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Teaching mathematics in college: The need for a set of professionally oriented tasks

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Abstract

The purpose of the study is to solve this problem, which consists of substantiating, developing, and implementing a methodological system for preparing students for professionally oriented mathematics education in college. Professionally oriented mathematics education in colleges is advisable, as it helps students see the practical benefits and importance of mathematics in their future professional activities. This approach allows us to better prepare students for their future professions. Research problem: what are the leading directions, principles, content, and forms of methodological preparation of students for professionally oriented mathematics education in college? In achieving this goal, we distinguish a complex of professionally oriented tasks in the fact that they reflect specific scenarios and difficulties that specialists face in their professional activities, and this allows students to gain experience in specific tasks from their field. Research methods: interviewing and testing students, teachers; observation, study, and generalization of pedagogical experience; development of an author's methodology for preparing students for professionally oriented mathematics education in college. We identified criteria to verify the effectiveness of the training methodology, assessing the students' assimilation of subject knowledge and their increased motivation for learning. The results of the pedagogical experiment show that the process of teaching mathematics in a college with a professionally oriented methodological learning system, implemented through the use of a set of professionally oriented tasks, contributes to an increase in the level of mathematical training and educational motivation of students.

Keywords: Applied task, College, Future specialist, Professional training of students, Mathematics, Professionally oriented mathematics education, Professionally oriented task, Mathematical readiness of college students.

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1. Introduction

1.1. Relevance of the Study

The rapid change in working conditions and the emergence of new fields of activity at the present stage of society's development have led to new requirements for the level of training of future specialists in vocational education institutions. The sustainable development of Kazakhstan in the 21st century, as part of its innovative economy, depends on the level of mathematical education received by a student in college. The mathematics teacher is more than just a source of new subject knowledge for students. They also act as facilitators of contemporary ideas, methodologies, and technologies, which are crucial for fostering competency development among students. Their role extends to guiding students towards more efficient approaches to professional work, ultimately impacting the preparation of skilled individuals for contemporary society [1].

Education and professional skills are the main hallmarks of the modern education system. In accordance with the strategy "Kazakhstan 2050," it is necessary to provide for the development of a system of modern educational institutions-engineering education and modern technical specialties. Therefore, the task of many technical educational programs is to train highly qualified, competent specialists of the economy of the Republic of Kazakhstan to be competitive in rapidly changing socio co economic conditions in the construction, oil, gas, and transport sectors. In the address of the head of state, K. K. Tokayev, to the people of Kazakhstan in 2022 "Unity of the People and Systemic Reforms: A Solid Foundation for the Country's Prosperity," the head of state noted the need to fulfill large-scale urgent tasks in order to develop the sphere of technical and vocational education [2]. Therefore, Kazakhstan, along with universities and colleges, began to pay more attention to the methodology of teaching basic subjects, especially mathematics, in the education system. The college education system in Kazakhstan is an important part of the national education system and provides various programs for the training of intermediate-level specialists. Here are some key characteristics of the college education system in Kazakhstan: Learning structure: College educational programs are usually focused on gaining practical skills in a specific professional field. Programs are usually two or three years long and may offer courses in various specializations such as medical services, information technology, construction, technical specialties, and others. Study programs: Colleges offer a wide range of study programs, which can be both technical and vocational-theoretical. Depending on the direction of the program, students can study various subjects, including mathematics, science, languages, professional skills, and practical exercises. Qualification: Upon completion of the program, students receive a diploma of secondary vocational education, which allows graduates to start working in their chosen field or continue their education at the university to obtain a bachelor's degree. Practical orientation: Colleges focus on the practical training of students by providing practical classes, internships, and opportunities to gain work experience in the relevant field. Professional skills development: One of the colleges' main goals is to train qualified professionals with the necessary knowledge and skills to work successfully in their professional field. The educational system of colleges in Kazakhstan plays an important role in the training of mid-level specialists to meet the needs of the labor market and the development of the national economy [3].

The key qualities essential for a specialist in contemporary society include professional competence, competitiveness, and adept problem-solving abilities across various social, professional, and personal contexts. Consequently, there's a crucial emphasis on updating the content of vocational education to align it with societal and labor market demands, along with a reassessment of educational goals and outcomes [4]. After looking at math books that are suggested for college students studying technical fields and professions, it was discovered that most of them only have standard tasks with practical information for studying the subject and don't have a full list of tasks that are designed to be used in the real world for all course topics. Thus, the specifics of college students and the need to implement the professional orientation of mathematics education in colleges dictate the need to develop a methodological system of professionally oriented mathematics education in colleges, since mathematics occupies a special strategic place among technical disciplines, being a powerful tool for solving professional problems [5].

So, research on professionally oriented mathematics education in col-leges is highly relevant for several reasons:

- Preparation for real professional tasks: the modern labor market requires specialists with in-depth mathematical skills applicable to specific tasks and areas of professional activity. Research in this area helps to identify the most effective teaching methods that prepare students for real-world tasks.
- The connection between mathematics and professional fields: studying mathematics in the context of specific professional fields helps students better understand and use mathematical concepts in their future careers. This is critical for the development of competitive specialists in a variety of fields.
- Creative Problem Solving: professionally oriented college mathematics education helps to develop creative thinking skills and apply mathematical knowledge to innovative solutions to problems in various industries.
- Socio-economic importance: the development of mathematical thinking skills and the application of mathematical concepts in the professional field have significant socio-economic significance, affecting the development of industry, the economy, and society as a whole.

Research in the field of professionally oriented mathematics education in colleges helps to optimize curricula, improve teaching methods and prepare specialists who are ready to effectively apply their mathematical knowledge in practice.

1.2. Literature Review

Over the years, well-known teachers and scientists Heissenberger-Lehofer and Krammer [6] and Sadovaya, et al. [7] others devoted their works to the issues of professional orientation in teaching.

In educational institutions, you can find several works aimed at improving the methodology for teaching mathematics.

Rudyk and Sulima [8] in their research consider the problems of the formation of mathematical competence in students. The process of teaching mathematics for the formation of mathematical competence of students of a technical university shows that problem-solving tasks that will be solved when mastering new knowledge contribute to the successful assimilation of educational material, the determination of its applied orientation, and the preparation of students for a future profession.

Wu and Li [9] presented an innovative pedagogy of teaching in college using the method of project-based teaching of mathematics using educational technologies. Scientists' has developed a poster project." The Art of the World Culture, created using graphs for calculating equations, "and put into practice in the spring semester of 2016 as part of a pilot calculation course at the Manhattan Municipal College of the City University of New York. This project was designed for students of technical specialties using Maple technology. When completing this project, students ' knowledge in the field of graphics, as well as their Maple technical skills were formed.

The works of Gorskaya, et al. [10] discuss the issues of teaching mathematics at an engineering university at the general educational level, which is aimed at the general cultural development of students, as well as teaching special disciplines for the subsequent solution of professional problems. The research is aimed at solving problems of improving the methodology of teaching mathematics courses in engineering specialties using project learning and and thematic research (project-case technology). It determines that it contributes to the development of professional competencies in students of construction and engineering specialties by using the solution of practical-oriented tasks.

After analyzing the above scientific works, one can understand the need to develop the methodology of teaching mathematics in technical specialties in accordance with modern requirements.

The issues of improving the professional training of students at a pedagogical university have been the subject of research by many leading scientists in the field of mathematics teaching methods throughout the history of the development of mathematical education [11, 12]. There are various approaches to improving the professional training of students; we will consider the two areas closest to our research.

The methodological direction entails fostering a cohesive interaction between fundamental and professional aspects within teacher training. This involves laying the groundwork with core educational elements in both school and university mathematics. Subsequently, there's a focus on theoretically synthesizing structural units towards the professionalization of knowledge and the development of the teacher's persona. Moreover, it involves aligning the teaching of fundamental mathematical disciplines with pedagogical principles, establishing connections with corresponding school mathematics courses across the methodical teaching system, and expanding the breadth of mathematical courses, specialized modules, and elective offerings [13].

The technological direction entails a qualitative overhaul of all aspects of the methodological training system for future mathematics teachers at pedagogical universities, primarily via elective courses [14].

The research of these scientists makes a significant contribution to the training of students in college mathematics and solves many problems of improving professional pedagogical education through the formation and introduction of new advanced psychological and pedagogical concepts, the use of productive methods of knowledge transfer, and the design of innovative methodological systems and teaching technologies.

Calamatova [15] devoted their works to professionally oriented education of college students, considering the continuity of professionally oriented education in the college system. However, there has been no recent research on a systematic approach to professionally oriented college mathematics education.

The analysis of scientific and methodological literature, regulatory documents, and the results of the ascertaining and search experiment revealed contradictions between the need for pedagogical science for a theoretical and methodological justification of the target, substantive and procedural characteristics of professionally oriented mathematics education in technical colleges, and their insufficient scientific development. In connection with these contradictions, we formulate the problem of research: what are the target, substantive, and procedural components of the methodological system of professionally oriented mathematics education in colleges.

Research hypothesis: the educational motivation of college students, as well as the level of their mathematical training, will increase if mathematics education is based on a specially developed methodological system of professionally oriented mathematics education, which is based on the application of a set of professionally oriented tasks and a special methodology for its use.

To achieve this goal and test the hypothesis, it became necessary to develop and test a special educational and methodological complex consisting of a bank of professionally oriented tasks and methodological recommendations for its use as a means of professionally oriented teaching mathematics. We aim to experimentally test the effectiveness and efficiency of implementing a methodical system of professionally oriented education in colleges.

2. Materials and Methods

2.1. The Goals and Main Methods of Research

The experimental method includes various tools and methods, including questionnaires of students and teachers, pedagogical control at all stages of the experiment, control work, analysis of laboratory work, and evaluation of tests and test results in experimental and control groups. The research team used the following methods to solve the tasks: the following research methods were used: - theoretical: study and analysis of psychological and pedagogical, mathematical, and methodological literature on the subject of research; empirical: observation, questioning, testing, and analysis of the results of control work by students; pedagogical experiment; mathematical methods: the Paul-Christian, et al. [16].

In order to verify the effectiveness of the implemented experimental training, criteria were identified on the basis of which the degree of assimilation of subject knowledge by students and the degree of increased motivation for learning were assessed: Academic performance the volume of successfully mastered didactic units, as well as the increment of knowledge in mathematical disciplines, which is characterized by the ability to solve problems of various levels of complexity; quality is the use of subject knowledge in solving professionally oriented tasks and in practical actions, which is characterized by choosing the optimal way to solve a problem, applying mathematical knowledge in practical situations, as well as the ability to solve problems of an applied nature.

2.2. The Experimental Base and Participants of the Study and the Stages of Its Implementation

The study was conducted in three stages, from 2020 to 2023. The main base of the experimental work was the Almaty College of Economics and the College of Economics of Narkhoz University in Almaty, Kazakhstan. The pedagogical experiment was conducted with first-year students in two directions: «06130100 Software» and «04130100 Management». The experimental and control groups included 40 and 44 students, respectively.

At the first stage of the study (2020-2021), the analysis of psychological, pedagogical, scientific, methodological, and special literature on the problem of research was carried out; the specifics of professionally oriented teaching in mathematics were revealed; the conceptual apparatus of the study was formulated, goals and objectives were defined, the hypothesis of the study was formulated, and contradictions were revealed.

At the second stage of the study (2021-2022), a new didactic model of professionally oriented mathematics education in college was designed, and its content was revealed using the graph of correspondence between the components of the model.

Educational and methodological support for the methodological system of professionally oriented mathematics education in college was developed and tested.

We carried out pilot work at the third stage (2022-2023) to verify the effectiveness of the methodological system's implementation. The analysis of the level of mathematical training and educational motivation of students in the technical specialties of the college was carried out. The data obtained by empirical research methods were analyzed using mathematical statistics, before and after the experiment in the control and experimental groups, and appropriate conclusions were drawn.

2.3. Methods of Testing the Effectiveness of Implemented Experimental Training and Research Hypotheses

We identified criteria to verify the effectiveness of the implemented experimental training, assessing the degree of student's assimilation of subject knowledge and their increased motivation for learning: Academic performance is the volume of successfully mastered didactic units, as well as the increment of knowledge in mathematical disciplines, which is characterized by the ability to solve problems of various levels of complexity; quality is the use of subject knowledge in solving professionally oriented tasks and in practical actions, which is characterized by choosing the optimal way to solve the problem.

We formulate the following statements as working hypotheses: H0: levels of learning motivation in the compared groups do not differ; H1: levels of learning motivation in the compared groups differ; the applied criterion is the Wilcoxon-Mann-Whitney criterion.

To assess the dynamics of changes in motivation to study mathematical and general professional disciplines, the method of Dubovitskaya [17] was used.

2.3.1. Instruction Manual

Carefully read the motives for admission to the university given in the section, including the actual motives of teaching and professional motives. Evaluate the motives for studying at a pedagogical university that are significant to you: 5 points are very significant, 3-4 points are significant, 0-2 points are insignificant, and mark the points on the form. Answer quickly, without hesitation.

For answers, let's list some of the questions on the letterhead:

I. What influenced your decision to pursue this specialization?

The drive to get a higher education

Interest in the profession

The best abilities are in this area.

II. What's most important to you in your teaching?

Successfully continue your studies in subsequent courses.

Do not start studying academic subjects.

Get intellectual satisfaction.

III. What's most important to you in your teaching?

Successfully continue your studies in subsequent courses.

3. Results

3.1. The Place and Features of Teaching Mathematics in the Professionally Oriented Training of Students in Economic Specialties of the College

The main purpose of teaching mathematics in the professional training of college students is not only mathematical education, but also students' knowledge of the practical application of this knowledge. Therefore, college teachers should not only equip students with mathematical information, but also logically comprehend it, give a logical assessment, and consider the issue of obtaining it in their professional activities. Scientists call this "predicting future professional activity" [18].

In order to anticipate future professional work, the student undergoes special vocational training at colleges. The student understands the need to master an effective and rational teaching methodology. This is how the teacher recognizes that in the professional training of a student, subject-methodical competence is a milestone that is necessary for a specialist, but difficult to master, which is not easy to achieve.

Then it is necessary to effectively carry out professional training for future specialists in the field of economics, and this is a very important and complex process [19]. The question arises, what is the structure of the professional training of future specialists in the field of economics, what components are included in it, and how do we form a professional orientation based on this training?

As a result of analyzing a large amount of scientific literature and textbooks, we have identified ways to effectively implement mathematics education in colleges:

- The use of professionally directed mathematical material in the formation of concepts in mathematics;
- Solving a professionally directed mathematical problem;
- The use of instructional and technological documentation in mathematics lessons;
- Application of design works in mathematics of an industrial nature.
- The work of students on the teacher's instructions with reference literature to perform calculation work related to their profession.

The issue of the implementation of the professional orientation of teaching mathematics at the College of Economics is widely considered in modern scientific, methodological, psychological and pedagogical literature. Various directions in the study of this problem are highlighted (Table 1).

Table 1.
The place and features of teaching mathematics in the professional training of students in economic specialties of the college.

The place and features of college mathematics teaching	
The place and features of teaching mathematics in the professional training of students	• Develops logical and mathematical thinking of future technical specialists.
	• Trains the performance of mathematical operations and transformations, reveals the quantitative and qualitative values of technical objects and experiments.
	• Understands the practical significance and connection of mathematical knowledge with life.
	• Trains future technology specialists in independent work, hard work, and resilience to overcome difficulties.
	• Forms mathematical concepts.
	• During classes, he poses a problematic situation in the field of economics and helps to solve it.
	• Promotes the strengthening of interdisciplinary connections.

Mathematics plays a key role in economics, providing tools for analysis, forecasting, and decision-making in financial and economic fields. Here are a few of the main areas in which mathematics is an integral part of economics: Mathematical statistics and data analysis: Mathematical methods and statistics are used to analyze economic data, including assessing trends, correlations, forecasting market growth or decline, modeling consumer behavior, etc. Financial mathematics: mathematical methods are used in the financial sector to assess risks, manage portfolios, determine the value of financial instruments, predict investment returns, etc [20].

The use of mathematics in economics allows for more accurate analysis and understanding of complex economic phenomena, making more informed decisions, and making more accurate forecasts, which is a key aspect of modern economics and practice.

To prepare students for professionally oriented mathematics education in colleges, we have developed a methodological system for teaching mathematics (Figure 1).

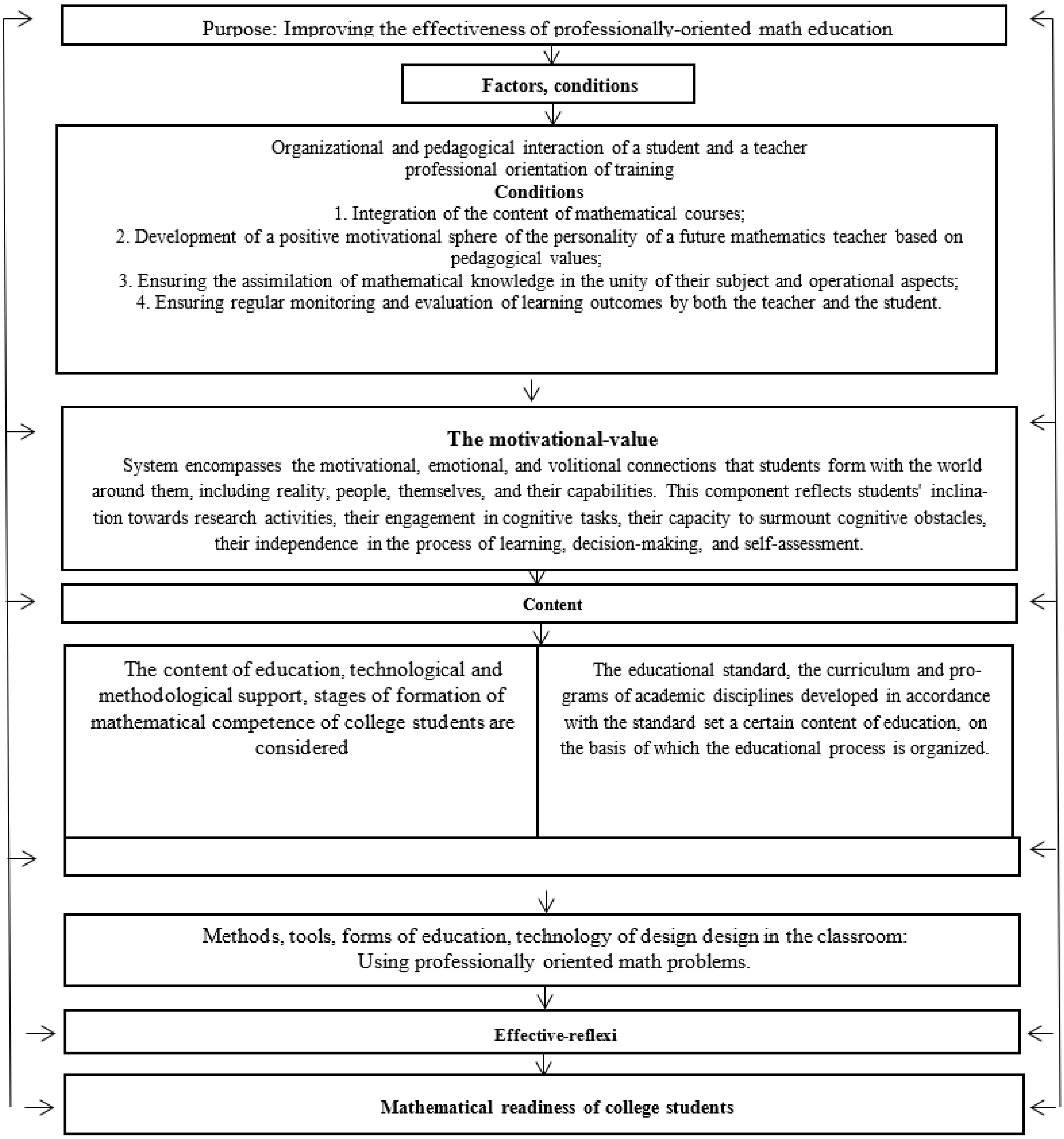

Figure 1.
Mathematical readiness of college students.

3.2. The Process of Teaching Mathematics in Terms of Using Professionally Oriented Tasks

Specific professionally oriented math tasks may vary depending on the application area. Here are some examples of such problems and, possible approaches to their solution:

Financial Mathematics:

Task: Estimating the value of options on the stock exchange.

Solution: Using mathematical models such as the Cherny-Scholes model to calculate the value of options, taking into account price volatility, interest rates and other factors.

Forecasting in the economy:

Task: Forecasting the country's GDP growth for the next few years.

Solution: Using time series and econometrics methods to analyze and predict the dynamics of economic indicators based on past data.

Optimization of business processes:

Task: Optimization of the company's production costs.

Solution: Using linear programming to optimize resource allocation, minimize production costs, or maximize profits under constraints.

Statistical analysis in medicine:

Task: To analyze the effectiveness of a new medical drug.

Solution: Conducting a statistical analysis of patient data to assess the effectiveness of the drug, taking into account exposure factors and side effects.

Cryptography and Information Security:

Task: Development of a new encryption algorithm.

Solution: use number theory and combinatorics algorithms to develop new mathematical methods of encryption and information protection.

These examples demonstrate how mathematical methods are applied to solve practical problems in various fields, emphasizing the importance of mathematical knowledge for professional success in various fields.

We give examples of professional-oriented problems as a mathematical tool in the preparation of college students, taking as a basis the above scientific literature.

Example: suppose that the earth should be built into a triangular device located in a rectangular parking lot on a large square for bicycles. The design road construction bureau should determine the criteria for this need.

In determining the solution to this task, future specialists must first prepare a diagram of the task (Figure 2).

We denote the height of the desired rectangle KL by x, and get y through the base DE. The area is then matched to the formula. There are no independent variables x and y, they are related to each other in a certain sequence.

Based on the similarities between triangles DBE and ABC, the heights BK and BL are proportional to the bases DE and AC. We have a relationship (1):

$$\frac{BK}{BL} = \frac{DE}{AC} \text{ or } BK = h - x,\ DE = y,\ BL = h,\ AC = b, \quad (1)$$

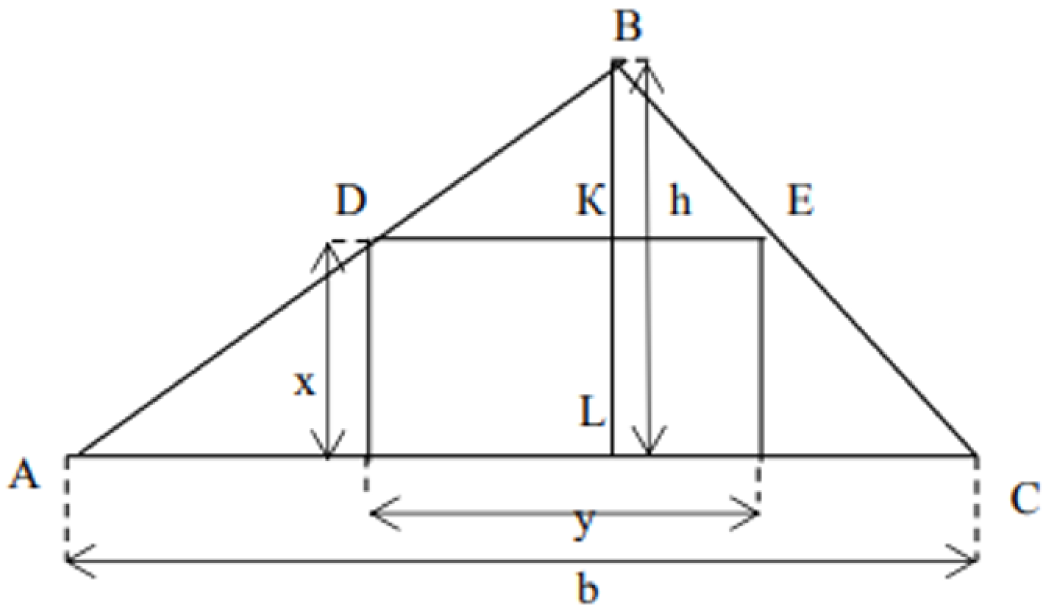

Figure 2.
Schematic view of the bike parking lot.

From relation (1) we obtain Equation 2:

$$\frac{h - x}{h} = \frac{y}{b}. \quad (2)$$

From Equation 2 we obtain Equation 3:

$$y = \frac{b}{h}(h - x)(3)$$

Before taking these answers into account, we find in their expression for U (4):

$$U = \frac{b}{h}(h - x)x = \frac{b}{h}(hx - x^2) \quad (4)$$

From here we find the maximum of the function (5):

$$U' = \frac{b}{h}(h - 2x)(5)$$

Equating the derivative to zero (6),

$$h - 2x = 0 \text{ or } x = h/2 \text{ we get a solution.} \quad (6)$$

In principle, it is easy to determine that this value of x gives the maximum value of the function U, when you get the second derivative.

$$U'' = -\frac{2b}{h} < 0 \quad (7)$$

We get the expression (7).

Hence, $x = h/2$ when the area will (8):

$$U_{\max} = \frac{bh}{4}. \quad (8)$$

As a result, it becomes clear that the area of the largest rectangular parking lot for bicycles is half that of the Triangle.

To solve this problem, you must know techniques such as:

- conditions for determining the extremum of a function and finding the derivative of the first and second orders of a function of one variable;
- It is also necessary to pay attention to the above conditions in order to solve an unknown equation with one variable, the formulas of the area of the triangle and the parallelogram, and to build a relationship with similar parties.

The interconnection of fundamental and special knowledge acquired by students of the College of Economics in mathematics helps to implement modeling tasks aimed at the formation of professionally important qualities in graduates. As a result of the analysis of many textbooks and teaching aids presented economically, it can be seen that the pure material is professionally determined. Therefore, the inclusion of various subjects in courses, including professionally oriented tasks solved by mathematical methods, is of great relevance at present. In our opinion, the use of its concepts, theorems, rules, and algorithms when solving applied tasks:

- Demonstrate the use of already established standard methods to solve professionally important problems;
- Implementation of their practical application;
- Systematization of previously acquired knowledge and skills;
- Allows you to develop creative and subject-logical thinking of students, their cognitive motivation in the engineering field.

In solving a number of problems related to the choice of information material, the development of a professionally oriented mathematical problem related to the project, and the formation of technological activities on its basis, we recommend that the teacher be guided by the following principles:

- The introduction of project tasks into the course of mathematics should be aimed at increasing the motivation and activity of students, which should not lead to a violation of the logic and interdisciplinarity of the subject;
- Information must be available for students ' admission and linked to the curriculum for teaching other disciplines;
- Educational and professional literature, as well as departmental teachers, should serve as a source for compiling tasks;
- The time to solve a problem can be medium or large compared to considering typical mathematical cases; in this case, it is advisable to propose several solutions. If the task is voluminous, then part of it should consider the possibility of solving it collectively, for example, in a general way, and the rest of the cases should be left to the student for independent work outside the audience;
- The plot of the task may be of an applied nature, that is, it may contain information that is important from the point of view of the future profession of students, or it may contain material that will be used when studying other disciplines. In this case, there may be a description of phenomena and processes of cognitive interest for the future builder;
- Elements of the project task should provide for the possibility of quantifying the mathematical characteristics of the described phenomena;
- In addition to mathematics, the objects of plot problems can be phenomena or processes that the student considers when studying disciplines such as physics, theoretical mechanics, resistance of materials, machine parts, economics, ecology, and electrical engineering. These tasks are propaedeutic in nature and stimulate the student's interest in learning.

The formation of design and technological activities has a high probability of formation not only during the implementation of project tasks [10] but also in the process of solving mathematical modeling problems. It, like a method for solving practical problems, develops students' logical culture, theoretical and algorithmic thinking. It strengthens the practical significance of the studied material and unifies it, thereby enabling the developmental function of learning to take precedence over the information system

Modeling and study of the constructed mathematical model of the phenomenon, object, or process under consideration can be carried out in the study of many sections of higher mathematics:

- "linear and vector algebra";
- "Analytical geometry in plane and space";
- "differential and integral calculations of functions of one and several variables";
- "Differential equations";
- "Multiples and curvilinear integrals";
- "Series," "probability theories," and others.

During the stage of developing model development skills within the project framework, the teacher typically establishes the learning environment, while the student adjusts the subsequent stages of the plan, ensuring they are consistently followed:

- Explanation of tasks and problems;
- Divide the situation into components, build a system of relationships between them, and identify them;
- Selection of dependent and independent variables, determination of areas of their change, and nature of interaction;
- The initial mathematical model under study was created.
- Checking the adequacy of the mathematical model created
- Selection of the method for further analysis of this model and its study;
- Interpret the results obtained, monitor their compliance with the set goal; determine the level of completion of the study, etc.

When analyzing the model and choosing research methods, a list of available intellectual resources (knowledge, skills, etc,.) is determined. An example can serve to illustrate this scenario.

When studying the topic "Diagnostics of highways" in the field of construction, you can calculate the comfort of movement, the characteristics of movement, and the saturation coefficient of movement and using the formula (9) below.

$$r = q_z / q_{\max}, \quad (9)$$

where q_z - is the average traffic density; $q_{\max}$ - is the maximum traffic density.

When solving the maximum and minimum problems, we must pay attention to the following conditions, taking one of the variables as a basis and fully defining the rest of the variables through it. Next, to study this function in the desired variable extremum, you need to find the largest or smallest function. The change interval of an independent variable is determined by the conditions of the problem.

Task: the concrete paver moves according to the following formula (10). $S = 21t + 3t^2 - t^3$. (10)
Find its maximum speed.

Solution. Required function (11): $v = \frac{ds}{dt}$ (11)
set the speed, this is necessary for research (12):

$$v = 21 + 6t - 3t^2 \quad (12)$$

Function research (13): $v' = 6 - 6t$ (13)

during the $t = 1$ take the derivative $v' = 0$. Because $v'' = -6$ for any t function, then $t = 1$ the function has a maximum of, that is, $v_{\max} = 24$ the speed is determined.

In the implementation of this type of project-based task, research work can be carried out by modeling dependency equations. In this case, the project task will serve as an impetus for the development of a new learning technology, for example, a modeling method for mastering new material. This allows students to form an active perception of the topic and get a complete idea of the research work at various stages of design and technological work. Therefore, solving professional-oriented problems is an integral part of the process of teaching mathematics, because it is found in all types and stages of mathematics lessons and in extracurricular activities.

3.3. Results of the Pedagogical Experiment

The results of the pedagogical experiment show that the process of teaching mathematics in a college, implemented through the use of a set of professionally oriented tasks, helps to increase the level of mathematical knowledge of students, which is necessary for practical application, the study of related disciplines, and lifelong education.

The (Table 2) presents the results from the students in the control and experimental groups.

Table 2.
Survey results (In control and experimental groups).

Group	Survey period	Percentage of students with a threshold level	Percentage of students with a standard level	Percentage of students with a reference level	The motivation coefficient of the group
CG	Before studying the discipline	40	50	10	60
	After studying the discipline	35	45	20	65
EG	Before studying the discipline	45	45	10	55
	After studying the discipline	20	55	25	80

Before studying the subject "mathematics" and after studying it in control and experimental groups, the results of the survey are presented in Figures 3, 4.

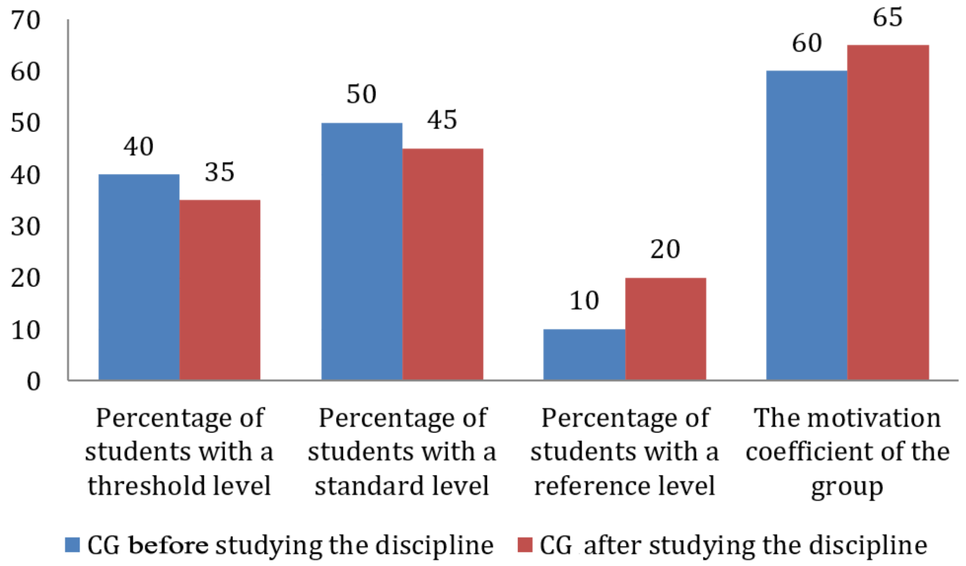

Figure 3.
The results of the survey before and after studying the discipline "mathematics" in the control group.

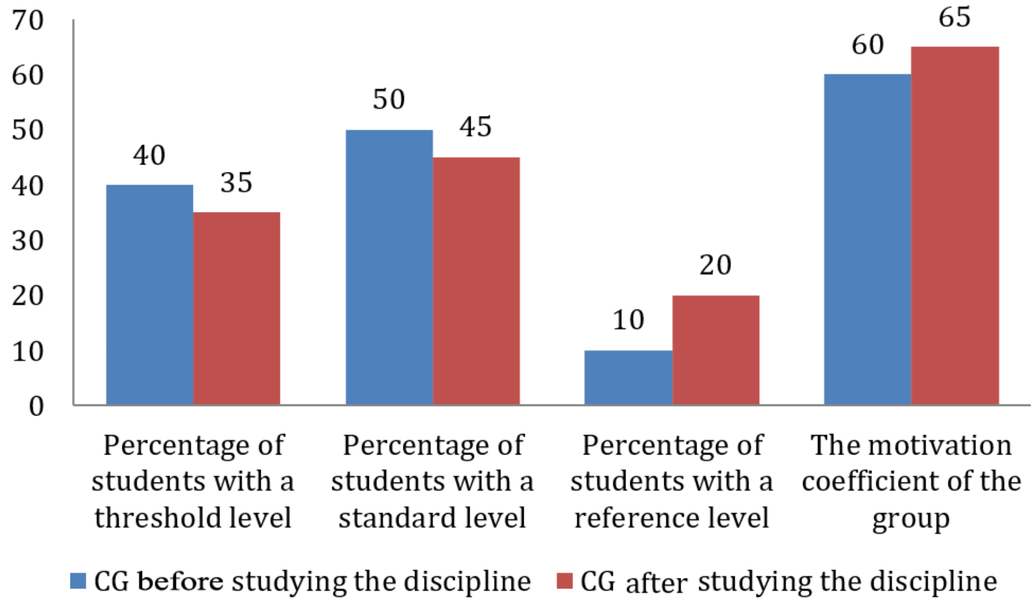

Figure 4.
The results of the survey before and after studying the discipline "mathematics" in the experimental group.

Analysis of the results showed that before studying the discipline "mathematics," the motivation coefficients of the two groups were practically close (60 and 55). After studying the subject" mathematics," the motivation coefficient of control groups increases by 5 percent, and in experimental groups-by 15 percent. At the same time, students with a standard level of formation of the motivational-value component make up almost half both before and after studying the subject "mathematics." The motivation coefficient of groups increases by changing the ratio of the number of students with the threshold level and the reference level of the formation of the motivational-value component. Students with a threshold level before studying the subject are 40-45 percent. After studying the discipline" mathematics," such students have 35% in the control groups and 20% in the experimental ones.

Students with a basic level before studying the subject make up 10 percent of both groups. After studying the discipline" mathematics, " in the control and experimental groups of such students, there were 20% and 25%, respectively. Thus, in the control groups before and after studying the discipline mathematics. There are more students with a marginal level of formation of the motivational-value component than students with a reference level, and in experimental groups after studying the discipline, there are more students with a reference level than students with a threshold level.

The empirical value of the Mann-Whitney criterion for each of the tested cases is calculated using the following formula:

$$U = \sum_{i=1}^{N} a_1 \quad (14)$$

Here N is the number of students in the first group to be compared. The obtained values are given in the Table 3.

Table 3.
Empirical values of the Mann-Whitney criterion.

Group	EG 1	EG 2
CG 1	950	860
CG 2	600	520

The empirical value of the Wilcoxon criterion is determined by the following formula:

$$W_{эмпи} = \frac{\left| \frac{N \cdot M}{2} - U \right|}{\sqrt{\frac{N \cdot M (N + M + 1)}{12}}}$$

Here N, M is the number of students in the groups being compared. The empirical values of the criterion for each of the cases are presented in the table (Table 4).

Table 4.
Empirical values of the Wilcoxon criterion.

Group	EG 1	EG 2
CG 1	2.55	2.47
CG 2	2.6	2.25

The empirical values of the Wilcoxon criterion were higher than the critical value, which was 1.96 at the level of .05. Thus, according to the Wilcoxon-Mann-Whitney statistical criterion, the reliability of differences in the characteristics of experimental and control groups of students is 95%.

The test and test results give approximately the same percentage distribution of students across the levels of formation of the interest component of college students.

4. Discussions

In pedagogical research, there are different definitions of professionally oriented tasks. A set of professionally-oriented tasks is understood as tasks selected on a specific topic of any section of mathematics, including professionally significant content from the field of future professional activity [21].

To use such problems in the process of teaching mathematics, we offer the following recommendations: we recommend selecting the necessary material from the mathematics course sections and establishing interdisciplinary connections between mathematics and practical applications related to the future profession from the subject areas of special and general professional disciplines [22]. Simultaneously, we propose the following prerequisites for such tasks:

- The technical plot of the problem, contributing to the motivation for studying the relevant mathematical material;
- Target orientation: solving problems should contribute to the solid assimilation of mathematical knowledge, techniques, and methods that are the basis of professional activity;
- The interdisciplinary nature of the tasks manifested itself either in the condition or in the solution process.

The principle of professional orientation can be implemented by performing laboratory tasks using application software packages [23]. The basis for the construction of a cycle of laboratory work in mathematics using application software packages in technical specialties was based on the following requirements: taking into account the specifics of the specialty, a differentiated approach, the relationship between theoretical knowledge and practical skills, and professional orientation.

A professionally oriented task is a task in the course of which the professional activity of future specialists is modeled. These include professionally oriented tasks, tasks for performing laboratory work using computer technology and professionally oriented projects. Each type of task performs its own specific pedagogical functions, is used in a certain form of organization of the educational process, requires the use of specific learning tools.

The data obtained indicate that at the significance level of 0.05, the levels of mathematical training in the control and experimental groups are statistically indistinguishable before the experiment and statistically distinguishable after it.

Therefore, the outcomes of the pedagogical experiment substantiate the study's hypothesis. The integration of a professionally oriented methodological teaching system into mathematics education at a technical college, which emphasizes the integration of mathematics with related disciplines and the exploration of interdisciplinary connections through the utilization of a series of professionally oriented tasks, leads to an enhancement in both the level of mathematical proficiency and the educational motivation of students.

5. Conclusion

The research demonstrates that the primary mechanisms for implementing the principle of professional orientation in college settings are interdisciplinary connections and the utilization of a series of professionally oriented tasks.

Interdisciplinary connections implement the substantive aspect of professionally-oriented learning, a set of professionally-oriented tasks implements the procedural aspect. Each type of task must meet the requirements, perform certain functions, then the mechanisms of their influence on educational motivation and the degree of assimilation of mathematical knowledge and skills will be included.

Consistent engagement with professionally oriented tasks throughout all stages of mathematics education, coupled with the use of diverse educational process organization methods, enables the simultaneous advancement of students' mathematical knowledge and skills while broadening their comprehension of the practical and professional relevance of mathematics. A comprehensive array of professionally oriented tasks has been devised, including tasks tailored to specific professional contexts, laboratory assignments utilizing application software packages, and professionally oriented projects. We detail the methodology for integrating each type of task into the mathematics teaching process.

The study experimentally tested the effectiveness of implementing the developed methodological system in the process of teaching mathematics in college. The results of the pedagogical experiment show that the use of a bank of professionally oriented tasks, compiled on the principles of integrating mathematics with special disciplines, taking into account interdisciplinary connections, at all stages of learning contributes to improving the quality of mathematical training for students. The data obtained during the pedagogical experiment allow us to recognize the validity of the initial hypothesis of the study and the effectiveness of the developed model of professionally oriented learning.

References

[1] N. Lebedeva, V. Ismatullina, S. Sheymardanov, and T. Zhussipbek, "The teacher is a guide or barrier to mathematics: Case studies in Russia, Kyrgyzstan and Kazakhstan," *Education and Self Development,* vol. 17, no. 3, pp. 278–295, 2022. https://doi.org/10.26907/esd.17.3.20

[2] K. Tokayev, "Address of the head of state to the people of Kazakhstan "unity of the people and systemic reforms – a solid foundation for the country's prosperity", Astana," Retrieved: https://www.akorda.kz/kz/memleket-basshysy-kasym-zhomart-tokaevtynkazakstan-halkyna-zholdauy-183555. 2022.

[3] S. G. Karstina, "Engineering training in the context of digital transformation," presented at the IEEE Global Engineering Education Conference, EDUCON, IEEE Computer Socie-ty. https://doi.org/10.1109/EDUCON52537.2022.9766473 2022.

[4] N. G. Yusupova and G. N. Skudareva, "Ongoing education of math teachers and pisa quality assessment: From professional compe-tence to the mathematical literacy of schoolchildren," *Education and Self Development,* vol. 15, no. 3, pp. 203–214, 2020. https://doi.org/10.26907/esd15.3.17

[5] S. Dunekacke, G. Wittmann, and L. Jenßen, "Differentiated description of pre-service early childhood teachers' skill to plan actions with respect to math-related learning support—An ex-ploratory study," *Teaching Science,* vol. 51, no. 2, pp. 265-288, 2023. https://doi.org/10.1007/s42010-022-00158-7

[6] K. Heissenberger-Lehofer and G. Krammer, "Internship integrated practitioner research projects foster student teachers' professional learning and research orientation: A mixed-methods study in initial teacher education," *European Journal of Teacher Education,* vol. 46, no. 3, pp. 456-475, 2023. https://doi.org/10.1080/02619768.2021.1931112

[7] V. V. Sadovaya, A. O. Luchinina, and A. A. Reznikov, "Students professional orientation to the teaching profession in educational environment," *International Electronic Journal of Mathematics Education,* vol. 11, no. 1, pp. 327-337, 2016.

[8] T. O. Rudyk and O. V. Sulima, "The formation of mathematical competence of future bachelors in process of teaching mathematics in technical university," *Pedagogical Sciences Reality and Perspectives,* vol. 2, no. 80, pp. 119–123, 2021. https://doi.org/10.31392/npu-nc.series5.2021.80.2.24

[9] L. Wu and Y. Li, "Incorporating a maple project of multi-cultures art in college mathematics teaching," *Journal of Education and Learning,* vol. 7, no. 5, pp. 42-51, 2018. https://doi.org/10.5539/jel.v7n5p42

[10] T. Y. Gorskaya, I. I. Golovanova, R. S. Khammatova, A. E. Polichka, and L. N. Romanchenko, "Features of a project-case technolo-gy in teaching students further mathematics," *Eurasia Journal of Mathematics, Science and Technology Education,* vol. 16, no. 11, pp. 1–13, 2020. https://doi.org/10.29333/ejmste/8562

[11] E. N. Gerasimova *et al.*, "Coexistence of theory and practice in training the future mathematics teacher: The experience of the Russian education system," *Eurasia Journal of Mathematics, Science and Technology Education,* vol. 13, no. 12, pp. 7695-7705, 2017. https://doi.org/10.12973/ejmste/80359

[12] T. F. Blanco, A. Gorgal-Romarís, C. Núñez-García, and P. G. Sequeiros, "Prospective primary teachers' didactic-mathematical knowledge in a service-learning project for inclu-sion," *Mathematics,* vol. 10, no. 4, p. 652, 2022. https://doi.org/10.3390/math10040652

[13] A. Döşemeciler and A. S. K. Kartal, "A mathematical course model for architectural education: Geometry of design," *Nexus Network Journal,* vol. 24, no. 3, pp. 717-732, 2022. https://doi.org/10.1007/s00004-022-00620-0

[14] T. Hodovaniuk and D. Voznosymenko, "The value-competent approach in the professional training of future teachers of mathemat-ics," *Collection of Scientific Papers of Uman State Pedagogical University,* no. 4, pp. 24–31, 2022. https://doi.org/10.31499/2307-4906.4.2022.269290

[15] V. A. Calamatova, *A system of professionally oriented tasks in vocal training teacher college students*. Vladislav Ivanov: Private Enterprise, 2020.

[16] B. Paul-Christian, D. Philipp, and H. Heinz, "Optimal design of the Wilcoxon-Mann-Whitney-test," *Biometrical Journal,* vol. 59, no. 1, pp. 25-40, 2016. https://doi.org/10.1002/bimj.201600022

[17] T. D. Dubovitskaya, "Diagnosis of the significance of an academic subject for the development of a student's personality. Vestnik Orenburgskogo Gosudarstvennogo Universiteta, p. 70-75," 2004. Available: https://cyberleninka.ru/article/n/diagnostika-znachimosti-uchebnogo-predmeta-dlya-razvitiya-lichnosti-uchaschegosya

[18] Q. Yang, N. Hayat, A. Al Mamun, Z. K. M. Makhbul, and N. R. Zainol, "Sustainable customer retention through social media marketing activities using hybrid SEM-neural network approach," *Plos One,* vol. 17, no. 3, p. e0264899, 2022. https://doi.org/10.1371/journal.pone.0264899

[19] L. T. Eskerkhanova, L. B. Beloglazova, N. M. Masyutina, T. S. Roman-ishina, and T. B. Turishcheva, "Increasing the competitive-ness of future economists for work in industry 4.0," *Prospects for Science and Education*, vol. 62, no. 2, pp. 158–173, 2023. https://doi.org/10.32744/pse.2023.2.9

[20] J. I. J. Sánchez, "Applets for teaching financial mathematics," *Lasallian Research Magazine*, vol. 19, no. 2, pp. 17–35, 2022. https://doi.org/10.22507/RLI.V19N2A2

[21] C. K. Baker and T. M. Galanti, "Integrating STEM in elementary classrooms using model-eliciting activities: Responsive professional development for mathematics coaches and teachers," *International Journal of STEM Education*, vol. 4, no. 1, pp. 1-15, 2017. https://doi.org/10.1186/s40594-017-0066-3

[22] P. Kiyko and N. Shchukina, "Interactive methods of teaching mathematics, contributing to the formation of competencies in students of the field of training Agronomy format," presented at the BIO Web of Conferences, EDP Sciences. https://doi.org/10.1051/bioconf/20224202009 2022.

[23] Y. Hery Murtianto and B. A. Herlambang, "Cognitive load theory on virtual mathematics laboratory: Systematic literature review," *KnE Social Sciences*, pp. 413–420, 2022. https://doi.org/10.18502/kss.v7i19.12461