courses "Mathematics" and "Methods of solving professionally directed problems in mathematics".

Studying the variety of competencies of future specialists of the technical university, A. Asaduzzaman and R. Asmatulu [19] identified subject competencies that are aimed at specific attributes of the field of study and are formed as a result of competency-based learning of the relevant discipline and determine the subject aspect of the graduate's competence. Based on the considerations given by the researchers in the study, it is considered correct to identify the following subject competencies of a future specialist of a technical university, developed in the process of teaching mathematics:

– psychological readiness to apply mathematical knowledge in professional activity;
– experience in applying knowledge in quasi-professional activities;
– motivation for the use of mathematical methods in the process of solving problems in the context of future professional activity;
– readiness for self-educational activities.

The outlined approach is considered correct because the designated subject competencies should be developed in the context of professionally oriented training during the study of the author's special course "Methods for solving professionally oriented problems in mathematics".

Exploring the issues of the implementation of the professional orientation of teaching mathematics to future specialists of a technical university and the structure of professional competence in the field of mathematics, J. Bergmann [20] identified a system of didactic and methodological resources of professional orientation for the formation of outlined competence of students. Such resources, according to the researcher, include interdisciplinary connections of mathematics; priority of active methods and forms of learning; provision of subjective experience, and reflection. Regarding the results obtained in this study, the use of the proposed approach may be correct, namely, to ensure the development of professional competence of future specialists of a technical university, mathematics should be professionally directed, which can be implemented by increasing the time to solve professional tasks in the process of performing practical work during the course "Mathematics" and the author's special course "Methods of solving professionally directed problems in mathematics".

The implementation of professionally oriented mathematics education for future specialists of a technical university, according to S. O'Hara and R.H. Pritchard [21], is possible by fulfilling the following requirements:

– actualisation of the close interrelations of mathematics with the cycle of general professional and special disciplines;
– integration of professionally directed tasks into the content of mathematics;
– use of active learning methods for the development of professional competencies;
– ability to establish links between theory and practice;
– development of the skills and abilities to carry out mathematical modelling of real processes and phenomena that take place in the future professional activity of specialists of a technical university.

According to I. Abualrub et al. [12], professional-pedagogical and professional-psychological orientation in the development of personality are interrelated and are the key to the development of not only professional competencies, but also professional knowledge. It is worth agreeing with the opinion of researchers and highlighting the following components of professionally oriented education, namely: persistent motivation to study mathematics and subjects of the mathematical cycle; development of professional knowledge and interests, and mastering the methodology for solving professionally oriented tasks; providing future specialists with knowledge and skills to realise self-realisation and self-improvement in the context of their own professional activities.

M. O'Sullivan [5] and P. Rudd et al. [22] actively investigated the development of the issue of the professional direction of the personality of a technical specialist, as a result of which components of their readiness to carry out professional activities were identified. Namely: personal (formation of needs, desires, interests, ideals, beliefs, worldviews, value orientations of a specialist). Reflexive (ensuring the development of self-esteem for further persistent improving their professional competencies, striving to improve professionally). Procedural (consists in the development of professional competencies as a guarantee for implementation in the professional field).

However, the results described above contradict this, since in the system of development of professional competencies of future specialists of a technical university in the process of professionally oriented mathematics education, the following components should be distinguished: motivational, cognitive and operational, and reflexive. The following skills are highlighted that future specialists should possess in the process of professionally oriented mathematics education: organisational skills, professional, communicative, projective, reflexive, and creative.

Studying the competence-based approach to training with the application of a professionally applied orientation among specialists of a technical university in Kazakhstan, A. Scharle and A. Szabo [23] came to the conclusion that the essence of this approach is the independent acquisition of knowledge, the application of a creative approach in the process of solving non-standard tasks. Regarding the results obtained in this study, the use of the proposed approach may be correct, namely, because there will be a correspondence between mathematics and the disciplines of the technical cycle; determination of the elements of the content component of training that ensures the development of competencies and diagnostics of the effectiveness of the outlined process; identification of the features of the procedural component, which is the key to the implementation of competence-oriented training of future specialists of a technical university; ensuring the organisation of teacher training for work in a competency-based approach.

The results of this study confirm that the basis for the professional training of future specialists of a technical university is mathematical knowledge, which students receive in the process of studying mathematics, as a key to mastering disciplines of a special cycle. That is why future specialists should be focused on acquiring professional competencies for their qualitative use in future professional activities.

Considering the above-mentioned features of the implementation of professionally oriented mathematics education in universities of the technical direction of the Republic of Kazakhstan in the study, the following areas of mathematical training are proposed:

- reorganisation of the educational process based on providing motivation for professional activity, considering the specifics of studying at a technical university;
- connection of theory with practice through the implementation of the cognitive activity component of readiness;
- ensuring self-reflection during the implementation of professional activities;
- updating the curriculum content;
- variety of forms of educational activity;
- activation of independent cognitive activity;
- use of digital technologies in the process of studying mathematics;
- use of professionally oriented tasks.

Conclusions

In the course of the study, it was concluded that high-quality professional training of future specialists of a technical university in higher educational institutions is based on qualitatively organised professionally-oriented training, for the implementation of which it is necessary to predict the effective component of the content, requiring the conclusion of an integrated system of development of professional competencies.

It is proved that the active introduction of the latest technologies and methods of organising the educational process in higher education, in particular, in mathematical disciplines, requires increased pedagogical skills, social adaptation, and a creative approach to solving professional problems, responsibility, activity and independence in decision-making. In the process of conducting the study, the concept of "professionally oriented training" was defined, it was found that the level of readiness of future specialists of a technical university to form professional competencies through professionally oriented mathematics training is at a low and average position. It is determined that such a trend requires the creation of the necessary methodological tools, which would increase the level of readiness of future specialists of the technical university to develop professional competencies through professionally-oriented mathematics education.

During the ascertaining stage of the experiment, the following components and criteria of readiness were identified, namely: motivational (value criterion), cognitive and operational (knowledge-operational), and reflexive (subjective). The levels of development of the components of readiness among the specialists of the technical university are determined. Diagnostics of readiness levels for selected components has been carried out. Based on the results of the data obtained, conclusions are drawn about the need to reorganise the methodology for the development of professional competencies. The formative stage of the experiment was carried out, during which the author's special course "Methods for solving professionally directed problems in mathematics" was developed during the study, an experimental technique was introduced among the respondents of the experimental groups and the results of the development of readiness components were verified. The generalised data of the research results allow drawing conclusions about the effectiveness of the implemented methodological tools for the development of readiness components. The policy of educational institutions in Kazakhstan must be focused on updating the methodological component of the training of future technical university professionals.

The following areas of scientific research can be distinguished, which should reveal the features of the development of professional competencies of future specialists of a technical university with the help of professionally oriented training: development of mathematical competence among future specialists; use of integrated courses in mathematics and computer science in the development of professional competence; solving the problem of the development of professional competence of future specialists of a technical university in the process of teaching mathematics; consideration of opportunities for the development of general scientific competence in the process of teaching mathematics.

Thus, scientific research and the conclusions formulated can be used as an effective basis for improving the training of future specialists of a technical university, finding ways to improve the level of organisation of professionally oriented student education, using the experience of developed countries, the introduction of digital resources for organising this type of training; deepening the study and introduction of new methods of organisation professionally oriented education in universities.

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Conflict of Interest

None.

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Розвиток професійних компетентностей майбутніх спеціалістів технічних університетів через професійно-орієнтоване викладання математики

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Анотація

Актуальність. У сучасних умовах глобалізації питання перспектив організації професійно-орієнтованої математичної освіти в Республіці Казахстан є однією з найважливіших проблем покращення якості технічної освіти в державі.

Мета. Метою дослідження є аналіз та практичне впровадження методологічного компонента для підвищення рівнів готовності майбутніх спеціалістів технічного університету до розвитку професійних компетентностей, що є гарантією підготовки компетентного спеціаліста, готового до професійної діяльності.

Методологія. Використовувалися наступні методи: аналіз, порівняння, систематизація, класифікація, узагальнення та експеримент, а також методи математичної статистики.

Результати. Дослідження, проведене в Кизилординському університеті імені Коркит Ата, розробило методологічний інструментарій, спрямований на підвищення професійних компетентностей майбутніх спеціалістів технічних університетів через професійно-орієнтоване викладання математики. Основні висновки включають виявлення ефективних педагогічних умов, таких як різноманітні форми навчальної діяльності, активація самостійної пізнавальної роботи, інтеграція цифрових технологій у процес вивчення математики та використання професійно-орієнтованих завдань, що спільно сприяють підвищенню рівнів готовності студентів.

Висновки. Дослідження підкреслює важливість структурованого підходу до професійно-орієнтованої математичної освіти в технічних університетах. Запроваджуючи методологічну систему, що включає компоненти та критерії готовності, навчальні заклади можуть значно покращити професійні компетентності майбутніх спеціалістів. Дослідження свідчить, що подальше вдосконалення цих методологій може продовжувати підвищувати якість технічної освіти в Республіці Казахстан, забезпечуючи, що випускники будуть добре підготовлені до професійної діяльності.

Ключові слова: вища освіта; методи викладання; компоненти готовності; педагогічні умови навчання; цифрові технології.