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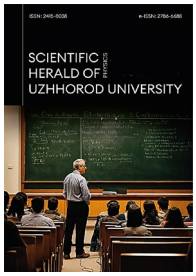

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Preparation of bachelors for professionally oriented teaching of mathematics to schoolchildren at a pedagogical university

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Abstract

Relevance. In accordance with the requirements of modern society, it has become necessary to change approaches to teaching in pedagogical higher educational institutions. The problem of preparing bachelors in the speciality "Mathematics" for professionally oriented teaching of mathematical disciplines to schoolchildren is becoming urgent.

Purpose. The purpose of this study is to identify methods and forms of professionally oriented mathematics teaching in the educational process of pedagogical higher educational institutions.

Methodology. Methods of analysis and synthesis, comparison, pedagogical observation, interviews, and questionnaires were used to achieve the goal.

Results. During the study, it was established that the method of mathematical modelling can be the basis for professionally oriented teaching of mathematics, and the use of modern technologies can improve the educational process. A survey was conducted among students of the Abai Kazakh National Pedagogical University, A. Baitursynov Kostanay Regional University, Korkyt Ata Kyzylorda University to determine the relevant problems in the preparation of bachelors of the speciality "Mathematics". Based on the results obtained, a model of bachelor's degree preparation for professional activity and professionally oriented education of schoolchildren was built, the effectiveness of which was tested.

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Conclusions. The results of the study demonstrated that the method of mathematical modelling is effective in preparing students for professionally oriented teaching of schoolchildren and the formation of their mathematical literacy. In addition, after introducing the proposed model into the educational process, students' readiness for professional activity and professionally oriented training increased by 19%, demonstrating its positive impact on the preparation of bachelors. The results of this study can be used by the management of pedagogical higher educational institutions and teachers to improve the educational process and effectively form the professional competencies of future specialists.

Keywords: educational methods; students' competencies; practical skills; modelling method; innovative technologies.

Introduction

Teaching mathematics to schoolchildren is an important part of their preparation for further education and the basis for the development of their cognitive processes (memory, thinking, attention). In addition, the educational process should be aimed at the possibility of applying mathematical knowledge and skills in the real life of schoolchildren and their future professional activities, which necessitates the formation of their mathematical literacy. A teacher focused on quality education and with a professionally oriented orientation of pedagogical activity can cope with such a task. Thus, A. Yessikyzy *et al*. [1], revealing the features of the formation of logical thinking in schoolchildren in mathematics lessons, note that in a modern educational environment, teaching mathematical disciplines should be aimed not only at gaining knowledge but also at the possibility of applying them in real life situations, and at developing students' thinking, which requires meaningful actions from teachers. N.V. Stanogina [2], in the study on the mathematical literacy of schoolchildren, also notes the need for students to develop practical skills, which creates favourable conditions for their development, further education and self-improvement throughout their lives.

A.A. Bubich & S.V. Osipova [3], exploring the organisational forms of teaching mathematics to schoolchildren, argue that in the context of updating the content of education in the Republic of Kazakhstan, there is a need to search for new forms and methods of teaching mathematical disciplines. The researchers concluded that the most effective approach to learning would be the synergy of three models of the educational process: active, passive and interactive, which will be aimed at developing students' abilities for independent activity and the application of acquired knowledge in practice. N.B. Ospanova *et al*. [4], investigating the training of teachers to use innovative approaches, concluded that at this stage of the development of the educational system of the Republic of Kazakhstan, changes in the methodology of training future teachers and the introduction of modern technologies are necessary, both in the process of their education and in their future professional activities. In the modern world, the use of information and communication technologies in the course of education is an integral part of the educational process. Their use is advisable in preparing bachelor students and their further professional activities and teaching schoolchildren. Thus, for example, A.V. Tkachev & E.Zh. Smagulov [5] identified the features of using a bot textbook in teaching mathematics and concluded that the development of perception, attention, memory, thinking, imagination, and speech of students can be effective using modern technologies but must consider their individual psychological and pedagogical characteristics and be built on didactic principles.

According to D.B. Toibazarov *et al*. [6], exploring the use of applied tasks in teaching students of the speciality "Mathematics", it is crucial to demonstrate to future specialists the practical importance of the discipline to make the educational process more effective and form students' ability to use the acquired mathematical knowledge in practice. According to the researchers, at this stage in the Republic of Kazakhstan, there are no modern methods of training future mathematics teachers for professionally oriented teaching of schoolchildren, and the solution to the problem is considered to be the introduction of applied problems, mathematical modelling, and pedagogical practice into the preparation of bachelors. The same opinion is stated by B.R. Kaskataeva *et al*. [7], examining mathematical modelling as a method of improving mathematical literacy and defining it as the most effective. However, S.K. Satbaev [8], analysing the peculiarities of teaching mathematics by teachers in the context of real-life situations, conducted an examination among 84 teachers of secondary educational institutions of the Republic of Kazakhstan and concluded that most of them are not familiar with mathematical modelling and are not ready for professionally oriented training, which necessitates the revision of bachelor's degree models in Mathematics.

Thus, the formation of mathematical literacy among schoolchildren, the development of the cognitive sphere, and the development of the ability to apply the acquired knowledge in real-life situations are the tasks of a teacher of mathematical disciplines. In addition, the modern educational process should include modern technologies and approaches, to which researchers have attributed mathematical modelling. The analysis of the sources under study showed that mathematics teachers are not familiar with modern approaches, which requires a revision of the models for preparing bachelors of the speciality "Mathematics" for professional activity. This determines the purpose of the study: propose a model for preparing bachelors of the speciality "Mathematics" for professionally oriented education of schoolchildren and test its effectiveness.

Materials and Methods

In this study, methods of analysis and synthesis, comparison, pedagogical observation, interviews, and questionnaires were used. The analysis method was used to identify existing problems in the preparation of students of the speciality "Mathematics" and possible ways of solving them. The analysis helped to reveal the concept of "mathematical literacy", its components and the importance of its development in schoolchildren and also helped to analyse professionally oriented learning and determine its role in the modern educational process. This method was also used to create a model for preparing

bachelors for professional activity and professionally oriented teaching of mathematics to schoolchildren [9].

A study was conducted among 145 students of higher educational institutions in the Republic of Kazakhstan to identify existing problems in the training of future specialists and verify the compiled model's effectiveness. The study involved 65 students of the Abai Kazakh National Pedagogical University, 45 students of A. Baitursynov Kostanay Regional University, 30 students of Korkyt Ata Kyzylorda University. All the examined students are 4th-year students of the speciality "Mathematics". The students are 22-24 years old, 106 female respondents and 39 male respondents. A survey was conducted to identify existing problems in the training of specialists and to verify the effectiveness of the proposed model of preparation for professionally oriented teaching of mathematics to schoolchildren. The author's questionnaire included 15 questions aimed at determining readiness for professional activity, assessing the level of theoretical knowledge and practical skills (Table 1).

Table 1. The author's questionnaire to determine the readiness of bachelors for professional activity and professionally oriented training

No.	Question	Yes	No
1	Do you think your level of theoretical knowledge is high?		
2	Do you think your level of practical knowledge is high?		
3	Do you have information about modern methods of teaching mathematics to schoolchildren?		
4	Are you able to use modern teaching methods in your professional activities?		
5	Do you have information about the use of information and communication technologies in the process of teaching mathematics to schoolchildren?		
6	Are you able to apply information and communication technologies in your professional activities?		
7	Do you know what mathematical literacy is?		
8	Do you think that you have developed mathematical literacy?		
9	Are you able to form mathematical literacy among schoolchildren in the process of their education?		
10	Do you understand the role of developing students' practical skills?		
11	Do you think that practical skills are being effectively formed in your educational institution?		
12	Are you able to form practical skills among students in the process of their education?		
13	Do you know what mathematical modelling is?		
14	Are you capable of using mathematical modelling in the process of your education and in the process of professional activity?		
15	Are you ready for a professional career?		

Source: compiled by the authors.

For each answer "Yes" the student receives 2 points, for each answer "No" – 1 point. The number of points scored allows determining the readiness for professional activity and professionally oriented education of schoolchildren, where:

- 1-10 points – there is no readiness for professional activity and professionally oriented training;
- 11-20 points – the medium level of readiness for professional activity and professionally oriented training;
- 21-30 points – a high level of readiness for professional activity and professionally oriented training.

Pedagogical observation was used during the practice of bachelors in secondary schools in Almaty, Kostanay, and Kyzylorda to monitor the effectiveness of students' practical activities, determine the progress of their readiness for professional activity and professionally oriented education of schoolchildren. Monitoring the professional activities of future teachers helped to determine the effectiveness of bachelor's degree training for the proposed model and identify aspects that require improvement.

An interview was conducted, which included two questions to obtain more detailed information about the quality of students' professional training, the difficulties encountered in the learning process and practical activities,

1. Do you think you are fully ready for professional activity? Justify the answer.

2. What do you think needs to be changed in the process of training specialists at a higher educational institution?

The interview demonstrated the degree of readiness of the bachelors for professional activity, their beliefs regarding their theoretical knowledge and practical skills, and their views on improving the professional training of bachelors.

The comparison method was used to correlate the level of knowledge and practical skills of bachelors before introducing the proposed model of preparation for professional activity and professionally oriented teaching of mathematics to schoolchildren into the educational process and after it and helped to determine its effectiveness. The synthesis method was used to summarise the results obtained, determine the effectiveness of the proposed bachelor's degree training model and methods for its improvement [10].

Results

Teaching students mathematical disciplines is integral to their preparation for admission to higher education institutions and further professional activities. Researchers identify at least five reasons for the need to study mathematics: the formation of logical thinking, the development of the ability to solve everyday problems, the ability to calculate patterns and summarise the experience gained, the development of creative skills, and increased awareness of events in the world [11; 12]. In the Republic

of Kazakhstan, the need for students to study mathematical disciplines is determined by the Resolution of the Government of the Republic of Kazakhstan No. 988 "On Approval of the State Programme for the Development of Education and Science of the Republic of Kazakhstan for 2020-2025" [13]. However, the results of the PISA [14] and TIMSS [15] studies demonstrated that despite the fact that students of the Republic of Kazakhstan have a high level of theoretical knowledge, there is still a problem in the application of practical skills, which necessitates the formation of mathematical literacy among schoolchildren, as the basis of the ability to apply the acquired knowledge.

Mathematical literacy is applying mathematical knowledge in various life situations [16]. It is one of the most essential competencies necessary for a successful education and professional activity, an indicator of the intellectual development of a person and the ability to solve problems arising in professional activity with the help of logical thinking [17; 18]. Mathematical literacy emphasises the ability to apply mathematical knowledge in solving problems in everyday life, influences the development of critical thinking, develops individuality of thought, which is the basis of an intelligent and competitive society [19].

The teacher must have highly formed professional competencies and have a professionally oriented orientation of their activities to form the described knowledge and skills in the younger generation [20]. Professionally oriented teaching of mathematics can be considered an approximation of the subject preparation and development of mathematical literacy of schoolchildren to their practical needs, formed on the effective interaction of the teacher and the student. Researchers call professionally oriented learning realistic, as it is based on the close connection of acquired knowledge and skills with real-life situations in which they can be used [11; 21]. The main objectives of professionally oriented teaching mathematics to students of higher pedagogical educational institutions are: the formation of the ability to set learning goals, the search for effective methods and forms of improving the educational process, which will be aimed at mastering practical skills and the ability to use them in real life situations, the formation of the ability to use the method of mathematical modelling as the primary method of professionally-oriented learning.

Mathematical modelling is a method of qualitative and quantitative description of a process using a mathematical model describing a real process using an adequate mathematical apparatus [22; 23]. Mathematical modelling helps to understand the nature of the phenomena under study and identify the relationship between them, described in mathematical terms. The use of mathematical modelling in professionally oriented training contributes to the ability to solve real-life problems through mathematical calculations [24-26]. The advent of modern computer technologies has increased the possibility of applying mathematical modelling in real-life situations, as it allows calculating using computer programmes. However, when preparing bachelors in pedagogical higher educational institutions, due attention is not paid to the professional orientation of the examined disciplines. In addition, mathematical modelling, as the primary method of professionally oriented education, is not familiar to teachers and cannot be effectively used in professional activities. This determines the need to change approaches to the preparation of bachelors in Mathematics [27; 28].

A survey was conducted among students to create an effective bachelor's degree preparation model, which helped to identify the needs of students, problems in their preparation for professional activity and the most effective methods of solving problems in their opinion. The results of the preliminary survey were as follows: 67% (97 people) of students believe that their level of theoretical knowledge is high, but only 48% (70 people) of students consider their practical level of knowledge to be high. 60% (87 people) of respondents noted that they have information about modern mathematics teaching methods to schoolchildren, but only 45% (65 people) of students believe that they can use them in practice. 90% (130 people) of students noted that they have information about the use of information and computer technologies in the process of teaching schoolchildren, and only 74% (107 people) noted that they can use them in professional activities. 80% (116 people) of the surveyed students know about mathematical literacy, but only 54% (78 people) of respondents are confident in their ability to form it among schoolchildren. 60% (87 people) of students believe that their mathematical literacy is formed at a sufficient level. 88% (127 people) of respondents are aware of the role of practical skills, but therewith, 35% (51 people) of students note that their practical skills are not formed effectively in an educational institution and only 45% (65 people) of respondents believe that they can form practical skills in schoolchildren. 70% (101 people) of the respondents are familiar with the concept of mathematical modelling, but only 47% (68 people) indicated that they can apply it in the educational process and professional activities. In general, only 50% (72 people) of the respondents are ready for professional activity.

Thus, there is a gap between the theoretical knowledge of bachelors and their practical skills, which may be due to insufficient practical training at a higher educational institution, inability to engage in independent activity without the supervision of a teacher, or lack of self-confidence. An interview with students was conducted to confirm this assumption, which included two questions:

1. Do you think you are fully ready for professional activity? Justify the answer (Most students noted that they are not fully ready for professional activity. Among the most common reasons for unavailability were noted: lack of confidence in their practical skills, fear of professional activity, and lack of control and prompts within the framework of professional activity to which students are accustomed in the educational process. Some students noted a lack of understanding of the essence of professionally oriented education, unwillingness to use mathematical modelling).

2. What do you think needs to be changed in the process of training specialists at a higher educational institution? (Among the necessary changes, the following were most often highlighted: the introduction of information and communication technologies into the educational process and training in their effective use, the introduction of mathematical modelling into academic disciplines, and the possibility of independent work with teacher feedback).

Thus, the students attributed the following to the most common problems: a low level of knowledge about professionally oriented teaching and mathematical modelling, fear of professional activity without teacher supervision, and inability to apply modern methods and technologies. Based on the information received, a model was compiled for preparing bachelors of the speciality "Mathematics" for professionally oriented training based on mathematical modelling, which included 4 blocks (Table 2).

Table 2. The model of bachelor's degree preparation for professional activity and vocational-oriented education

No.	Block	Description	Expected result
1	Theoretical skills	At this stage, students develop theoretical knowledge about professionally-oriented learning and mathematical modelling by: listening to lectures; watching videos and/or presentations; reading digital textbooks.	Students form ideas about the professional orientation of their activities, mathematical modelling, its goals and possibilities of use in the learning process and real-life situations.
2	Solving applied problems under the guidance of a teacher	At this stage, students, under the guidance of a teacher, solve applied problems through mathematical modelling and develop skills in using information and communication technologies.	Students form ideas about the practical application of mathematical modelling and acquire practical skills under the guidance of teachers.
3	Independent activity	At this stage, students independently compose applied problems with a certain professional orientation and solve them using mathematical modelling, in particular, using the Maxima computer mathematics system.	Students actively develop practical skills in mathematical modelling, skills in using information and communication technologies, and their readiness for professional activity is strengthened.
4	Applying the acquired knowledge in practice	In this stage, students apply their knowledge in the course of teaching practice. They conduct professionally oriented classes, forming students' mathematical literacy.	Students are able to effectively form their' mathematical literacy through the professional orientation of their activities. Classes are held in a positive atmosphere in the classroom, effective communication between students. Students' professional competencies are strengthened, and their readiness for professional activity is increased.

Source: compiled by the authors.

The results of the survey before the implementation of the proposed model showed the following results: 30 students are not ready for professional activity and professionally oriented training, 70 students have a medium level of readiness for professional activity and professionally oriented training, and 45 students have a high level of readiness for professional activity and professionally-oriented training (Figure 1).

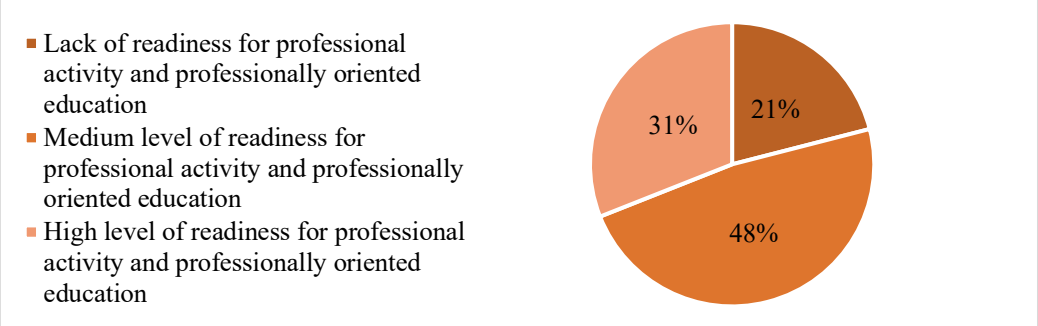

Figure 1. The percentage of students' readiness for professional activity and professionally oriented education before the introduction of the training model

At the first stage of the implementation of the proposed bachelor's degree training model, students developed theoretical skills in professionally oriented learning and mathematical modelling. The teachers used lecture materials, presentations and videos, and digital textbooks. The lecture materials were built considering all didactic principles, in particular: consistency, accessibility, activity, and considering the individual needs of each individual group of students and each student as a whole. The lectures were accompanied by materials such as audio tracks, videos, and presentations, which influenced the quality of information perception and knowledge assimilation. Within the framework of the proposed model, lectures were held on such topics as "Introduction to mathematical modelling", "Differential equations in mathematical modelling", "Connection of mathematical modelling with related industries", "Use of information and communication technologies in the educational

process of secondary and high schools", "Solving mathematical modelling problems using software", "Statistical hypothesis testing and its application in real life situations". The lectures were accompanied by the reading of electronic textbooks, which not only formed the necessary knowledge among students but also developed the ability to use information and communication technologies to gain knowledge and apply it.

In the second stage of implementing the training model, students solved applied problems using mathematical modelling with the help of teachers. Among the proposed tasks were the following:

1. The air in the 40-litre flask contains 80% nitrogen and 20% oxygen. 0.2 litres of nitrogen are added to the container every second, and after continuous mixing, the same volume of the mixture is obtained again. After how long will the flask contain 99% nitrogen?
2. In a city of 40 thousand people, 20 people are infected. The spread rate of the virus is 0.6, and the average disease time is 0.2. What will be the dynamics of the spread of this virus in this city after 10 days without measures?
3. The investor distributes his capital between stocks and bonds. The expected return on shares is 8% per annum, and bonds are 5% per annum. The deviation in the yield of shares is 15% per annum, and bonds are 10% per annum. The expected risk level is 0.01. How to maximise portfolio profitability with the expected level of risk?

The researchers distinguish three stages of the mathematical modelling process: the description of the proposed problem in mathematical terms, the solution of the problem within the framework of mathematical theory and the formulation of the result (its interpretation), which was used in the bachelors' training [7]. Students also developed the ability to solve applied problems using the Maxima computer mathematics system, by defining variables and parameters and the goal/optimisation function. Maxima software can successfully solve the following types of differential equations: linear, nonlinear, equations with separable variables, second-order equations: coefficient, constant coefficient, and non-constant coefficient. Using such software not only accelerates the solution of applied problems through mathematical modelling but also forms the ability to use information and communication technologies not only within the framework of mathematical disciplines, but also in real-life situations. In addition to this software, MATLAB, Mathematica, and Sage can also be used, which requires a high level of information and communication skills. Since students noted the fear and inability to carry out professional activities without the support of teachers, the third stage was aimed at the formation of independent activity of bachelors of the speciality "Mathematics". Initially, students were asked to solve 21 applied problems using mathematical modelling, among which 7 were of high complexity, 7 were of intermediate level, and 7 were of entry-level. Solving all the tasks was optional, but at least one task of a high difficulty level had to be solved. After solving the tasks, students could get feedback from teachers and other students. Problem-solving was demonstrated before the class, and the teacher and other students participated in their discussion and analysis. Then, the students were asked to independently create applied problems of different levels of complexity and solve them using mathematical modelling.

In the last stage, students conducted professional activities within the framework of pedagogical practice, during which they were monitored. During this stage, students needed to conduct several classes with a professionally oriented orientation, forming students' mathematical literacy and skills in using mathematical skills in real-life situations by solving mathematical modelling problems. In addition, students had to show a high level of professional competence and the ability to perform effective professional activities. After the students had passed all its stages, a repeated questionnaire was conducted to check the effectiveness of the proposed model, which showed the following results: 75% (108 people) of students consider their level of theoretical knowledge to be high, and 65% (94 people) of students consider their practical level of knowledge to be high; 75% (108 people) of respondents noted that they have information about modern methods of teaching schoolchildren and 55% (79 people) of students believe that they can use them in practice; 100% (145 people) of students noted that they have information about the use of information-computer technologies in the process of teaching schoolchildren and 84% (122 people) noted that they can use them in professional activities. 98% (142 people) of the surveyed students know about mathematical literacy, 80% (116 people) of the respondents are confident in their ability to form it among schoolchildren, and 77% (111 people) of students believe that their mathematical literacy is formed at a sufficient level. 95% (137 people) of the respondents are aware of the role of practical skills; 67% (97 people) of the respondents believe that they are able to form practical skills in schoolchildren. 90% (130 people) of the respondents are familiar with the concept of mathematical modelling, and 65% (94 people) indicated that they can apply it in the educational process and professional activities. In general, 75% (108 people) of the respondents are ready for professional activity.

After the introduction of the bachelors' preparation model for professional activity and professionally oriented training into the educational process, there was a positive trend in the practical level of skills and in the level of theoretical knowledge and readiness for professional activity. There are 17 students who are not ready for professional activity and professionally oriented training (13 fewer people), and 73 students who have a high level of readiness for professional activity and professionally oriented training (28 more people). The changes are reflected in the figure and in the table (Figure 2, Table 3).

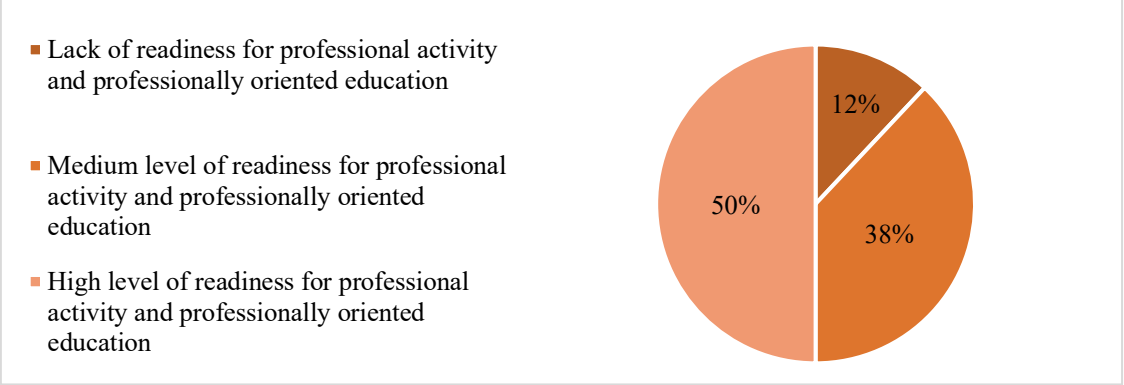

Figure 2. The percentage ratio of students' readiness for professional activity and professionally oriented education after the introduction of the training model

Table 3. Comparison of students' readiness for professionally oriented teaching of mathematics to schoolchildren before the introduction of the proposed training model and after

Readiness level	Indicator before the implementation of the training model	The indicator after the implementation of the training model	Difference
There is no readiness for professional activity and professionally oriented training	21%	12%	-9%
The medium level of readiness for professional activity and professionally-oriented training	48%	38%	-10%
High level of readiness for professional activity and professionally oriented training	31%	50%	+19%

Source: compiled by the authors.

An interview was conducted again to confirm the results obtained, which showed that a larger number of students, compared with the first interview, are ready for professional activity. Students note a high level of theoretical knowledge about professionally oriented teaching and mathematical modelling and the ability to apply them in practice. However, there are respondents among the students who still fear professional activity and are unwilling to apply the acquired knowledge, which may indicate the need to increase practical training in the educational process of higher educational institutions. The students also noted the need for more practical training, describing the necessary changes in the training of specialists. The students also noted the expediency of introducing innovative technologies such as artificial intelligence and virtual reality into the educational process, which, in their opinion, can improve the educational process and make it more interesting. In addition, pedagogical observation of the respondents' professional activities showed that the formation of mathematical literacy among schoolchildren can be effective with the help of mathematical modelling and professionally oriented learning. A positive atmosphere in the classroom during training, high-quality communication with students, and the selection of tasks based on the individual characteristics of each individual class and each individual student can improve this process [29-31].

Thus, the results of the conducted research have shown a sufficiently high efficiency of bachelor's degree preparation for professional activity and professionally oriented training using the proposed model based on mathematical modelling. Mathematical modelling can be the basis of professionally oriented learning, as it can be used not only in the mathematical field but also in other disciplines and in real-life situations. Only a trained teacher with all the necessary professional competencies is capable of developing mathematical literacy and the ability to use the acquired skills to solve emerging problems among schoolchildren, which necessitates high-quality training of bachelors in Mathematics [32; 33].

Discussion

The study of mathematics is important for schoolchildren, as it affects further education, professional activity, and the comprehensive development of a student as a literate, highly intelligent person. E. Can Yurt [34], comparing the training of mathematics teachers in Finland, South Korea, and Turkey, notes that mathematical disciplines are closely related to all aspects of life, in particular, science and technology, art and architecture. In addition, the researcher notes that mathematics can develop cognitive processes, critical thinking and intelligence, which correlates with the results of this study. M. Nurwahid & S. Ashar [19], examining approaches to the formation of mathematical literacy, believe that the purpose of studying the exact sciences is to form students' mathematical literacy, which they define as the ability to use mathematics in various life situations. However, according to experts, students still have difficulties in applying their knowledge to solve real problems. The goal of the teacher in this process is to form theoretical mathematical knowledge and the ability to apply it in solving mathematical problems, expand the range of tasks performed, and form the ability to use logical thinking in solving new problems, even outside mathematical disciplines. S. Incikabi *et al*. [35], examining the requirements for mathematical literacy in Turkey, Singapore, and Australia, also define mathematical literacy as the ability to interpret mathematical knowledge in the

context of various life situations. In addition, according to the researchers, mathematical literacy allows teachers and students to broaden their horizons and discover new possibilities for applying mathematical knowledge.

Exploring approaches to improving students' mathematical literacy, D.M.C. Limbong & E. Napitupulu [11] concluded that one of the most effective methods to improve mathematical literacy is a realistic (professionally oriented) approach. I. Nurfadilah *et al*. [36], exploring a realistic approach to solving mathematical and real-life problems, note that students whose education used a professionally oriented approach formed mathematical literacy at a higher level, while students who did not learn to use mathematical skills in real-life situations developed mathematical literacy at a lower level and much more slowly. Only a highly qualified teacher who has formed competence at a sufficient level is capable of forming students' mathematical literacy and the ability to apply mathematical knowledge in real-life situations. G.S. Jarassova *et al*. [17] agree with this statement, which identified the impact of mathematics teacher training on the quality of education at school and concluded that only well-trained teachers with well-formed professional competencies can provide a high level of teaching mathematical disciplines. R. Torres Castillo [37] also supports this opinion, exploring the role of mathematics teacher training to improve the quality of the educational process. The expert concluded that high-quality teacher training should have both a theoretical and practical orientation, which corresponds to the bachelor's degree training model proposed in this study, which includes both a block aimed at the formation and consolidation of theoretical knowledge and a block aimed at the formation and consolidation of practical skills.

Identifying aspects of the training of mathematics teachers in his paper, G.A. Cruz-Rojas [38] notes that the purpose of practical training is to develop and introduce applied problems and effective methods of solving them into the educational process, which can be used both in the framework of studying other disciplines and in solving real-life situations. This statement is supported by R.A. Mangarin & L.V. Chan [39], examining the professional competencies of teachers of mathematical disciplines. According to the researchers, the development of new methods, approaches, instructions, and their implementation in the educational process not only improve the effectiveness of student learning but also develop teachers as professionals in their field. F.A. Ningtiyas & Jailani [40], determining the role of professional competence development in training teachers of mathematical disciplines, also note that a highly qualified teacher must constantly develop, broaden their horizons, acquire theoretical and practical knowledge, and learn to apply modern approaches and technologies. However, S. Suryanti *et al*. [41], analysing the use of problematic tasks in teacher training, concluded that teachers and students are not ready to use the acquired skills in real-life situations. S. Tamani *et al*. [42], revealing in their study the assessment of the qualification training of teachers of mathematical disciplines, also came to the conclusion that teachers of mathematical disciplines are not satisfied with their level of training. The results of the examination conducted by experts demonstrated that teachers lack both theoretical and practical skills and the ability to use information and communication technologies. This correlates with the results of this study and proves the need to improve the preparation of bachelors of the speciality "Mathematics" for professional activity and, in particular, for professionally oriented education of schoolchildren.

One of the methods that teachers can use for professionally oriented teaching of schoolchildren in this study is mathematical modelling, which helps to interpret real-life situations in mathematical terms and search for their solution. Y. Dede & Z. Taşpinar Şener [43], exploring the use of mathematical modelling by teachers, define it as the use of mathematical knowledge and tools to build a model that provides solutions to real-life situations. The researchers note that teachers do not always understand the essence of mathematical modelling, have difficulty using it, and, as a result, cannot apply it in teaching schoolchildren. The researchers see theoretical training and the opportunity to use the knowledge gained in practice as an effective method of solving this problem, corresponding to the results obtained during this study and the proposed training model. The results of this study showed that the proposed model of bachelors' preparation for professional activity and professionally oriented education is effective, however, students still noted a lack of practical activities, modern methods, and approaches in the educational process. F.M. Moreno-Pino *et al*. [44], examining the training of teachers of mathematical disciplines, note the need for professional training in integral learning, interdisciplinarity, the development of critical thinking, the development of creative thinking, reflective thinking, and inclusion in the training programme of sustainability aimed at developing new forms and approaches, modifying existing approaches and using modern technologies.

Regarding modern technologies, after introducing the model, students noted the practicality of using such methods as artificial intelligence and virtual reality in the educational process. Ü. Çakıroğlu *et al*. [45], exploring virtual reality in forming mathematical literacy, agree on the expediency of using this technology in the educational process. Experts conducted a survey among 20 students, which showed that the use of virtual reality develops all aspects of mathematical literacy but requires the intervention of a teacher, which offers ways to improve the model proposed in this study through the introduction of innovative technologies and the need to prepare future teachers for their use. J.L. Gaston & B.A. Lawrence [46], investigating the peculiarities of the formation of mathematical modelling skills among teachers, proposed the following to improve professionally oriented bachelors' training: expand the possibilities of using mathematical modelling, develop a long-term mathematical modelling course for both students and already working teachers, create curricula based on mathematical modelling and introduce it into as many disciplines as possible, develop a repository of educational materials for students of the speciality "Mathematics" and teachers, instructions on the use of mathematical modelling.

Thus, the importance of students studying mathematical disciplines and developing their

mathematical literacy is beyond doubt. The ability to use the acquired mathematical knowledge in real-life situations is necessary for the effectiveness of future professional activity and to solve problems that arise in everyday life [47-50]. A highly qualified teacher who conducts professionally oriented activities is able to form students' mathematical literacy and the ability to use the acquired knowledge in real life. The researchers note that professionally-oriented learning is the most effective method of forming mathematical literacy, and its basis can be mathematical modelling. However, the results of the analysed studies have shown that most teachers are not ready for professionally oriented activities and are not capable of mathematical modelling, which proves the need to develop new approaches to the preparation of bachelors in "Mathematics". The researchers note that the training of future teachers should include both the theoretical and practical parts, including the possibility of independent activity, which correlates with the model built in this study. In addition, the results of the study showed a low level of knowledge of information and communication technologies and a lack of their use, which is confirmed by the analysed papers. Notably, the use of modern technologies, in particular, virtual reality, can positively affect the educational process and effectively form students' mathematical literacy. The formation of mathematical literacy, mathematical modelling skills, a high level of practical and theoretical training among bachelors leads to an expansion of the possibility of using acquired knowledge and skills in the educational process and, as a result, an improvement in the training of schoolchildren, which demonstrates the need for constant professional development of future specialists and the important role of practical skills in teaching mathematics to schoolchildren.

Conclusions

This study analyses the preparation of bachelors of the speciality "Mathematics" for professionally oriented education and the formation of mathematical literacy among schoolchildren as the basis for their further development. It is determined that mathematical literacy is the ability to apply mathematical knowledge in real-life situations, which can be effectively formed using mathematical modelling. A teacher who has received high-quality training for professionally oriented education can develop such skills among schoolchildren. A survey was conducted among 145 students of the Abai Kazakh National Pedagogical University, A. Baitursynov Kostanay Regional University, Korkyt Ata Kyzylorda University to identify the problems that arise in the preparation of bachelors for professionally oriented education.

Based on the analysed sources and the results of the survey of respondents, a model of bachelors' preparation for professional activity and professionally oriented training was compiled. The model included 4 blocks: the development of theoretical skills, practical activities under the guidance of teachers, independent practical activities, and pedagogical practice. The model is based on the formation of students' practical and theoretical knowledge and skills, the ability to independently solve problems through mathematical modelling, and the application of acquired skills in the course of pedagogical practice. Before the introduction of the model, the number of students ready for professional activity and professionally oriented training was 31% (45 people), and after – 50% (73 people), which is 19% (28 people) more. During the interview, students also noted an increase in self-confidence and their professional effectiveness after the introduction of the proposed model, an increase in their level of proficiency in modern technologies, and increased motivation for further training and the development of their professionalism. However, there are still students among the respondents who are not ready for the practical application of their knowledge.

Based on this, the prospect of further research may be to improve the practical training of students, expand the proposed training model, and test the effectiveness of mathematical modelling in forming knowledge and skills among schoolchildren.

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Conflict of Interest

None.

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Підготовка бакалаврів до професійно орієнтованого навчання математики школярів у педагогічному університеті

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Анотація

Актуальність. Відповідно до вимог сучасного суспільства виникла необхідність зміни підходів до викладання у педагогічних вищих навчальних закладах. Актуальною стає проблема підготовки бакалаврів спеціальності «Математика» до професійно орієнтованого навчання математичних дисциплін школярів.

Мета. Метою даного дослідження є визначення методів і форм професійно орієнтованого навчання математики в освітньому процесі педагогічних вищих навчальних закладів.

Методологія. Для досягнення мети було використано методи аналізу та синтезу, порівняння, педагогічного спостереження, інтерв'ю, анкетування.

Результати. Під час дослідження було встановлено, що метод математичного моделювання може бути покладений в основу професійно орієнтованого навчання математики, а використання сучасних технологій дозволяє вдосконалити навчальний процес. Було проведено опитування серед студентів Казахського національного педагогічного університету імені Абая, Костанайського регіонального університету імені А. Байтурсинова, Кизилординського університету імені Коркит Ата з метою визначення актуальних проблем у підготовці бакалаврів спеціальності «Математика». На основі отриманих результатів було побудовано модель підготовки бакалаврів до професійної діяльності та професійно орієнтованої освіти школярів, ефективність якої було перевірено.

Висновки. Результати дослідження продемонстрували, що метод математичного моделювання є ефективним у підготовці студентів до професійно орієнтованого навчання школярів та формування їх математичної грамотності. Крім того, після впровадження запропонованої моделі в освітній процес готовність студентів до професійної діяльності та професійно орієнтованого навчання зросла на 19%, що свідчить про її позитивний вплив на підготовку бакалаврів. Результати дослідження можуть бути використані керівництвом педагогічних закладів вищої освіти та викладачами для вдосконалення освітнього процесу та ефективного формування професійних компетентностей майбутніх фахівців.

Ключові слова: методи навчання; компетенції студентів; практичні навички; метод моделювання; інноваційні технології.