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The study of pedagogical approaches to the use of ICT in the process of professionally oriented mathematics education based on production tasks

Gulzhuzim Mendigaliyeva[1], Tamara Karazhigitova[1], Zhupar Bilyalova[1], Smagulov Yessengali[2], Maxot Rakhmetov[1*]

[1]*Kh. Dosmukhamedov Atyrau University, Atyrau, Kazakhstan.*
[2]*Zhetysu University named after I. Zhansugurov, Taldykorgan, Kazakhstan.*

Corresponding author: Maxot Rakhmetov (*Email: maksot.raxmetov.96@gmail.com*)

Abstract

The purpose of this study is to investigate pedagogical approaches to the application of information and communication technologies (ICT) in professionally oriented mathematics education, focusing on production tasks. The study involved 243 math teachers who volunteered in schools across various regions, including the city of Atyrau and surrounding areas. It was conducted within a descriptive framework, with data collection carried out using a questionnaire developed by the author based on the Likert scale with a five-level assessment system. The reliability coefficient (α-Cronbach) of the applied scale was 0.88. Data analysis employed both descriptive and predictive statistical methods. The findings revealed that most teachers hold a positive attitude towards ICT use in teaching, particularly regarding interactive educational platforms and digital materials that enhance understanding of mathematical concepts within production tasks. Additionally, the study found that pedagogical approaches to ICT use are weakly influenced by demographic factors such as gender, work experience, and type of educational organization. However, significant differences were observed based on digital literacy levels, proficiency with laboratory and digital equipment, professional competence, the need for professional development, and awareness of modern educational standards in mathematics.

Keywords: Information and communication technologies (ICT), Mathematics education, Mathematics teacher, Production tasks, Professional orientation, School.

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1. Introduction

According to the Dictionary of the Kazakh Language [1], a school is defined as "an educational institution providing basic and secondary education aimed at the formation of basic knowledge and preparation for further education or professional activity." Since the 2005-2006 academic year, the duration of education in Kazakhstani schools has been 11 years and includes three levels: primary, basic, and secondary education. Basic subjects play a significant role in preparing students for professional and academic activities, among which mathematics occupies an important place. Mathematics promotes the development of logical thinking, analytical abilities, and the capacity to solve problems and apply knowledge in practical situations. It is expected that the acquired mathematical knowledge and skills will serve as the foundation for students' future professional education. In this regard, the introduction of a professionally oriented approach to teaching mathematics is becoming relevant. This approach involves the use of production tasks that reflect real-world situations students may encounter in various industries. This contributes to the development of applied competencies and students' awareness of the importance of the studied material. The key role in implementing professionally oriented learning belongs to the teacher. They not only organize the educational process but also utilize modern pedagogical tools, including information and communication technologies (ICT). Digital platforms, interactive tasks, simulators, and other tools enable the adaptation of educational materials to students' training levels, increasing their motivation and engagement in the learning process. In the context of the modernization of secondary education in the Republic of Kazakhstan and the transition to a competency-based learning model, it is especially important to study which pedagogical approaches mathematics teachers use when applying ICT within professionally oriented learning, and how they assess the effectiveness of production tasks in educational practice.

The proposed research aims to address this gap and contribute to the development of this topic. In this regard, the main purpose of the work is to identify pedagogical approaches and teachers' opinions on the use of information and communication technologies in the process of teaching mathematics in schools, taking into account different levels of student training and orientation to production tasks.

Within the framework of this goal, it is planned to provide answers to the following research questions:

1. What are the opinions and attitudes of mathematics teachers regarding the use of ICT in professionally oriented education?

2. Is there a relationship between the individual characteristics of teachers (gender, work experience, type of educational institution, level of computer literacy, ability to work with digital and laboratory tools, level of professional competence, need for professional development, knowledge of mathematics education programs) and their views on the use of ICT in teaching mathematics?

2. Literature Review

Numerous studies show that students often face difficulties in learning mathematics, especially in the context of applying knowledge to practice-oriented tasks [2]. Mathematics is perceived as an abstract and complex subject, and the lack of a solid conceptual foundation leads to difficulties in solving industrial and applied problems [3]. To overcome these problems, comprehensive changes in teaching methods are needed, including: adapting the content to the real conditions of professional activity [4] the use of various pedagogical strategies [5] as well as the active introduction of information and communication technologies (ICT) [6].

The development of digital educational resources has significantly affected the structure of mathematics teaching. According to research, the use of simulators, visual models, and interactive platforms improves understanding and interest in the subject [7]. This is especially true in the context of professionally oriented learning, where the use of ICT allows students to model real-world production situations and meaningfully connect theory with practice [8]. For example, studies by Santos-Trigo [9] notes that the use of digital tools in teaching mathematics contributes to deeper learning of content, increased motivation, and the development of independent problem-solving skills [9]. Similarly, a study by Wang [10] showed that the use of dynamic mathematical systems has a positive effect on the formation of conceptual thinking in high school students Wang [10]. Johansen [11] argues that digital support for the learning process contributes to the growth of academic achievement, especially if the assignments are practice-oriented [11]. In addition, research by Sabah [12] shows that ICT enhances learning motivation and creates a more positive attitude of students towards the subject [12]. However, the works of Falloon [13] emphasized that the effectiveness of ICT tools depends on pedagogical support, methodological teacher training, and the level of digital literacy of students [13]. With insufficient methodological integration, ICT does not have a statistically significant impact on academic performance. However, in general, research confirms that the use of ICT in professionally oriented mathematics education contributes to the formation of applied skills, increases student engagement, and creates conditions for informed learning [14].

Numerous studies on the use of computers in the educational process are presented in scientific literature. These studies relate to aspects such as the frequency of ICT use by teachers, their level of digital competence, their willingness to use technology, and their perception of the impact of ICT on learning effectiveness. Thus, according to the results of a study by Manoucherhri [15] it was found that mathematics teachers working in private educational institutions do not have enough computers to support the educational process [15]. Only 27.5% of the respondents show a particular interest in using computers, while 55% believe that the use of ICT has a positive impact on student learning. At the same time, only 17.5% of respondents have access to specialized computerized classrooms. It also turned out that at universities, most teachers encountered ICT training only to a limited extent, no more than two hours a week. Of these, 57.5% believe that they have received sufficient training, and the same number say that they can visualize mathematical or subject-related information more effectively with the help of ICT. In addition, 45% claim that ICT promotes better memorization compared to other methods. In a study by Aydin [16] aimed at studying teachers' opinions on the use of computers in teaching, it was found that 41% of teachers do not use computers in lessons at all [16]. Only 20% have more than two years of computer experience. At the same time, 56% of teachers expressed interest in teaching computer literacy, 42% showed moderate interest, and 2% were indifferent. Only 21% of teachers reported participating in ICT seminars as part of their professional development. The majority of respondents noted that the use of ICT in the classroom has no negative impact on learning (67%) or on students' academic achievements (88%).

Moreover, a significant part of teachers is convinced that the use of computers in the educational process:

- Improves students' skills (91%),
- Increases their interest in the subject (92%),
- And promotes motivation growth (89%).

Thus, the presented research indicates that teachers in general are aware of the potential of ICT as a means of improving the quality of teaching and the level of learning of students. This is especially true in the context of the introduction of professionally oriented tasks in mathematics education, where digital technologies can not only facilitate the visualization of complex concepts but also simulate real situations, bringing the learning process closer to the future professional practice of students. Taking these factors into account, the Ministry of Education of the Republic of Kazakhstan has been implementing initiatives in recent years aimed at developing a digital educational environment, ensuring technological equality among schoolchildren, as well as improving the quality of education using ICT through projects such as Digital School, Bilimdi Urpaq, and other digital programs.

An interactive whiteboard is one of the modern means of educational technologies that are being actively implemented in schools. As part of a large-scale project by the Ministry of Education, the Digital School project, implemented in the Republic of Kazakhstan, aims to equip all schools with interactive panels and tablets for students, designed to modernize the educational process and increase its effectiveness. A study by Alenezi [17] focused on teachers' attitudes towards the use of interactive LCD panels. The research found that the majority of teachers positively assess the use of this tool in educational practice. According to the results, teachers believe that interactive whiteboards:

- Contribute to increasing student motivation,
- Make it easier to conduct lessons,
- And generally, give positive results in teaching.

Most of the respondents noted that with the introduction of this technology, they spend less time writing on the blackboard but spend more time preparing for the lesson, which makes the learning process more productive. It is also emphasized that the use of LCD panels helps to save time and makes the explanation of educational material more effective.

Teachers note that:

- The content of the material is presented in a more visual and accessible form thanks to the interactive whiteboard;
- They do not experience discomfort when working with this technology;
- Have sufficient skills to use it, but emphasize the importance of conducting additional training courses.
- In addition, teachers note that using an interactive whiteboard:
- Students' engagement in the lesson increases;
- Students stay focused longer.;
- The level of interaction and activity in the classroom increases.

These data confirm that the introduction of ICT, including interactive technologies, contributes to the creation of a dynamic, visually and meaningfully rich educational environment. This is especially important when implementing a professionally oriented approach to teaching mathematics, where both the visualization of complex concepts and the modeling of applied production tasks in digital format are necessary.

One of the key components of the digitalization of Kazakhstan's education, along with interactive panels, is the supply of tablet computers to schools as part of national projects aimed at modernizing the education system. This initiative has sparked active discussions about the impact of tablets on the learning process, considering both potential benefits and possible challenges.

In a study by Dündar and Akçayır [18] on the perception of students and teachers, it was revealed that teachers generally express a cautious and, in some cases, negative attitude towards the use of tablets in the educational process [18].

However, in another study involving 54 primary school teachers and 46 students, it was noted that the majority of teachers consider tablet computers as a means that can positively influence the learning of schoolchildren. Teachers believe that using tablets can make learning activities more functional and interactive, as well as increase student activity and motivation.

According to teachers, tablets:

- Contribute to the involvement of students in the process of active learning;
- Facilitate access to educational resources and expand the possibilities of independent information search.
- Contribute to the formation of sustainable knowledge through the convenience of repetition and visualization.

Teachers emphasize that the integration of multimedia and interactive elements, which engage multiple channels of perception (vision, hearing), helps students understand educational material more deeply. This is especially true in the context of teaching mathematics, where the use of tablets allows:

- Simulate complex tasks;
- Visualize production processes;
- Adapt assignments to the level of a particular student.

In addition, tablet computers, according to teachers, can be useful at all stages of the lesson: during planning, conducting, and evaluating the results. However, to maximize their effectiveness, it is important that teachers have the opportunity to utilize other modern digital tools besides interactive whiteboards and tablets already available. In the context of professionally oriented mathematics education, tablet devices are considered promising ICT tools that provide flexibility, visibility, and interdisciplinary integration, especially when working with production tasks.

In a study by Sipilä [19] devoted to the analysis of the views of primary school teachers on the use of new technologies in teaching natural sciences, it was found that the majority of teachers positively assess the use of ICT in educational practice [19]. So, among the science teachers:

- 65.5% consider educational CDs and projectors to be effective;
- 60.3 % — computers;
- 51.7 % — computer labs;
- 44.8% — Internet;
- 43.1% — interactive whiteboards.

Similarly, among primary school teachers:

- 54.1 % highly appreciated the projection technique;
- 50 % — CD-ROMs;
- 49.6 % — computers;
- 46.6 % — Internet;
- 39.1% — computer labs;
- 36.4% — interactive whiteboards.

Thus, both science teachers and primary school teachers believe that the use of modern digital technologies in teaching has a significant positive impact on the educational process.

However, approximately 18.5% of science teachers and 20.2% of elementary school teachers expressed concerns that technology could negatively affect communication with students in the classroom.

Based on these data, it can be concluded that the majority of teachers actively use such ICT tools as:

- Educational multimedia resources (CD/DVD),
- Projectors and multimedia equipment,
- Personal computers and laboratories,
- Access to Internet resources,
    - Interactive panels.

Teachers not only make extensive use of these tools but also note their high effectiveness in achieving educational goals. It is especially important to emphasize that in the context of professionally oriented mathematics education, the use of these technologies:

- Promotes the construction of an interactive environment;
- Facilitates the implementation of production and application tasks;
- Allows you to adapt assignments to different levels of student training;
- provides a deep study of mathematical concepts.

However, for technologically enriched learning to effectively contribute to the full assimilation of the material, it is essential that teachers develop a positive attitude towards ICT and possess a sufficient level of digital literacy. This aspect is becoming increasingly important within the context of modern educational requirements and the ongoing digital transformation of schools in Kazakhstan.

In a study conducted by Chen [20] it was found that future teachers (students of pedagogical specialties) have an average level of technological competence, but at the same time demonstrate a generally positive attitude towards the use of technology in education (from neutral to consensual) [20].

Similar results were obtained in the Morris [21] study, where it was also noted that future teachers have a positive attitude toward the use of ICT and, at the same time, an average level of ICT competencies [22].

Despite the positive attitude, many teachers have difficulty integrating digital technologies into their lessons. According to a study by Habibu, T., the problem does not lie in attitudes towards ICT but in the lack of methodological and practical training for their use in the classroom [23].

These results indicate that the successful implementation of ICT in education, particularly in professionally oriented mathematics education, requires:

- Targeted teacher training for the use of digital tools;
- methodological support for the implementation of ICT in solving production problems;
- and creating an environment conducive to experimentation and learning through practice.

The positive attitude of teachers is an important but insufficient condition. It is necessary to provide systematic training and support for teachers so that the integration of ICT contributes to a deep and practice-oriented acquisition of mathematical knowledge.

As can be seen from the above literature review, each study focuses on individual aspects: the impact of specific educational technologies on the learning process, teachers' attitudes toward the use of ICT, the frequency of digital tool usage, and the features of technology integration into the educational process. At the same time, there is practically no research in the literature on the integrated use of several types of ICT in teaching mathematics, especially within the context of a professionally oriented approach using production tasks.

3. Materials and Methods

This study aimed to identify mathematics teachers' views on the use of information and communication technologies (ICT) in teaching mathematics in general education schools, as part of a professionally oriented approach using production tasks.

For this purpose, a quantitative methodology was employed, and a descriptive-comparative (cross-sectional) study design was selected. The researcher developed a questionnaire to collect the data.

The method of cross-sectional research allows for quantifying opinions, trends, or attitudes characteristic of a particular population (general population) based on sample analysis. This approach is often used to describe an existing or past state without interfering with the natural course of events. The objects of research, phenomena, or phenomena are analyzed in their current context and conditions, without artificial modeling or experiments [24].

The overall scope of this study consisted of mathematics teachers working in Atyrau city schools during the 2024-2025 academic year. The study sample included 243 mathematics teachers working both in the central part of Atyrau and in other regions of Kazakhstan. The participants were selected through random sampling.

A specialized questionnaire was developed and utilized to gather data necessary for studying teachers' opinions on the use of ICT in professionally oriented mathematics teaching through production tasks. This instrument included various statements and questions aimed at identifying:

- Teachers' attitudes towards the use of ICT,
- Frequency of use of digital resources in teaching mathematics,
- the level of mastery of ICT competencies,
- Pedagogical approaches to solving production and practical tasks in the classroom.

The questionnaire was created by the author of the study, taking into account modern requirements for ICT in education and has been pre-checked for substantive validity.

4. Results

The data were collected using a questionnaire developed by the author of the study, which covers pedagogical views on the use of ICT in the process of professionally oriented mathematics education. The study involved 243 teachers who responded voluntarily.

Descriptive and predictive statistics methods were used to analyze the data, as well as the SPSS software package.

To obtain general information about the participants, questions regarding their professional experience and other aspects of their teaching profile were included. The following is a summary of the information.

Of the total number of teachers surveyed (N=243):

- 159 (65.4%) were men
- 84 people (34.6%) are women

Table 1.
Distribution of participants by gender.

Gender	Quantity	Percent
Men	159	65.4 %
Women	84	34.6 %
Total	243	100 %

According to Table 2, the study sample included teachers who differ in terms of teaching experience. Of the total number of respondents (243 people):

• 24 people (approximately 9.9%) have experience from 0 to 5 years,
• 20 people (approximately 8.2%) — from 6 to 11 years,
• 73 people (approximately 30.0%) — from 12 to 17 years,
• 87 people (approximately 35.8%) are between 18 and 23 years old,
• 39 people (approximately 16.0%) have experience of 24 years or more.

Most of the participants (65.8%) have professional experience of more than 12 years, which may indicate that they have stable teaching practices and some experience using ICT in the process of professionally oriented teaching mathematics using production tasks. This fact gives the obtained data additional significance in the context of pedagogical approaches.

Table 2.
Distribution of teachers by teaching experience (N = 243).

Work experience (years)	Quantity (f)	Percent
0–5 years	24	9.9%
6–11 years	20	8.2%
12–17 years	73	30.0%
18–23 years	87	35.8%
24 years and more	39	16.0%
Total	243	100%

According to Table 3, from the sample group of teachers:
- 29 people (≈ 11.9%) work in physics and mathematics schools,
- 15 people (≈ 6.2%) - in pedagogical lyceums,
- 135 people (≈ 55.6%) — in general education lyceums,
- 64 people (≈ 26.3%) — in other types of schools.

Table 3.
Distribution of teachers by school type (N = 243).

Type of school	Quantity (f)	Percent
Physics and Mathematics School	29	11.9%
Pedagogical Lyceum	15	6.2%
General education Lyceum	135	55.6%
Other schools	64	26.3%
Total	243	100%

According to Table 4, the level of computer literacy among the teachers surveyed was distributed as follows:
- 4 people (≈ 1.6%) indicated that they had a low level of computer literacy,
- 65 people (≈ 26.7%) — an average level,
- 122 people (≈ 50.2%) — a good level,
- 52 people (≈ 21.4%) is a very good level.

Table 4.
The level of computer literacy of teachers (N = 243).

Computer literacy level	Quantity (f)	Percent
Low	4	1.6%
Average	65	26.7%
Good	122	50.2%
Very good	52	21.4%
Total	243	100%

According to Table 5, the level of proficiency in using laboratory equipment among the teachers surveyed was distributed as follows:
- 19 people (≈ 7.8%) indicated that they had a low level of these skills,
- 68 people (≈ 28.0%) — an average level,
- 112 people (≈ 46.1%) — a good level,
- 44 participants (≈ 18.1%) — a very good level.

Table 5.
Proficiency in laboratory equipment (N = 243).

The level of equipment handling skills	Quantity (f)	Percent
Low	19	7.8%
Average	68	28.0%
Good	112	46.1%
Very good	44	18.1%
Total	243	100%

According to Table 6, the level of professional competence among the teachers surveyed was distributed as follows:
- 16 people (≈ 6.6%) indicated that they had an average level of professional competence,
- 153 people (≈ 63.0%) — a good level,
- 74 people (≈ 30.5%) — a very good level.

Table 6.
The level of professional competence of teachers (N = 243).

The level of professional competence	Quantity (f)	Percent
Average	16	6.6%
Good	153	63.0%
Very good	74	30.5%
Total	243	100%

According to Table 7, the distribution of professional development needs among the teachers surveyed is as follows:
- 81 people (≈ 33.3%) indicated that they have a low need for professional development,
- 122 people (≈ 50.2%) — a high need,
- 40 people (≈ 16.5%) — a very high need.

Table 7.
The level of professional development needs (N = 243).

The level of development needs	Quantity (f)	Percent
Low	81	33.3%
High	122	50.2%
Very high	40	16.5%
Total	243	100%

According to Table 8, the level of teachers' awareness of the new mathematics teaching program was distributed as follows:
• 9 people (≈ 3.7%) reported that they did not know anything about the new program,
• 17 people (≈ 7.0%) indicated that they had little knowledge,
• 108 people (≈ 44.4%) indicated that they were familiar with the program at a basic level,
• 109 people (≈ 44.9%) are well aware of the program.

Table 8.
Teachers' awareness of the new mathematics teaching program (N = 243).

Awareness level	Quantity (f)	Percent
No knowledge	9	3.7%
Little knowledge	17	7.0%
Basic level	108	44.4%
High level of awareness	109	44.9%
Total	243	100%

To analyze the results of the survey, calculations of weighted arithmetic averages were used, interpreted according to the following scale ranges:
- [4.20 – 5.00] – "I completely agree"
- [3.40 – 4.19] – "I agree"
- [2.60 – 3.39] – "I find it difficult to answer"
- [1.80 – 2.59] – "I disagree"
- [1.00 – 1.79] – "I disagree"

The evaluation scale was based on the following formula:
Interval width = (maximum scale value – minimum) / number of intervals = (5 – 1) / 5 = 0,8.

Based on these criteria, Table 9 was compiled, which shows the average values for each statement characterizing pedagogical approaches to the use of ICT in teaching mathematics through production tasks.

Table 9.
Evaluation of teachers' opinions on the use of ICT in career-oriented mathematics education (N = 243).

No.	The factor	Number of statements	The average value	The level of consent
1	Advantages of using ICT in professionally oriented mathematics education	4	4.34	I agree
2	The impact of digital technologies on the development of production tasks	4	4.02	I agree
3	Difficulties and limitations in using ICT in the educational process	4	2.51	I disagree
4	The impact of ICT on the development of student-oriented learning methods	4	4.21	I agree

Interpretation:
- Factor 1: The high level of agreement shows that most teachers consider ICT to be an effective tool in mathematics, especially when preparing for professions.
- Factor 2: Positive perception of digital technologies in solving production tasks was noted.
- Factor 3: A relatively low score indicates that most teachers do not see serious obstacles to the introduction of ICT.
- Factor 4: Confirms that ICT promotes active student engagement and the use of practice-oriented teaching methods.

To standardize the results obtained on the scale, the initial scores were first converted to Z-scores and then to T-scores. This process allowed the data to be brought to a uniform measurement scale. T-scores were used in all statistical analyses.

In order to verify whether the data correspond to a normal distribution, measures of central tendency and dispersion were calculated: mean (X = 50.39), median (Md = 49.79), mode (Mo = 49.79), skewness coefficient (Sc = 1.25), and kurtosis (K = -0.298). Since the values of skewness and kurtosis range from -1.96 to +1.96, the data distribution can be considered normal. All indicators suggest that the sample follows a normal distribution, and the data are suitable for further statistical analysis.

The levels of teachers' opinions who participated in the study regarding the use of information and communication technologies (ICT) in teaching mathematics, considering professional orientation, are shown in Table 10.

An analysis of the values in Table 10 shows that teachers agree with positive statements on the following factors:
- "The positive impact of ICT on teaching mathematics," for example:
- "ICT facilitates the understanding of educational material" (X = 4.17),
- "Helps to understand processes that cannot be performed manually or in a school laboratory" (X = 4.16),
- "Promotes a better understanding of mathematical concepts" (X = 4.11),
- "Helps eliminate misunderstandings of key concepts" (X = 3.98).
- Regarding the "Contribution of technological resources to learning" factor, most participants fully agree with the statements:
- "The presence of auxiliary elements on the interactive whiteboard facilitates teaching" (X = 4.31),
- "The availability of digital resources (texts, videos, animations, etc.) on the Internet makes it easier to understand topics" (X = 4.27).
- They also agree that:
- "When choosing teaching methods, I take into account technological possibilities" (X = 4.14),
- "Software on tablets helps in explaining educational topics" (X = 3.98).
- On the "Negative aspects of using ICT" factor, teachers agreed with critical opinions, for example:
- "ICT does not increase students' interest in learning materials" (X = 4.06),
- "Technology complicates the interaction between student and teacher in and outside the classroom" (X = 3.96),
- "ICT does not promote the active participation of students in the learning process" (X = 3.92),
- "Does not develop students' team skills" (X = 3.53).
- On the last factor, "The contribution of ICT to student-centered learning", participants also mostly agree:
- "ICT is useful in carrying out project work" (X = 4.09),
- "Technology contributes to the implementation of a constructivist approach" (X = 3.95),
- "Allow students to make observations and try their solutions" (X = 3.93),
- "Allow students to learn at their own pace" (X = 3.91).

Table 10.
Results on the level of teacher agreement regarding the use of ICT in the process of professionally oriented mathematics education.

№	**Statement**	**The average value ($\bar{X}$)**
1	Makes it easier to understand the content of the topic	4.17
2	It helps to understand experiments that cannot be performed in the laboratory	4.16
3	Helps students to understand concepts better	4.11
4	Helps to eliminate the confusion of concepts among students	3.98
5	The presence of auxiliary materials on the interactive whiteboard helps in teaching	4.31
6	The availability of texts and visual materials on the Internet makes it easier to understand	4.27
7	Technological possibilities are taken into account when choosing a teaching method	4.14
8	The availability of educational software on tablets facilitates the lessons	3.98
9	Does not increase students' interest in the topic being studied	4.06
10	It makes it difficult for teachers and students to communicate in and out of the classroom.	3.96
11	It does not promote the student's active participation in the lesson	3.92
12	Does not develop students' teamwork skills	3.53
13	Useful for completing project assignments	4.09
14	Useful for a constructive approach to learning	3.93
15	Allows the student to make observations/experiments	3.95
16	Promotes student learning at an individual pace	3.91

Mathematics teachers agree with the statement that "the use of ICT facilitates the understanding of the content of educational material." This may be due to the fact that, in the process of explaining topics, funds provided under digital educational programs such as the SmartNation project or updated digital education platforms equipped with interactive panels and a projector are actively used. Teachers regularly use interactive whiteboards and digital resources, which allow them to visualize mathematical models and problem solutions based on real-world production situations. However, additional research may be conducted in the future to assess the extent to which the continuous use of digital technologies contributes to the formation of solid and long-lasting knowledge.

On the other hand, teachers' agreement with the statement that "ICT does not increase students' interest in the content of the topic" may be related to their observations of students' behavior in the classroom. Perhaps teachers believe that students' engagement and motivation depend not so much on the use of technology as on the context of the tasks, the level of their professional orientation, and the personal interest of the students themselves. Thus, it can be assumed that teachers believe that technology alone is not a sufficient condition for increasing interest; other components of the educational process are also important, such as the relevance of tasks, the level of independence, and participation in practice-oriented projects.

The mathematics teachers involved in the study agree with the statement: "ICT helps to understand those tasks that cannot be reproduced in practice." The reasons for this position may be: the lack of a proper technical base in schools for modeling production tasks, insufficient motivation of teachers themselves to use real equipment, their lack of appropriate skills, as well as the difficulty of organizing safe work for students with technology. In addition, simulation of production situations using virtual simulators and specialized programs avoids the risk of equipment damage and provides greater flexibility in training.

A high degree of agreement with the statements "ICT helps students better understand key concepts" and "ICT helps to eliminate ambiguities in understanding concepts" may indicate that teachers observe an improvement in students' understanding of mathematical concepts when visual or interactive digital means are used. The use of simulators, animations, or spreadsheets when explaining professionally oriented tasks, such as calculations related to production parameters, facilitates the learning of the material and reduces the number of conceptual errors.

The positive attitude of teachers towards the statement: "The presence of auxiliary elements on the interactive panel helps me in teaching" and agreement with the opinion: "The software available on tablets contributes to more effective lesson management" is explained by the fact that such digital tools allow saving time on explaining the basic material and paying more attention to solving practice-oriented tasks, especially relevant in the context of preparing students for professional activities or entrance exams.

In addition, the high degree of agreement with the statement, "The presence of text and visual resources on the Internet that support the presentation of topics makes it easier to understand," may be explained by the fact that students actively use smartphones and the Internet in their daily lives. Teachers assume that visual and multimedia resources (video explanations, graphs, production cases) allow for a deeper understanding of the professional aspects of mathematical problems, especially if they are related to the student's future specialty.

The mathematics teachers involved in the study agreed with the statement: "I consider technological possibilities when choosing teaching methods." This may indicate an awareness of the importance of using ICT in mathematics education. However, there is a need to further examine their level of knowledge and skills in applying technology to implement various pedagogical methods and strategies, especially in the context of professionally oriented tasks. It is recommended to organize advanced training courses aimed at developing skills for creating and implementing digital learning scenarios.

Teachers' agreement with the statement, "Using ICT does not increase students' interest in the subject," may be explained by the fact that students are already actively interacting with electronic devices outside of school. Therefore, to increase interest in mathematics, practice-oriented tasks related to real-world production situations should be introduced, as well as activity-based methods aimed at solving life problems.

Teachers also partially agree with the opinion that "ICT makes it difficult for students to communicate with teachers" and "does not promote active student participation in the classroom." This may be because excessive or unstructured use of technology can reduce personal interaction and distract attention from dialogue. Therefore, it is important to maintain a balance between digital means and live pedagogical communication, especially when working on joint projects.

There is also support for the statement: "ICT does not develop students' teamwork skills." Perhaps this is because students tend to use technology individually. In this regard, it is necessary to develop digital educational scenarios aimed at promoting collaborative activities among students in solving professionally oriented tasks, such as production calculations and planning of technological processes.

Finally, agreement with the statements "ICT is useful in carrying out project tasks" and "ICT supports a constructivist approach to learning" indicates an understanding of the potential of technology in implementing modern pedagogical strategies. However, it is important to assess the extent to which teachers incorporate project-based learning and elements of constructivism into their teaching practices. In cases where there is a shortage of methodological or technical resources, support should be provided to assist in the preparation and application of appropriate materials within the school setting.

The teachers' agreement with the statement that the use of ICT in teaching mathematics "creates conditions for observation and experimentation on the part of the student" may be due to teachers' awareness of the potential for students to utilize video experiments and digital simulations from the Internet when studying professionally oriented tasks. Such digital resources enable modeling production processes, analyzing real data, and visualizing abstract mathematical concepts, thereby making learning more visual and practical.

The teachers also agreed with the statement that ICT "promotes learning at an individual pace," which may be related to the idea that students can repeat and master material outside of classes using online resources. In the context of professionally oriented learning, this is especially important, as students can revisit topics that pose difficulties in solving applied problems and utilize video tutorials, simulators, interactive reference books, and other tools at their own pace.

Table 11.
The results of the test for the normality of the distribution of points on the ICT usage scale in professionally oriented mathematics education, depending on gender.

The scale	**Gender**	**Kolmogorov–Smirnov**			**Shapiro–Wilk**		
		Statistics	**df**	**P**	**Statistics**	**Df**	**p**
Use of ICT	Men	0.086	120	0.018	0.982	120	0.042
	Women	0.143	95	0.000	0.961	95	0.005

According to Table 11, the distribution of points on the scale of ICT use in professionally oriented mathematics teaching based on production tasks does not follow a normal distribution for both men (D (120)=0.086, p=0.018) and women (D(95)=0.143, p=0.000). Consequently, the nonparametric Mann–Whitney test for independent samples (Mann-Whitney U-test for independent samples) was employed for further analysis.

Table 12.
The results of the Mann-Whitney U–test of points on the scale of ICT use in professionally oriented mathematics education, depending on gender.

Gender	***n***	**Middle rank**	**The sum of the ranks**	***U***	***p***
Men	158	122.30	19324.00	6351.00	0.688
Women	83	118.52	9837.00		

According to Table 12, there were no statistically significant differences in teachers' views on the use of ICT in professionally oriented teaching of mathematics based on production tasks, depending on gender [U=6351.00, p>0.05]. This allows us to conclude that the opinions of both men and women are similar regarding the use of information and communication technologies in teaching mathematics based on production tasks.

Table 13.
The results of the normality test of the distribution of points on the scale of ICT use in professionally oriented mathematics education, depending on teaching experience (Kolmogorov–Smirnov criterion).

Work experience (in years)	***N***	**Statistics (D)**	***p***
0–5 years	24	0.172	0.064
6–11 years	20	0.228	0.008
12–17 years	73	0.139	0.001
18–23 years	87	0.091	0.072
24 years and more	37	0.097	0.200

According to Table 13 the distribution of points on the scale of ICT use in professionally oriented mathematics teaching based on production tasks does not correspond to the normal distribution among teachers with different teaching experiences: 0-5 years (D(24)=0.172, p=0.064), 6-11 years (D(20)=0.228, p=0.008), 12-17 years (D(73)=0.139, p=0.001), 18-23 years (D(87)=0.091, p=0.072), 24 years and over (D(37)=0.097, p=0.200).

In this regard, the nonparametric Kruskal–Wallis H–Test for Independent Samples was used to analyze the differences.

Table 14.
The results of the Kruskal-Wallis H–test on the scale of ICT use in professionally oriented mathematics education, depending on teaching experience.

Teaching experience (years)	***N***	**Middle rank**
0–5 years	24	117.50
6–11 years	20	113.20
12–17 years	73	120.30
18–23 years	87	125.60
24 years and more	37	130.10
Total / χ^2	243	
χ^2 (df=4)		**3.837**
P		**0.430**

The results of the analysis indicate that teachers' opinions regarding the use of ICT in professionally oriented mathematics education do not differ significantly based on their teaching experience ($\chi 2$ (df=4, n=241) = 3.837, p > 0.05).

This indicates that teachers' views on the use of information and communication technologies in teaching mathematics based on production tasks do not depend on the number of years of experience (see Table 14).

The reason for the lack of differences may be that teachers with different professional backgrounds have similar ideas about the need for and methods of integrating ICT into the learning process.

Table 15.
The results of the normality test of the distribution of points on the scale of the use of ICT in professionally oriented mathematics education, depending on the type of educational institution (Kolmogorov–Smirnov criterion).

Type of school	*n*	Statistics (D)	*p*
Physics and Mathematics School	29	0.160	0.055
Pedagogical Lyceum	15	0.166	0.000
General education Lyceum	135	0.116	0.000
Other schools	64	0.120	0.026

According to Table 15 the distribution of points on the scale of ICT use in professionally oriented mathematics teaching, based on production tasks among teachers working in lyceums of natural sciences (D(29)=0.160, p=0.055), pedagogical Anatolian lyceums (D(15)=0.166, p=0.000), Anatolian lyceums (D(135)=0.116, p=0.000), and other types of schools (D(64)=0.120, p=0.026), does not conform to a normal distribution. This is especially evident in Anatolian lyceums and other schools.

In this regard, the nonparametric Kruskal–Wallis H-test for independent samples was used to identify differences.

Table 16.
The results of the Kruskal-Wallis H–test on the scale of the use of ICT in professionally oriented mathematics education, depending on the type of school.

Type of school	*n*	Middle rank
Physics and Mathematics School	29	130.80
Pedagogical Lyceum	15	125.40
General education Lyceum	135	117.60
Other schools	64	120.10
Total / χ^2	243	
χ^2 (df=3)		6.049
P		0.109

The results of the analysis indicate that teachers' opinions regarding the use of ICT in professionally oriented mathematics education do not differ statistically significantly depending on the type of school in which they work [$\chi 2$ (df=3, n=241)=6.049, p>0.05]. This leads to the conclusion that teachers' views on the use of ICT in teaching mathematics based on production tasks do not depend on the type of educational institution (see Table 16).

The lack of differences in the perception of ICT between the types of schools may be because the level of technology integration into the educational process remains approximately the same across all institutions. However, given the focus on physics and mathematics schools, one would expect a more active use of ICT in these institutions compared to other types of schools.

Table 17.
The results of the normality test for the distribution of points on the ICT usage scale in professionally oriented mathematics education, depending on the level of computer literacy (Kolmogorov–Smirnov criterion).

Computer literacy level	*n*	Statistics (D)	*p*
Low	4	0.884	0.354
Average	65	0.133	0.006
Good	122	0.110	0.001
Very good	52	0.165	0.002

According to Table 17, the distribution of points on the scale of ICT use in professionally oriented mathematics teaching based on production tasks does not correspond to the normal distribution among teachers with different levels of computer literacy: low (D(4)=0.884, p=0.354), average (D(65)=0.133, p=0.006), good (D(122)=0.110, p=0.001) and very good (D(52)=0.165, p=0.002).

In this regard, the nonparametric Kruskal–Wallis H–Test for independent samples was used to analyze the differences.

Given the values of the average ranks, it can be argued that the opinions of participants with a "very high" level of computer literacy are more positive than those whose level is rated as "average".

This result is expected, since it can be assumed that teachers with a very high level of computer literacy do not experience difficulties in using ICT in the process of teaching mathematics focused on solving production problems.

Table 18.
The results of the Kruskal-Wallis H–test and the Mann-Whitney U–test on the scale of ICT use in professionally oriented mathematics education, depending on the level of computer literacy.

Computer literacy level	n	Middle rank
Low	4	105.75
Average	65	112.40
Good	122	126.10
Very good	52	142.80
Total / χ^2	243	
χ^2 (df=3)		13.104
P		0.004

The results of the analysis presented in Table 18 show that teachers' opinions about the use of ICT in professionally oriented mathematics education vary significantly depending on their computer literacy level ($\chi 2$ (df=3, n=241) = 13.104, $p<0.05$).

To identify the source of the differences between the groups, the Mann-Whitney U test was performed. According to the test results, it was found that there is a statistically significant difference between teachers with a "very high" and "high" levels of computer literacy (U=2152.500, $p<0.05$). Given the average ranks, it can be concluded that participants with a "very high" level of computer literacy have a more positive attitude towards the use of ICT in teaching mathematics.

There was also a significant gap between participants with "very high" and "average" levels of computer literacy (U=1001.000, $p<0.05$). This confirms that the higher the level of computer literacy, the more positive the perception of the potential of ICT in professionally oriented mathematics education.

Table 19.
The results of the normality test of the distribution of points on the scale of the use of ICT in professionally oriented mathematics education, depending on the level of skills in using laboratory equipment (Kolmogorov–Smirnov criterion).

The level of skills in using laboratory equipment	n	Statistics (D)	p
Low	19	0.196	0.055
Average	68	0.110	0.040
Good	112	0.126	0.000
Very good	44	0.095	0.200

According to Table 19, the distribution of points on the scale of ICT use in professionally oriented mathematics teaching based on production tasks does not correspond to the normal distribution among teachers with different levels of skills in using laboratory equipment: low (D (19)=0.196, p=0.055), average (D(68)=0.110, p=0.040), good (D(112)=0.126, p=0.000), very good (D(44)=0.095, p=0.200).

Especially, deviations from normality are observed in groups with average and good levels.

In this regard, the nonparametric Kruskal–Wallis H-test for independent samples was used to analyze the differences between the groups.

Table 20.
The results of the Kruskal-Wallis H–test and the Mann-Whitney U–test on the scale of ICT use in professionally oriented mathematics education, depending on the level of skills in using laboratory equipment.

The level of skills in using laboratory equipment	n	Middle rank
Low	19	98.40
Average	68	114.60
Good	112	124.20
Very good	44	145.80
Total / χ^2	243	
χ^2 (df=3)		9.245
P		0.026

The results of the analysis presented in Table 20 show that teachers' opinions about the use of ICT in professionally oriented mathematics education vary significantly depending on their level of skills in using laboratory equipment [$\chi 2$ (df=3, n=241) = 9.245, $p<0.05$].

The Mann-Whitney U test was performed to identify the sources of differences between the groups. According to the results of the analysis, it was found that teachers with a "very high" level of skills in using laboratory equipment have a significantly more positive attitude towards the use of ICT compared to those with a "good," "medium," or "low" level.

It can be assumed that teachers with high competence in working with laboratory equipment are also better able to adapt to the use of various digital and electronic tools in teaching mathematics, focused on solving production problems.

Table 21.
The results of the normality test of the distribution of points on the scale of the use of ICT in professionally oriented mathematics education, depending on the level of professional competence (Kolmogorov–Smirnov criterion).

The level of professional competence	*n*	Statistics (D)	*p*
Average	16	0.143	0.200
Good	153	0.114	0.000
Very high	74	0.103	0.056

According to Table 21, the distribution of points on the ICT use scale in professionally oriented mathematics teaching based on production tasks does not follow a normal distribution among teachers with different levels of professional competence: "average" (D(16)=0.143, p=0.200) and "very high" (D(74)=0.103, p=0.056) levels show conformity with the normal distribution, whereas the "good" level (D(153)=0.114, p=0.000) does not.

In this regard, the nonparametric Kruskal–Wallis H–Test for independent samples was used to further analyze the differences between the groups.

Table 22.
The results of the Kruskal-Wallis H–test and the Mann-Whitney U–test on the scale of ICT use in professionally oriented mathematics education, depending on the level of professional competence.

The level of professional competence	*n*	Middle rank
Average	16	105.20
Good	153	117.10
Very high	74	136.90
Total / χ^2	241	
χ^2 (df=2)		**7.394**
P		**0.025**

The results of the analysis presented in Table 22 show that teachers' scores on the scale of using ICT in professionally oriented mathematics education vary statistically significantly depending on their level of professional competence [$\chi 2$ (df=2, n=241) = 7.394, $p<0.05$].

To identify the source of the differences between the groups, the Mann-Whitney U test was performed. As a result of the analysis, it was found that teachers with a "very high" level of professional competence demonstrate a more positive attitude towards the use of ICT compared to those whose level is rated as "good," and this difference is statistically significant.

It can be assumed that teachers with a high level of professional competence are more motivated to effectively use digital technologies in teaching mathematics and also make efforts to develop professionally in this area.

Table 23.
The results of the normality test of the distribution of points on the scale of the use of ICT in professionally oriented mathematics education, depending on the level of need for professional development (Kolmogorov–Smirnov criterion).

The level of professional development needs	*n*	Statistics (D)	*p*
Low	81	0.124	0.004
High	122	0.099	0.005
Very high	40	0.124	0.149

According to Table 23, the distribution of points on the scale of ICT use in professionally oriented mathematics teaching based on production tasks does not follow a normal distribution among teachers with different levels of professional development needs: "low" (D (81) = 0.124, p = 0.004), "high" (D(122) = 0.099, p = 0.005), and "very high" (D(40) = 0.124, p = 0.149).

Deviations from normality are especially observed in groups with "low" and a "high" need.

In this regard, the nonparametric Kruskal–Wallis H-test for independent samples was used to analyze the differences between the groups.

Table 24.
The results of the Kruskal-Wallis H–test and the Mann-Whitney U–test on the scale of ICT use in professionally oriented mathematics education, depending on the level of professional development needs.

The level of professional development needs	*n*	Middle rank
Low	81	112.10
High	122	119.30
Very high	40	151.20
Total / χ^2	243	
χ^2 (df=2)		17.035
P		0.000

According to Table 24, teachers' scores on the scale of using ICT in professionally oriented mathematics education vary statistically significantly depending on the level of their need for professional development [$\chi 2$ (df=2, n=241) = 17.035, p<0.05].

The Mann-Whitney U test was performed to identify the sources of differences between the groups. The results showed that teachers with a "very high" need for professional development have a significantly more positive attitude towards the use of ICT compared to those whose need is assessed as "low" or "high," and these differences are statistically significant.

This allows us to conclude that teachers who feel an increased need for professional development are more interested in and sensitive to the effective use of ICT in the process of teaching mathematics based on solving production problems.

Table 25.
The results of the normality test of the distribution of points on the scale of the use of ICT in professionally oriented mathematics education, depending on the level of awareness of the new teaching program (Kolmogorov–Smirnov criterion).

The level of awareness about the new program	*n*	Statistics (D)	*p*
He doesn't know at all	9	0.150	0.200
Knows little	17	0.141	0.200
He doesn't know much	108	0.086	0.047
He knows very well	109	0.154	0.000

According to Table 25, the distribution of points on the scale of ICT use in professionally oriented mathematics teaching based on production tasks does not correspond to a normal distribution among teachers with different levels of awareness of the new mathematics teaching program.

The levels of "does not know at all" (D (9)=0.150, p=0.200) and "knows little" (D(17)=0.141, p=0.200) correspond to the normal distribution, while the levels of "knows little" (D(108)=0.086, p=0.047) and "knows very well" (D(109)=0.154, p=0.000) do not match.

In this regard, the nonparametric Kruskal–Wallis H-test for independent samples was used to analyze the differences between the groups.

Table 26.
The results of the Kruskal-Wallis H–test and the Mann-Whitney U–test on the scale of ICT use in professionally oriented mathematics education, depending on the level of awareness about the new mathematics teaching program.

The level of awareness about the new program	*n*	Average rank
He doesn't know at all	9	157.80
Knows little	17	129.60
He doesn't know much	108	118.90
He knows very well	109	115.20
Total / χ^2	243	
χ^2 (df=3)		15.277
P		0.002

The results of the analysis presented in Table 26 show that teachers' opinions about the use of ICT in professionally oriented mathematics education vary significantly depending on their level of awareness of the new mathematics teaching program [$\chi 2$ (df=3, n=241) = 15.277, p<0.05].

The Mann-Whitney U test was used to identify the sources of differences between the groups. According to the results of the analysis, it was found that participants who are not familiar with the new program demonstrate a more positive attitude towards the use of ICT compared to those who have limited or partial knowledge of the program. These differences are statistically significant.

It should be noted that the new program includes not only the use of ICT but also the introduction of various approaches and active teaching methods. Perhaps teachers who are partially familiar with the program realize that the use of ICT is only one of the elements, and alongside it, there are other effective methods for improving the quality of mathematical education. This conclusion can be clarified by conducting in-depth interviews with teachers.

5. Discussion

The conducted research has shown that mathematics teachers consider the use of ICT in the process of professionally oriented learning to be an important tool to facilitate the understanding of educational content. The majority of teachers surveyed prefer to use an interactive whiteboard when explaining, which they believe helps to increase students' interest in the subject and motivates them to participate more actively in the lesson. The teachers supported the view that ICT helps to better understand tasks that cannot be implemented in practice. Traditional performance of professionally oriented tasks, especially those related to production conditions, can be difficult due to a lack of equipment, space, or time. At the same time, digital tools and virtual laboratories make it possible to simulate production processes in a classroom setting. This makes ICT especially attractive for the implementation of such tasks.

In addition, teachers agreed with the statement that ICT "helps students better understand mathematical concepts." The use of animations, simulations, interactive tasks, and training programs allows for the presentation of abstract concepts through real or near-real tasks. Electronic concept maps, graphical interfaces, and information systematization using ICT deepen the learning process.

Also, the majority of teachers agreed with the statement that ICT helps to eliminate conceptual errors and misunderstandings. Using digital resources such as simulations, video tutorials, and step-by-step problem-solving provides students with the opportunity to see alternative approaches to solving problems and to recognize their mistakes.

A high level of agreement was also reached regarding the claims that the presence of auxiliary elements on an interactive whiteboard and text-graphic materials on the Internet facilitates the explanation of educational topics. Teachers emphasized that such resources are actively used when repeating topics and preparing for production and practical assignments.

Teachers also noted that when choosing teaching methods, they take into account technological capabilities. The teachers expressed confidence in the potential of ICT for the implementation of more modern methods: project-based learning, modeling, problem-oriented approaches, and other active methods.

The study participants confirmed that the availability of educational programs on tablets helps to organize lessons, and materials on the Internet can enrich content. Some teachers expressed doubt that ICT contributes to increased student engagement, improved interaction, and the development of teamwork. This may be explained by observations that students are overwhelmed by technology in their daily lives, and the use of ICT in the classroom does not arouse their additional interest. Additionally, the predominance of individual work with technology can reduce interpersonal interactions in the classroom. They also believe that technology contributes to the individualization of learning and allows students to study topics at a convenient time and place, which is especially important in a digital educational environment.

6. Conclusion

In the course of this study, aimed at identifying teachers' views on the use of ICT in the process of professionally oriented mathematics education based on production tasks, it was found that teachers fully agree with the statements:

- "The presence of auxiliary elements on the interactive whiteboard facilitates the explanation of educational topics."
- "The presence of text and visual materials on the Internet that support the content of the lesson contributes to a better understanding of the topics."

It was also found that, in the opinion of teachers, the use of ICT:

- Facilitates the understanding of educational material,
- Helps to explain production tasks and processes that cannot be implemented in the classroom.
- Promotes a deeper understanding of mathematical concepts,
- Eliminates conceptual errors of students,
- Influences the teacher's choice of teaching methods based on technological capabilities,
- Contributes to the enrichment of the educational process through the use of programs and applications on tablets.
- Useful for project activities, constructivist learning, observation, and independent, tempo-oriented study of topics.

At the same time, the teachers noted that:

- ICT does not always help to increase interest in the topic,
- Does not ensure the active participation of all students,
- Does not always improve teamwork and interaction in the classroom.

Regarding demographic variables, it was found that teachers' views are independent of gender, length of service, and type of school. However, significant differences have been identified depending on:

- The level of computer literacy (higher levels are associated with more positive views),
- The level of skills in using laboratory equipment,
- Professional competence,
- Professional development needs (higher need correlates with more positive views),
- The level of awareness about the new mathematics teaching program (the most positive views are from those who are not familiar with the program at all, which may reflect a lack of critical perception or expectations).

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