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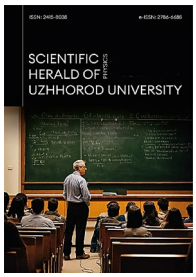

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Methodology for specialized teaching of the subject "Algebra and Beginnings of Analysis" for high school students

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Abstract

Relevance. The educational system of the Republic of Kazakhstan is gradually being updated based on international requirements. Changes have also affected the methodology of profile teaching of the subject "Algebra and Beginnings of Analysis" as an important element of training of high school students.

Purpose. The purpose of this study is to reveal the features of profile teaching of the subject "Algebra and Beginnings of Analysis" in the conditions of updating the content of education.

Methodology. To achieve the goal, the methods of analysis and synthesis, comparison, generalization, as well as the author's questionnaires were used.

Results. The study revealed the features of the new educational paradigm of the Republic of Kazakhstan, described the essence of updating the content of education and identified changes in the methodology of teaching mathematical disciplines. The role of profile teaching of the subject "Algebra and Beginnings of Analysis" for high school students was determined. To determine the actual problems in the methodology of teaching the subject "Algebra and Beginnings of Analysis", a study was conducted among 129 students of profile senior classes of secondary general education schools of the Republic of Kazakhstan. The results of the study demonstrated that students receive the necessary knowledge in the process of studying the subject "Algebra and Beginnings of Analysis" according to the updated methodology, but there is a lack of innovative technologies in the learning process and feedback from teachers. The methods of improving the methodology of profile education in the subject "Algebra and Beginnings of Analysis" were suggested, including additional work with teachers and improvement of their innovative competences, gamification of the educational process and providing students with opportunities to apply their knowledge in practice.

Conclusions. The results of this study can be used by the management of secondary general education schools of the Republic of Kazakhstan, as well as by teachers of mathematical disciplines to improve the educational process and better training of students of profile high schools.

Keywords: exact sciences; specialized teaching; content updating; mathematical literacy; secondary education; educational program.

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Introduction

The national project "Quality Education "Educated Nation" approved by the Government of the Republic of Kazakhstan is aimed at improving the efficiency of the educational process, reducing the gap in the quality of education between urban and rural schools, and creating an educational environment in secondary schools that will be effective and safe for students [1]. To realize these goals, the content of education in the Republic of Kazakhstan is being renewed at all levels. Time after the beginning of the process of changes in the educational system of the Republic of Kazakhstan, there is a need to study the advantages and disadvantages of new approaches and, in particular, approaches to profile teaching of the subject "Algebra and Beginnings of Analysis". Thus, A. Yessikyzy et al. [2], studying the formation of logical thinking in the teaching of mathematical disciplines, note that their in-depth study effectively forms pre-professional skills, develops students comprehensively and allows comprehensive study of the subject using all available methods. The researchers also believe that updating the content of education is important and necessary for the upbringing of the future generation.

In their work, A. Kagazbaeva and G. Rakhimova [3] revealed the state of geometry education in secondary schools in the Republic of Kazakhstan and noted that the content of mathematics education in the Republic should be aimed at the comprehensive development of students, as well as the acquisition of knowledge that will positively affect their intellect and can be used not only within the educational process, but also outside it. The researchers analysed the results of the international programmes Trends in International Mathematics and Science Study (TIMSS) and Programme for International Student Assessment (PISA) and came to the conclusion that students of the Republic of Kazakhstan have a sufficient level of knowledge, but do not know how to apply it in practice. N. Stanogina [4], studying approaches to the development of mathematical literacy in schoolchildren, also notes that a mathematically literate student is able to apply the acquired knowledge outside the educational institution.

Studying methodological approaches to the creation of textbooks on mathematical disciplines in the conditions of updating the content of education, L. Zhadrayeva and M. Iskakova [5] came to the conclusion that the modern educational process in the Republic of Kazakhstan should include the development of moral values in students, preservation of equal opportunities for each student, qualitative implementation of profile education, as well as increasing the priority of mathematical disciplines. In his work, S. Satbaev [6] has conducted a survey among teachers to reveal teachers' approaches to teaching mathematics in secondary schools, the results of which demonstrated that teachers lack resources to effectively teach mathematics. Also, according to teachers, students themselves are not attuned to the use of new approaches in the educational process; however, no research has been conducted among students.

Speaking about the peculiarities of profile teaching of mathematical disciplines, G. Abdikerova and M. Sadyrova [7], A. Raditya and N. Saputra [8], studying the professional preferences of high school students in the Republic of Kazakhstan, concluded that profile education, which is introduced in upper secondary schools, is important for students' choice of profession and can affect the economic development of the country in the future. This system of education organization is able to prepare personnel oriented to effective professional activity.

Thus, according to experts, the renewal of the content of mathematics education is effective and is able to comprehensively develop students of profile classes, preparing them for pre-professional activity. Scientists also note that profile education is important not only for the development of students' personality, but also for the future development of the country, which makes it necessary to study the methodology of profile education. In the conditions of updated content, students have a high level of knowledge, but according to the results of international programmes TIMSS and PISA – are not able to apply them in practice. There is also a lack of resources for teachers to effectively conduct classes. The results of the analysed studies showed that teachers do not observe students' readiness for the new teaching methodology, but there was no research among students to confirm this assumption.

On this basis, the aim of the present study is to identify current problems in the methodology of profile teaching of the subject "Algebra and Beginnings of Analysis" in the conditions of updated content. The objectives of the study are to provide effective methods of solving the found problems and to reveal approaches to teaching mathematical disciplines in the conditions of updated content.

Materials and Methods

This study used the methods of analysis and synthesis, method of comparison, method of generalization, as well as the author's questionnaires aimed at identifying possible problems in the methodology of profile teaching of the subject "Algebra and Beginnings of Analysis" in the conditions of updated educational content.

The method of analysis was used to describe the new educational paradigm of the Republic of Kazakhstan, as well as to describe the changes that occurred in teaching the subject "Algebra and Beginnings of Analysis" in the conditions of updated educational content. The method of comparison helped to find differences between the methodology of teaching mathematical disciplines before the renewal of the content of education and after. This method was also used to determine the difference between theoretical knowledge and practical skills of students of profile senior classes in the subject "Algebra and Beginnings of Analysis".

The method of generalization was used to identify general trends in the research results and summarize them. The method of synthesis was used to conclude the conclusions of the study and also helped in compiling effective methods to improve the methodology of teaching the subject "Algebra and Beginnings of Analysis" in the conditions of updated content.

In order to achieve the purpose of this work, a study was conducted among 129 students of secondary general education schools of the Republic of Kazakhstan. All

students are students of profile classes of high school and study the subject "Algebra and Beginnings of Analysis". Among the respondents, 68 pupils of 10th grade, 61 pupils of 11th grade. The age of the study participants is 16-17 years old. Among the research participants, 75 female and 54 male students.

The author's questionnaire was used to obtain information about the updated teaching methodology, the quality of the educational process and the effectiveness of teaching the subject "Algebra and Beginnings of Analysis" (Table 1).

Table 1. Author's questionnaire to determine the quality of teaching methods in the subject "Algebra and Beginnings of Analysis" among students

No.	Question	Yes	No
1	Do you highly rate the quality of teaching mathematics in your educational institution?		
2	Are you satisfied with the teaching methodology for the subject "Algebra and Beginnings of Analysis"?		
3	Are modern methods and technologies used in teaching the subject "Algebra and Beginnings of Analysis"?		
4	Are you satisfied with the level of your theoretical knowledge?		
5	Are you satisfied with the level of your practical skills?		
6	Is it possible to use the acquired knowledge in practice?		
7	Do you think the system for assessing your knowledge and skills is fair?		
8	Are you satisfied with the interaction with the teacher of the discipline "Algebra and Beginnings of Analysis"?		
9	Does the level of complexity of theoretical information correspond to your capabilities?		
10	Does the difficulty level of practical tasks correspond to your capabilities?		
11	Do you NOT feel overwhelmed while studying the subject "Algebra and Beginnings of Analysis"?		
12	Do you have access to modern technologies and resources for independent study of the subject "Algebra and Beginnings of Analysis"?		
13	Do you feel that studying the subject "Algebra and Beginnings of Analysis" has an impact on improving your cognitive sphere?		
14	Do you feel that studying the subject "Algebra and Beginnings of Analysis" influences your pre-professional preparation?		
15	Does the process of studying the subject "Algebra and Beginnings of Analysis" affect your overall satisfaction with the educational process?		

Source: compiled by the authors.

The number of positive answers demonstrated the attitude of senior school pupils to the improved teaching methodology and to the updated educational content in general, and showed the efficiency of the educational process within its framework (where the more positive answers – the higher the assessment of the educational process quality). To determine the level of pupils' knowledge and practical skills in the conditions of updated content, pupils of 10th and 11th grades were offered additional questionnaires (Tables 2 and 3).

Table 2. Questionnaire to determine the level of knowledge and skills of 10th grade students

No.	Contents of the academic subject "Algebra and Beginnings of analysis" (natural science profile)	Theoretical knowledge			Practical skills		
		1	2	3	1	2	3
1	"Function, its properties and graph"						
2	"Trigonometric functions"						
3	"Inverse trigonometric functions"						
4	"Trigonometric Equations"						
5	"Trigonometric inequalities"						
6	"Probability"						
7	"Polynomials"						
8	"Limit of function and continuity"						
9	"Derivative"						
10	"Application of derivative"						
11	"Random variables and their numerical characteristics"						

Source: compiled by the authors.

Table 3. Questionnaire to determine the level of knowledge and skills of 11th grade students

No.	Contents of the academic subject "Algebra and Beginnings of analysis" (natural science profile)	Theoretical knowledge			Practical skills		
		1	2	3	1	2	3
1	"An antiderivative and an integral"						
2	"Elements of mathematical statistics"						
3	"Degrees and roots. Power function"						
4	"Irrational equations and inequalities"						
5	"Complex numbers"						
6	"Exponential and logarithmic functions"						
7	"Exponential and logarithmic equations and inequalities"						
8	"Differential Equations"						

Source: compiled by the authors.

These tables show the topics of the basic content of the subject "Algebra and Beginnings of Analysis" for high school students of natural science profile. The questionnaire has two blocks – a block with theoretical knowledge and a block with practical skills. Pupils were asked to evaluate their level of knowledge and skills on the proposed topics separately in two blocks from 1 to 3, where 1 – knowledge/skills are formed at a low level, 2 – knowledge/skills are formed at an average level, 3 – knowledge/skills are formed at a high level. During the questionnaire survey it was taken into account that, based on the curriculum and calendar plans, some topics have not been fully learnt by pupils yet. The results of additional questionnaires demonstrated the level of theoretical knowledge and practical skills of pupils, allowed assessing the gap between them and making assumptions about the reasons for such results.

Results

The educational process of the Republic of Kazakhstan is annually modernized and improved to meet international requirements and increase the competitiveness of Kazakhstani personnel in the international labour market. Thus, in order to achieve high quality of the educational process, effective training of the younger generation and compliance with international standards, Decree of the Government of the Republic of Kazakhstan No. 941 "On approval of the Concept for the development of education of the Republic of Kazakhstan for 2022-2026" [9] defines the need to update the content of education. The need for changes in the educational process and its improvement is also determined by Decree of the Government of the Republic of Kazakhstan No. 726 "On approval of the national project 'Quality education Educated Nation'" [1].

Speaking about mathematical disciplines, their purpose in the educational process is the formation of creative and research skills of students, the development of cognitive processes and intellectual abilities, which can affect the formation and development of personality, as well as higher education and further professional activity. This determines the need for continuous modernization of mathematics education and the definition of new approaches to its teaching. According to the standard curriculum, the purpose of teaching the subject "Algebra and Beginnings of Analysis" is the intellectual development of students, the formation of universal and national values, the formation of students' mathematical knowledge and the ability to apply it in practice, in particular for the study of related disciplines and further education [10]. The objectives of teaching Algebra and Beginnings of Analysis, based on the model curriculum, are: to contribute to the further development of mathematical competences, to develop logical and critical thinking and creative abilities, to develop communication skills, to develop the ability to search for information and use it, to develop personal qualities (independence, initiative, perseverance, tolerance), to develop teamwork skills, to develop an understanding of the importance of the exact sciences for the development of the individual and the State, and to develop the ability to use information in the classroom.

The peculiarity of profile education in mathematical disciplines is the in-depth study of the subject, as well as the purposefulness of this process, both on the part of students and teachers [11; 12]. The aim of the teacher is to develop in students of profile classes the ability to self-direct their activities, to take responsibility for the in-depth study of the subject, to be creative in their independent work. The renewal of the content of education in the Republic of Kazakhstan was influenced by the increase in the number of international students, the development of modern technologies, changes in the labour market, in particular, the need for Kazakhstani personnel to meet international requirements and the need to improve their competitiveness. The aim of updating the content of education may also be to bring the curriculum in line with the needs of the state itself and to improve the efficiency of all educational structures [13; 14]. The renewal of educational content should be based on modern approaches such as: value-based, competence-based and STEAM (Science, Technology, Engineering, Art, Mathematics) approach [15].

The value-oriented approach provides for the education of the younger generation in basic life and national values. The competence approach is aimed at developing specific skills and competences that will help the younger generation to solve problems independently, based on the acquired experience. STEAM approach is a comprehensive training of students based on the integration of science, technology, engineering, art and mathematics. Within the framework of this approach, the methodology of teaching Algebra and Beginnings of Analysis should include: the use of all possible modern technologies, individual and team projects, experiments, assignments that require the application of knowledge from other disciplines or real-life situations, and creative assignments. The updated content also implies a criterion-based assessment system, integration of learning material, development of students'

21st century skills, and development of functional literacy. The criterion-based assessment system is based on predetermined objectives and assessment criteria (e.g. assessment of the level of knowledge, assessment of the ability to apply knowledge in practice, assessment of the ability to perform tasks independently, and so on, as well as the overall assessment of each individual student's achievement of the learning objective), each of which is analysed before scoring.

Twenty-first century skills are a structure of skills needed by today's youth for successful educational, career, and life development [16; 17]. In the context of renewed educational content, 21st century skills should be developed in all disciplines, including mathematics education. Among the 21st century skills that can be developed in the course of teaching Algebra and Beginnings of Analysis are: problem-solving skills, critical thinking, creativity, communication skills [18; 19]. The listed skills affect not only mathematical skills and success in learning the subject "Algebra and Beginnings of Analysis", but also develop students' functional literacy. Researchers understand functional literacy as an individual's ability to apply acquired skills (cognitive, verbal and computational) in real culturally specific situations; a set of knowledge, skills, and predisposition to continuous personal development in political, economic, cultural, social spheres of life [20; 21]. The normative documents of the Republic of Kazakhstan [15] identify the following components of functional literacy: reading literacy, science literacy, financial literacy, global competences, creative thinking and mathematical literacy, which is worth considering in detail.

Mathematical literacy is the ability to make sound mathematical judgements, apply and interpret mathematics to solve problems in different contexts [15; 22; 23]. To develop mathematical literacy, a teacher can use interactive tasks that require active participation of students, problem-oriented tasks aimed at solving real-life situations, textual tasks, and visual materials in the teaching process. The teaching methodology should also include work with methodological and reference literature, brainstorming sessions, and increase the number of modern technologies used [24-27]. Thus, the main changes in the methodology of teaching Algebra and Beginnings of Analysis are: introduction of a criterion-based assessment system, development of students' 21st century skills, development of functional and, in particular, mathematical literacy (which implies the ability to use mathematical knowledge to solve problems in other contexts and spheres), and reduction of students' workload through the use of modern approaches in teaching methods. However, there is a need to test the effectiveness of these changes and, if problems are found, to provide methods of remedying them. To test the effectiveness of teaching methods of the subject "Algebra and Beginnings of Analysis" in the conditions of updated content, a study was conducted among 129 students of 10-11 profile classes of secondary general education schools of the Republic of Kazakhstan.

The results of the study showed that 79% of respondents (102 people) highly evaluate the quality of teaching mathematical disciplines in their educational institution, and 70% (90 people) are satisfied with the methodology of teaching the subject "Algebra and Beginnings of Analysis". This indicates a positive impact of content renewal on the methodology of teaching mathematical disciplines. However, only 53% of pupils (68 persons) noted that teachers use innovative methods and technologies during lessons, which indicates that teachers are not sufficiently prepared to update the content of education, which provides for the use of modern teaching methods. 78% of students (100 persons) are satisfied with the level of their theoretical knowledge, while only 60% of students (77 persons) are satisfied with the level of their practical knowledge. This may indicate a lack of functional literacy and the ability to use the acquired knowledge in real life situations. Also, 52% of students (67 students) believe that their educational institution does not give them enough opportunities to use the acquired knowledge in practice, which confirms the low level of practical skills of high school students. The results of the study demonstrated that only 57% of the students (73 students) are satisfied with their interaction with their teachers, while 43% (56 students) do not receive feedback from their teachers. This may indicate that educators do not pay enough attention to students and the problems they have during the educational process.

To improve their practical skills, schoolchildren can independently study the subject "Algebra and Beginnings of Analysis", however, 47% of schoolchildren (60 persons) noted that in the process of self-education they do not have access to modern methods and technologies, which may hinder this process. At the same time, 67% of pupils (86 persons) noted that they feel improvement of cognitive processes related to studying the subject "Algebra and Beginnings of Analysis". 54% of pupils (70 persons) noted that they feel the influence of studying the subject "Algebra and Beginnings of Analysis" on their pre-professional preparation, which can be connected with the necessity to pass final state examinations in this discipline and its importance in entering higher education institutions. 67% of students (86 people) noted that the process of studying the subject "Algebra and Beginnings of Analysis" affects their overall satisfaction with the educational process, which determines the need to improve teaching methods and to form a positive attitude to this discipline. Thus, the results of the questionnaire have demonstrated that pupils are generally satisfied with the process of studying the subject "Algebra and Beginnings of Analysis" under the conditions of the updated content. Pupils also highly assess their knowledge, but note difficulties in applying it in practice. This demonstrates problems in the development of functional literacy, in particular, its component – mathematical literacy, as an element of the updated content of education. Pupils also noted the lack of innovative methods and technologies, both in classes and in self-education, as well as the lack of feedback from teachers.

Based on the results of the study, the methodology of profile teaching of the subject "Algebra and Beginnings of Analysis" in the conditions of the updated content meets the stated requirements and is highly appreciated by students. However, in order to check the knowledge and skills of high school students, additional questionnaires were used, which helped to determine how students are oriented in the topics that are included in the content of the subject "Algebra and Beginnings of Analysis" in students of 10th and 11th grades and how they assess their

knowledge and skills. Students assessed the level of mastery of theoretical knowledge and practical skills for each topic, then the average value for each student and for classes as a whole was found. The results of the supplementary questionnaire demonstrated that the majority of 11th grade pupils are well oriented even in those topics that, based on the curriculum and calendar plans, have not been fully studied yet, which may be due to active preparation for state examinations and admission to higher education institutions, while the results of 10th grade pupils were lower (Figures 1, 2).

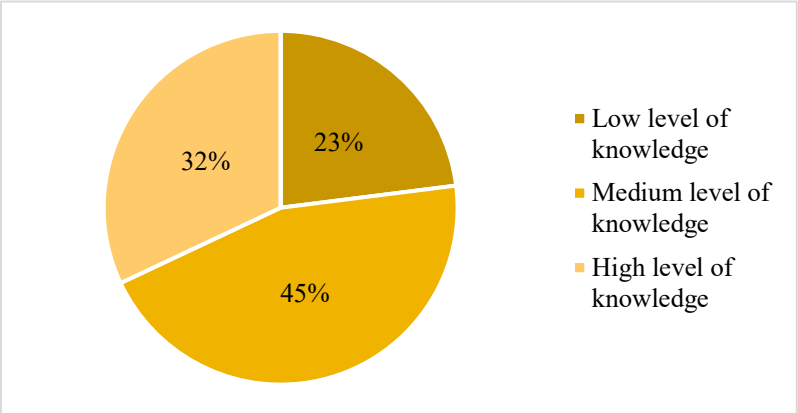

Figure 1. The percentage of 10th grade students with low, average, and high levels of knowledge in the subject "Algebra and Beginnings of Analysis"

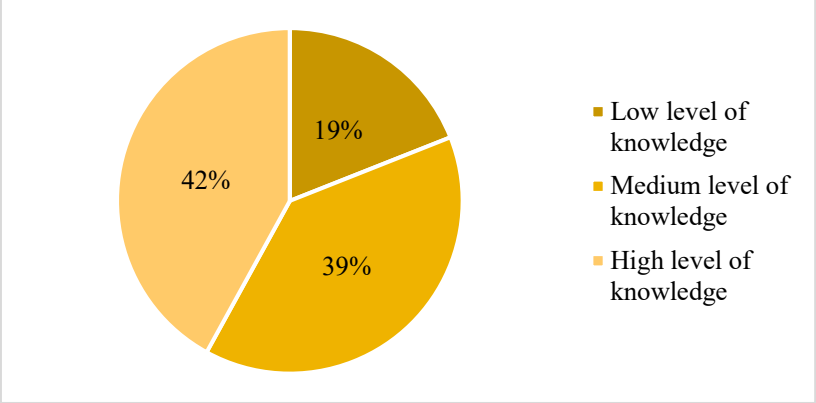

Figure 2. The percentage of 11th grade students with low, average, and high levels of knowledge in the subject "Algebra and Beginnings of Analysis"

However, the level of practical skills was not high among both 10th and 11th grade students (Figure 3, 4).

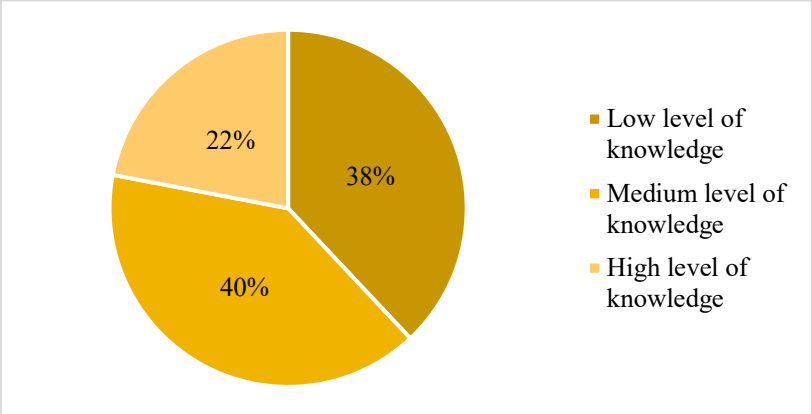

Figure 3. The percentage of 10th grade students with low, medium, and high skill levels in "Algebra and Beginnings of Analysis"

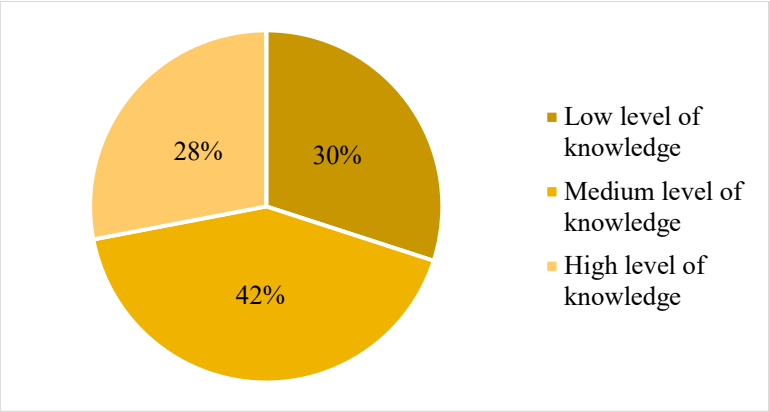

Figure 4. The percentage of 11th-grade students with low, medium, and high skill levels in "Algebra and Beginnings of Analysis"

Thus, 10th and 11th grade students assess their knowledge higher than their practical skills (Table 4). The difference in students' assessment of their theoretical knowledge and practical skills may be due to both shortcomings in teaching methodology, lack of feedback from teachers, and low motivation for learning and lack of opportunity to apply their knowledge in practice. This demonstrates the need to improve teaching methods, as well as the introduction of such elements in the educational process, which will motivate students and form in them not only knowledge, but also practical skills to apply the acquired knowledge in the framework of profile teaching of the subject "Algebra and Beginnings of Analysis".

Table 4. Difference in the level of theoretical knowledge and practical skills of students in the 10th and 11th grades in the subject "Algebra and Beginnings of Analysis"

Class	Knowledge level			Skill Level		
	L	M	H	L	M	H
10th grade (68 people)	23% (16)	45% (30)	32% (22)	38% (26)	40% (27)	22% (15)
Difference between knowledge and skill level	-15%	+5%	+10%	+15%	-5%	-10%
11th grade (61 people)	19% (11)	39% (24)	42% (26)	30% (18)	42% (26)	28% (17)
Difference between knowledge and skill level	-11%	-3%	+14%	+11%	+3%	-14%

Note: L – low level of knowledge/skills; M – medium level of knowledge/skills; H – high level of knowledge/skills.
Source: compiled by the authors.

The improvement of teaching methodology depends on the teacher's involvement in the educational process and interest in students' learning. The teacher's role in teaching a subject is quite high. The teacher should be able to manage the class, define learning objectives and relate the teaching methodology to them, his/her task is also to discover the potential of each pupil and to find an individual approach that allows the development of each pupil based on his/her starting knowledge and skills [28-30]. However, the results of the study demonstrated that school children lack the use of innovative methods and technologies and feedback by teachers. There is a need to encourage teachers to interact with students and help them with issues that arise during the educational process.

A developmental learning system aimed at changing the attitude of teachers to the process of teaching disciplines can be effective. The developmental system of teaching is aimed at unlocking the potential of students and using their zone of proximal development, and it is the teacher who can lead these processes, using innovative technologies and modern teaching methods, adapting them to the needs of students. However, to implement this approach in the methodology of teaching the subject "Algebra and Beginnings of Analysis", the teacher must not only have all the necessary resources and materials, but also have certain skills. Thus, to obtain the necessary materials, teachers can use the System-Methodological Complex (SMC), which is designed to provide methodological support and broadcast the pedagogical experience of Nazarbayev Intellectual Schools AOE for teachers of general education schools in the country [31].

The results of the study demonstrated that high school students lack the use of innovative methods and technologies in the learning process. This may be due to the unpreparedness of some teachers to use information and computer technologies (ICT). This necessitates the creation of a special platform or trainings that can better prepare teachers for the profile teaching of "Algebra and Beginnings of Analysis" in the context of updated content. The platform or trainings could include blocks on the use of ICT, ways of distance interaction with students (so that students can get feedback from the teacher outside the educational process), in-depth study of disciplines, as well as the possibilities of using ICT and gamification in teaching mathematics [32; 33].

Gamification can be a way that not only motivates students to study "Algebra and Beginnings of Analysis", but also facilitates memorization, develops the ability to independently and creatively solve tasks, develops research skills and reduces the learning load, which corresponds to the requirements of the updated content of education. For students of profile high schools,

gamification can include competitive elements (for example, dividing the class into several groups and solving tasks for speed), point systems (for example, a set of points for each correctly solved task or each correct answer, and, as a result, a bonus for those who gained the most points for a certain period), algebraic games (for example, puzzles, adaptation of well-known board games into mathematical topics). The use of gamification can also develop students' practical skills, but it is advisable to give high school students more opportunities to practice in order to better prepare them [34; 35]. For example, by creating algebra clubs on the basis of an educational institution, where high school students can gather and solve tasks, share experiences and help each other. Such an approach can not only improve students' skills but also enhance their ability to work in teams, which is important for their future careers [36-39].

Better training of teachers and the use of modern technologies and gamification elements in the process of profile teaching of the subject "Algebra and Beginnings of Analysis" can change students' attitudes towards the methodology of teaching mathematical disciplines and stimulate them to acquire knowledge. In the conditions of updated content, the key tasks are the development of creative and research abilities of students, as well as the development of functional literacy, which can be formed only by changing the approaches of the educational institution and teachers to teaching methods and improving them, based on the requirements and characteristics of each individual profile class.

Discussion

Updating the content of education is a necessity caused by changes in the economic, cultural and social spheres of the state, which in turn determines the importance of research on updated methods. E. Asmarawati [40] agrees with this statement when researching the implementation of an updated mathematics curriculum for grade 10. The researcher notes that changes in programmes, teaching methodologies are a complex process that requires more research and continuous improvement based on identified problems.

Mathematics disciplines are important for students because they shape their creative and research skills, critical thinking, and also influence students' pre-vocational training [41; 42]. In studying the impact of algebraic knowledge on the overall performance of schoolchildren, the same conclusion was reached by K. Imasuen and O. Stanley [43], noting that mathematics disciplines are important for pre-vocational training because knowledge from this area is used in manufacturing, economic industry and also influences the generation of new ideas. However, a study conducted by the researchers shows a low level of ability to apply the acquired knowledge in practice, which correlates with the results of the present study. Investigating the factors affecting students' success in solving mathematical problems.

I. Ali and S. Das [44] also believe that algebra is an important school discipline and can develop critical thinking and the ability to deal with real life situations. In their study, the researchers concluded that secondary school students may have difficulty in learning algebra due to the difficulty in interacting with the teacher and lack of resources for learning, which is in line with the findings of the present study. M. Kinanti et al. [45], in their work revealing the cognitive processes of students in the process of learning mathematics, noted that in addition to the standard cognitive processes that are developed during the learning process, their components are also mathematical communication, mathematical reasoning, modelling, mathematical problem-solving, and technical skills, which indicates the importance of learning algebra for the all-round development of students, in particular, the development of their intellectual abilities, the ability to apply their knowledge in the

The present study determined that the level of practical mathematical skills of students in the Republic of Kazakhstan is rather low. However, according to I. Stiphout et al. [46] such a trend is observed all over the world. Studying the formation of algebraic skills in pupils, the researchers noted that, based on the results of the international programmes TIMSS and PISA, there is a need to regularly review the methodology of teaching mathematical disciplines and improve it. L. Chan et al. [47], investigating the difficulties faced by students in solving algebraic problems, concluded that one of the reasons for the inability to use the acquired knowledge in practice may be the lack of time and resources for independent study and practical application of knowledge.

In this study, it was also found that 67% of the students who participated in the study felt the impact of studying Algebra and Beginnings of Analysis subject on the educational process in general. S. Das and I. Ali [48], while investigating the characteristics of algebraic problem-solving and its impact on students' academic performance, also found that there is a relationship between students' mathematical skills and their overall academic performance. Researchers also determined that the key role in the formation of mathematical skills is played by the teacher, his relationship with students and teaching methodology, which proves the need for more work with teachers and improving teaching methodology.

The results of this study demonstrated that the teaching methodology of the subject "Algebra and Beginnings of Analysis" in the conditions of updated content shows high results, and that the teaching methodology is important in students' mastery of knowledge and ability to apply it in practice. T. Richards and S. Samuels [49], investigating guided learning as a method of developing students' mathematical skills, also concluded that it is the teaching methodology that determines the effectiveness of the formation of knowledge and skills among students. The researchers also noted that students' greatest problems arise in the process of applying mathematical rules in practice, which confirms the lack of practical skills. G. Maheswari et al. [50], in their study of the Merdeka Education Programme in Indonesia, also identified that mathematics teaching methodology plays a high role in the effectiveness of the educational process and students' knowledge acquisition. In their study of this programme, the researchers concluded that the important thing in mathematics teaching methodology is the involvement of students in the educational process and active interaction between teachers and students through discussions, brainstorming, and joint search for solutions to tasks. At

the same time, it is important to develop students' ability to search for solutions to problems independently: whether it is solving problems during class or finding a solution in a real life situation [51-53].

To improve the methodology of teaching the subject "Algebra and Beginnings of Analysis" within the framework of this study, it was suggested to carry out additional work with teachers, through the creation of an additional platform or trainings, as well as to introduce game elements into the educational process. D. Rupasinghe et al. [54], investigating the professional development of mathematics teachers, concluded that additional training of teachers can affect student achievement and improve teaching methods in general. R. Changwe [55], while investigating the need to prepare educators to teach, concluded that poor quality training of mathematics teachers can affect the educational process and hinder the realization of learning objectives. The results of the analysed studies confirm the need for additional work with teachers to improve teaching methods.

Speaking about the elements of gamification, H. Iilonga and U. Ogbonnaya [56], who studied the role of verbal algebraic problems in students' ability to solve real life problems, concluded that the use of didactic games can indeed be effective in the methodology of teaching algebra. According to the researchers, didactic games can also be aimed at the formation of practical skills. J. Nautwima et al. [57], investigating the peculiarities of introducing gamification in mathematics teaching, agreed that it is an effective method that has a positive impact on the educational process, but its implementation can have difficulties based on the specifics of each individual subject and each individual educational institution as a whole. Despite the high role of teachers in the methodology of teaching mathematics, R. Poveda-Vásquez and M. Zumbado-Castro [58], investigating the implementation of an updated mathematics curriculum, concluded that the management of the process of updating educational content and implementation of curricula should be primarily the responsibility of the school administration, coordinating and guiding teachers.

Thus, the researchers agree on the need to update the content of education and the importance of researching updated teaching methods to find actual problems and methods of solving them. The researchers also point out the necessity of mathematical disciplines and their impact on students' personality, their cognitive and intellectual processes, on their general academic performance and future professional activity. The experts also found deficiencies in the practical application of skills by students and the importance of this skill (especially outside the educational institution, in real life situations), as well as the need to use modern technology. The proposed methods of improving teaching methods (additional training of teachers and the use of gamification to motivate students and develop their practical skills), according to the researchers, are effective. However, gamification has its own peculiarities and the success of its application may depend on each particular class and each individual student. Also, despite the fact that the teacher plays an important role in these processes, the researchers concluded that the coordination of teachers should be done by the management of educational institutions, as only integrated activities that are coordinated and coordinated at all levels can positively affect the effectiveness of the methodology of profile teaching of mathematical disciplines in the context of updated educational content.

Conclusions

The present study analysed the teaching methodology of the subject "Algebra and Beginnings of Analysis" for students of senior profile classes in the conditions of updated educational content. The study of exact sciences is important for students of the Republic of Kazakhstan, as their knowledge and ability to apply them in practice affects not only the cognitive sphere and intelligence of students, but also the quality of their future professional activity, which may affect the development of industries of the state. It is the teaching methodology that plays an important role in the process of knowledge assimilation. The methodology of teaching the subject "Algebra and Beginnings of Analysis" in the conditions of content renewal includes the use of value-oriented and competence-based approaches, STEAM-approach, development of students' 21st century skills, introduction of a criterion-based assessment system, development of functional literacy (including its component – mathematical literacy), reducing the load on students through the use of modern approaches and formation of their creative, research abilities, which they will be able to apply in real life.

In order to determine the problems arising in the process of teaching the subject "Algebra and Beginnings of Analysis" under the conditions of updated content, a study was conducted among 129 students of profile senior classes of secondary general education schools of the Republic of Kazakhstan. The study showed that 70% of the surveyed students are satisfied with the educational process and teaching methods in the conditions of the updated content of education. However, in teaching methodology there was found a lack of innovative methods and modern approaches to teaching, as well as a lack of proper interaction with teachers. It was also determined that 52% of respondents do not have sufficient opportunities to apply the acquired knowledge in practice. To confirm the obtained results, an additional questionnaire survey was conducted, which demonstrated that high school students highly evaluate their knowledge, but their practical skills are less developed. Thus, among 10th grade students, 32% rated their level of knowledge as high, but only 22% (-10%) of students believe they have a high level of skills. Among Grade 11 students, 42% of students felt that their knowledge was at a high level and only 28% (-14%) rated their skill level highly. This may indicate deficiencies in teaching methodology, lack of motivation to learn and inability to apply the acquired knowledge in practice. On the basis of the results obtained, methods of improving the methodology of profile teaching of the subject "Algebra and Beginnings of Analysis" were proposed, among which are: creating a platform for additional training of teachers to update the content of education or training sessions, gamification of the educational process and the creation of mathematical clubs for students on the basis of educational institutions, which will help to motivate high school students to learn and develop the ability to practical application of skills.

The prospects for further research are experimental confirmation of the effectiveness of the proposed methods, as well as the study of the role of the teacher and the management of the educational institution in the profile teaching of the subject "Algebra and Beginnings of Analysis" in high school.

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Conflict of Interest

None.

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Методика профільного навчання предмета «Алгебра і початки аналізу» для учнів старшої школи

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Анотація

Актуальність. Система освіти Республіки Казахстан поступово оновлюється відповідно до міжнародних вимог. Зміни торкнулися і методики профільного викладання предмета «Алгебра і початки аналізу» як важливого елемента підготовки старшокласників.

Мета. Метою даного дослідження є розкриття особливостей профільного навчання предмета «Алгебра і початки аналізу» в умовах оновлення змісту освіти.

Методика. Для досягнення мети використано методи аналізу та синтезу, порівняння, узагальнення, а також авторське анкетування.

Результати. У дослідженні розкрито особливості нової освітньої парадигми Республіки Казахстан, описано сутність оновлення змісту освіти та визначено зміни в методиці викладання математичних дисциплін. Визначено роль профільного викладання предмета «Алгебра і початки аналізу» для учнів старшої школи. Для визначення актуальних проблем у методиці викладання предмета «Алгебра і початки аналізу» було проведено дослідження серед 129 учнів профільних старших класів середніх загальноосвітніх шкіл Республіки Казахстан. Результати дослідження показали, що учні отримують необхідні знання в процесі вивчення предмета «Алгебра і початки аналізу» за оновленою методикою, але відчувається нестача інноваційних технологій в процесі навчання і зворотного зв'язку з боку вчителів. Запропоновано шляхи вдосконалення методики профільного навчання з предмета «Алгебра і початки аналізу», серед яких додаткова робота з учителями та підвищення їхньої інноваційної компетентності, гейміфікація навчального процесу та надання учням можливості застосовувати свої знання на практиці.

Висновки. Результати даного дослідження можуть бути використані керівництвом середніх загальноосвітніх шкіл Республіки Казахстан, а також викладачами математичних дисциплін для вдосконалення освітнього процесу та більш якісної підготовки учнів профільних старших класів.

Ключові слова: точні науки; профільне навчання; оновлення змісту; математична грамотність; середня освіта; освітня програма.