TIRASPOL STATE UNIVERSITY

"ION CREANGĂ" STATE PEDAGOGICAL UNIVERSITY

With manuscript title
C.Z.U.: 377.091:51(043.2)=111

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THE IMPACT OF MODERN EDUCATIONAL TECHNOLOGIES ON THE FORMATION OF PUPILS' MATHEMATICAL COMPETENCE IN POST-SECONDARY NON-TERTIARY TECHNICAL VOCATIONAL EDUCATION **(future primary school teachers)**

532.02. SCHOOL DIDACTICS ON LEVELS AND DISCIPLINES

Summary of PhD thesis in Sciences of Education

CHIȘINĂU, 2022

The thesis was developed within the **Doctoral School "Sciences of Education" of the Partnership of Higher Education Institutions State University of Tiraspol, "Bogdan Petriceicu Hașdeu" State University from Cahul and the Institute of Sciences of Education**

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The summary was sent 06.09.2022.

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CONTENTS

LIST OF ABBREVIATIONS

1. TE - Educational technologies

2. TEM - Modern educational technologies

3. ICT - Information and communication technologies

4. CM - Mathematical competence

5. PE - Educational process

6. PÎE - Teaching-learning evaluation

7. IPCAM - "Alexei Mateevici" College Public Institution from Chisinau

8. UST - Tiraspol State University (located in Chisinau)

9. OECD - Organization for Economic Cooperation and Development

10. TALIS - Teaching and Learning International Survey

11. TEDS-M - Teacher Education and Development Study in Mathematics

12. TIMSS - Trends in International Mathematics and Science Study

13. PISA - Program for International Student Assessment

14. SPSS - Statistical Package for the Social Sciences

15. STEM - acronym for Science, Technology, Engineering and Mathematics

16. STEAM - approach to learning that uses Science, Technology, Engineering, Arts and Mathematics

17. ANOVA - Analysis of Variances

CONCEPTUAL BENCHMARKS OF THE RESEARCH

The relevance and importance of the research topic:

The new orientations that have appeared both in economic-political life and educational life, require increasing the competitiveness of professional education connected to global competition, to the demands of employers from graduates. The concept for the development of long-term education in the Republic of Moldova for the period up to 2030 proposes to ensure the educational system at all levels with qualified, competent and competitive teaching staff.

Modern education at the current stage is more accelerated and teaching is more dynamic, more challenging and more demanding than ever, which is why teachers use various modern educational technologies in their work.

Modern educational technologies play an important role in solving the problems of training specialists in accordance with the requirements of the information society. At the same time, the implementation of new educational technologies comes together with the need to train highly qualified teachers who demonstrate competitiveness on the labor market but also a set of professional competences. Objective 5 of the development strategy "Education 2030" as well as of the report of the Organization for Economic Cooperation and Development, *Teaching for the Future: Effective Classroom Practices To Transform Education from 2018 [*48], highlight the same idea, i.e. for the pupils/students' good preparation and for the development of the comptences necessary for any adult, it is necessary to implement modern didactic technologies in the educational process.

The use of modern educational technologies in the process of the formation of the mathematical competence of the future primary school teachers' is viewed both from a psychological point of view, as a means of mastering the mechanisms of personality formation, and from a pedagogical point of view, as tools that make the mathematical educational process more interactive.

Researches have highlighted the fact that every teacher should possess a certain level of mathematical competence, this being one of the 8 key competences recommended by the European Union defined as "the ability to develop and apply mathematical thinking for solving a series of problems in everyday situations" [43].

TIMSS defines mathematical competence as "the set of the student's knowledge of facts and methods, the use of mathematical concepts, solving typical and nonstandard problems, mathematical reasoning and the student's abilities to independently draw conclusions and argue the answer based on the information provided" [45].

The PISA international assessment defines this concept as "the person's ability to formulate, use and interpret Mathematics in a variety of contexts" [12, p. 25].

The training of mathematical competence is also necessary in the pedagogical fields of specialist training, this is also reported in the TEDS-M study, which mentions the fact that good mathematical training is important not only for Mathematics teachers in general education, but especially for teachers in primary education [50, p.14].

Description of the situation in the field of research and identification of the research problem:

The study of the concept of competence can be found in a series of works from various fields, but the one who introduced this term in the scientific field is V. Makelvil in 1982 [7, p. 63]. In the area of the Republic of Moldova, the following researchers studied different aspects of the concept of competence: M. Hadîrcă (communicative and literary competence), V. Botnari (professional competence), V. Mîsliţchi (continuity in the formation of the linguistic competences of high preschool and low school age children), I. Botgros, L. Franţuzan (scientific knowledge competence), L. Sclifos (investigative competence), M. Ianioglo (assertive communication competence), L. Pavlenko (social competence), T. Veverita (digital skills) etc.

The study of the formation of mathematical competence was dealt with by: A. Vorobjovs (Factors influencing the formation of adolescents' mathematical competence), L.B.Resnick (Building mathematical competence based on everyday knowledge), А.Ю. Горун (Mathematical competence of future primary school teachers), Н.Г. Ходырева (Formation of the mathematical competence of the future primary school teacher during the university training), which claims that mathematical competence is an integral quality of personality based on the totality of fundamental mathematical knowledge, practical skills that attest the pupil's preparation and his ability to carry out professional activities [42].

The analysis of the latest psychological and pedagogical studies on this topic shows that the level of professional training of future primary school teachers depends largely on the quality of mathematical training. However, the problem of mathematical competence as a component of the formation of professional competence is less studied, which allows us to elucidate the following contradictions:

- between the requirements of modern society for the use of modern educational technologies in the didactic process and the lack of methodological support for the formation of pupils' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers);

- between the need to train future primary school teachers in post-secondary non-tertiary technical vocational education and the low level of their training, after graduating from secondary school;

- between the need to train highly qualified teaching staff to carry out the didactic process and the weak educational activity oriented towards the formation of mathematical competence.

The search for ways to resolve these contradictions determined the research problem: determining theoretical benchmarks and elucidating modern educational technologies that allow the formation of the **pupils**' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers).

The object of the research: The process of the formation of pupils' mathematical competence in post-secondary non-tertiary technical vocational education.

The purpose of the research: Determining the theoretical and methodological benchmarks for the valorization of educational technologies in the process of forming pupils' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers).

Research objectives:

- to analyze the theoretical approaches about the concept of mathematical competence and the pupuls' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers);
- to analyze and characterize the modern educational technologies used in the teaching-learning-assessment of Mathematics;
- to determine the principles, factors and pedagogical conditions for the formation of pupils' mathematical competence in post-secondary non-tertiary technical vocational education;
- to diagnose the level of the development of pupils' mathematical competence in post-secondary non-tertiary technical vocational education;
- to elaborate and validate the pedagogical Model of the formation of pupils' mathematical competence in post-secondary non-tertiary technical vocational education;
- to interpret the research results.

The realization of the research objectives will focus on the following **research methods**:

• ***theoretical methods***: documentation; scientific research; pedagogical design and modeling; analysis of specialized literature; synthesis; comparison; generalization; systematization;

• ***experimental methods***: pedagogical experiment; questioning; observation; testing; analysis and evaluation;

• ***analysis methods*:** statistical methods of collecting, grouping, processing and interpreting experimental data; quantitative and qualitative analysis of experimentally obtained results.

Scientific novelty and originality reside in:

- the analysis of theoretical approaches about mathematical competence and the future teachers' mathematical competence by specifying its structure;

- the development of the pedagogical Model of the formation of the mathematical competence of future primary school teachers by implementing modern educational technologies in the process of studying Mathematics;

- description of the implementation methodology of the elaborated pedagogical Model, which includes the use of modern educational technologies in order to develop pupils' motivation for studying Mathematics and for teaching it in primary school.

The obtained results that contributed to the solution of the important scientific problem reside in the conceptualization of the pedagogical Model of the formation of pupils' mathematical competence in post-secondary non-tertiary technical vocational education by studying Mathematics, which contributed to the formation of the pupils' mathematical competence.

The theoretical significance of the research consists in specifying the specifics and structure of the future teacher's mathematical competence in post-secondary non-tertiary technical vocational education; arguing the need for the formation of the mathematical competence of future primary school teachers through the use of modern educational technologies in the educational process.

The applied value of the research results from the development and successful implementation of the pedagogical Model of the formation of pupils' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers) in the process of studying the discipline of Mathematics, focused on the implementation of modern educational technologies.

The approval of the research results was carried out in accordance with the basic stages of the research, during the realization of the theoretical and the proposed experimental tasks. The main results were presented, approved and communicated in the meetings of the Department of Algebra, Geometry and Topology of Tiraspol State University, the Didactics of Sciences Department of Tiraspol State University, the Scientific Council of TSU and the Council of the Doctoral School of Education Sciences of the Partnership of Higher Education Institutions,

Tiraspol State University, B. P. Hașdeu State University of Cahul and the Institute of Education Sciences, as well as in 10 national and international scientific congresses and conferences.

The implementation of the scientific results was carried out within the pedagogical experiment, carried out on experimental and control groups, which included 163 students of the first year, specialty 11310 - Primary Education, from the "Alexei Mateevici" Public Institution) in Chisinau and from the "Mihai Eminescu" College Public Institution in Soroca.

Publications on the topic of the thesis:

The scientific and scientific-methodical results on the topic of the thesis are reflected in 16 publications: 5 scientific and scientific-methodological articles in national journals of category B; 1 scientific article in: The Scientific Journal of the Institute of Social Affairs of the Pedagogical University of Cracow, Poland (Labor and Education); 10 communications at conferences, congresses, national and international scientific forums.

Summary of thesis chapters: introduction, three chapters, general conclusions and recommendations, 129 pages of basic text, bibliography of 170 titles, 16 appendices, 22 figures and 40 tables.

Keywords: modern educational technologies, information and communication technologies, mathematical competence, educational process, knowledge, skills, attitudes, motivation, didactic principles, pedagogical Model.

THESIS CONTENT

The **Introduction** of the research contains the argumentation of the topicality and importance of the research topic, as well as the description of the situation in the field of study. Also here are formulated the research problem, the purpose and objectives of the research. The scientific novelty, the theoretical and applied importance of the investigation are described. The scientific results obtained are also highlighted and approved in Introduction.

Chapter 1, "**THEORETICAL FOUNDATIONS OF PUPILS' MATHEMATICAL COMPETENCE IN POST-SECONDARY NON-TERTIARY TECHNICAL VOCATIONAL EDUCATION (FUTURE PRIMARY SCHOOL TEACHERS)"** is dedicated to the analysis of the situation in the field, regarding the study of the concept of mathematical competence and the mathematical competence of the future primary school teachers both through the lens of national and international studies as well as through a pedagogical and psychological perspective.

A detailed analysis of international studies and available researches highlighted the fact that the mathematical competence, as a key competence recommended by the Council of the European Union of 22 May 2018 regarding the lifelong learning, highlights the personality ability

to acquire the mathematical material, to deepen in the field of mathematical knowledge, to solve various problems in everyday life and to obtain significant results in the professional activity.

The international evaluations TIMSS, PISA, PIAC define mathematical competence as the set of all pupil's knowledge and abilities to analyze, use, communicate mathematical information in different learning and everyday contexts, including employment in the labor field, allowing the pupil to make decisions necessary for any constructive citizen.

The studies of researchers L. D. Kudryavtsev, N. G. Khodyrevoy, I. N. Razlivinskikh, N. A. Kazaček consider that the mathematical competence is a trait of the pupil's personality that includes his mathematical knowledge, the ability to solve mathematical problems with different levels of difficulty, to interpret certain results/mathematical data and the abilities to carry out various activities.

Analyzing these definitions, we believe that the concept of mathematical competence is valued by the fact that it brings to the fore the basic mathematical knowledge without which the problems could not be solved and the answer could not be argued.

M. Niss, [46], distinguishes two dimensions through which mathematical competence is manifested, as follows:

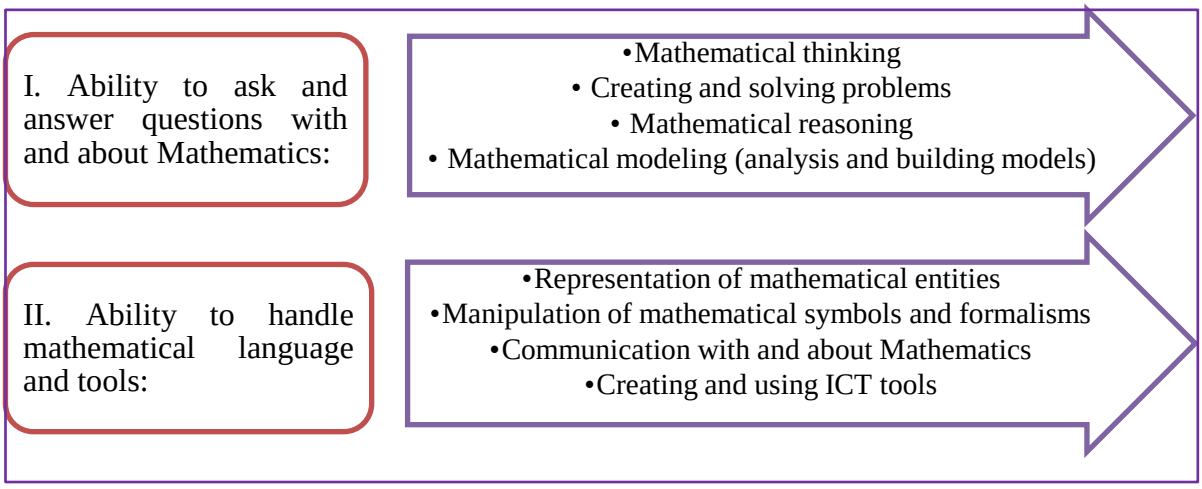


Figure 1. Dimensions of the manifestation of the mathematical competence

All eight of these elements relate to mental or physical processes, activities, and behaviors. In other words, the focus is on what individuals can do. These characteristics also make the competence behavioral. The analytical aspect of the competence focuses on understanding, interpreting, examining and evaluating mathematical phenomena and processes, such as following a chain of mathematical arguments or understanding the nature of mathematical representations. The practical aspect focuses on building and carrying out processes, such as creating a chain of arguments or using mathematical representations in a given situation.

Based on the definition of competence and mathematical competence, the TEDS-M international study (Teacher Education and Development Study in Mathematics) understands by

the teacher's mathematical training the set of knowledge specific to Mathematics, but also knowledge specific to the methodology of teaching Mathematics including his attitude towards Mathematics as a science and towards the Mathematics teaching-learning process.

Starting from the definition of the teacher's mathematical competence, the Mathematics teacher's mathematical competence and teacher's mathematical competence in primary school, defined as the characteristic of the pedagogue to understand and apply Mathematics in solving problems with mathematical and methodological content, and from the mathematical competence of a high school pupil (the individual level of his mathematical training), in the research there was developed the structure of the pupil's mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teacher) (fig. 2).

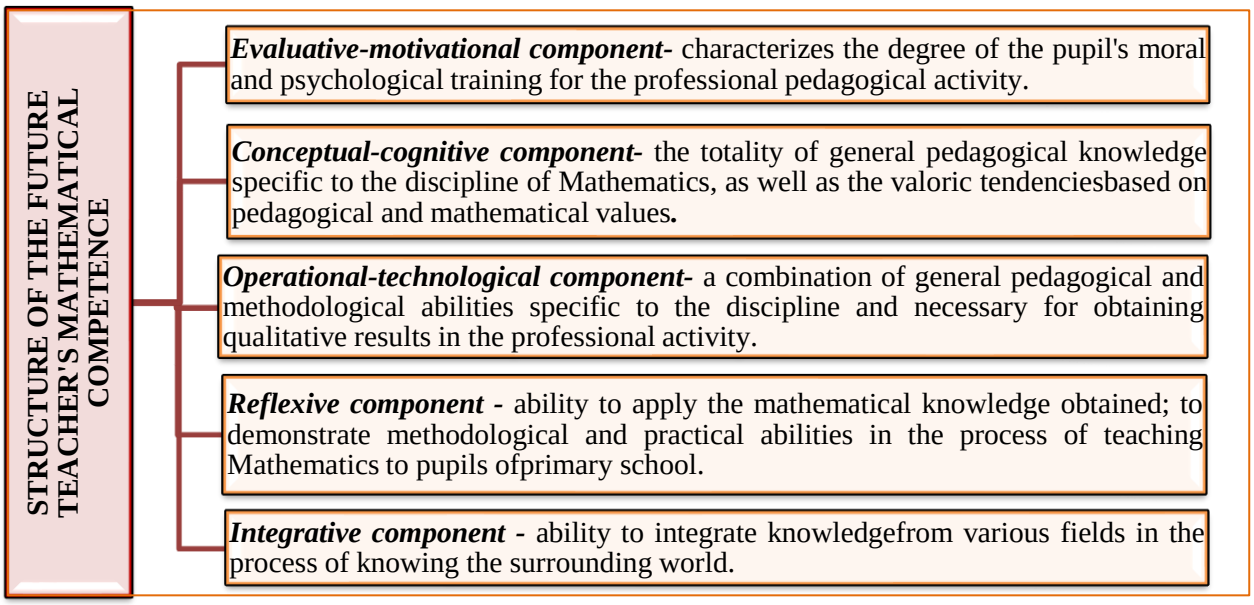


Figure 2. Structure of pupils' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teacher)

The research also analyzes the pupil's motivational aspect in post-secondary non-tertiary technical vocational education (future primary school teachers) for studying Mathematics, starting from the results offered by national and international assessments, as well as the courses with mathematical content.

The study of Mathematics from two perspectives: as a pupil but also as a future primary school teacher contributes productively to: the development of mathematical culture, but also to the development of the pupils' system of knowledge and skills to operate with basic mathematical notions and to be able to apply them in a professional context.

Chapter 2, "**METHODOLOGICAL BENCHMARKS OF MODERN EDUCATIONAL TECHNOLOGIES**" is dedicated to the analysis of the specifics of modern educational technologies as well as to the elaboration, the theoretical foundation of the pedagogical

Model of the formation of pupils' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers) and the methodology of using it.

Modern educational technology covers the entire educational process, and when this term is used, special attention is paid to the training organizational aspect. Educational technology contains the main element - guaranteeing the minimum level of learning and ensuring potentially positive results, which will be ensured by optimizing the educational process.

The definitions of the term Modern Educational Technology and its components allowed the elaboration of the own definition of this concept, namely, in our opinion, modern educational technology represents the interaction between the set of didactic-methodological tools, between the teacher's pedagogical mastery and the pupil's psychological peculiarities. In this context, we consider that: since the teacher is the one who elaborates and implements the educational technology (TE) through the use of different teaching methods and tools, adapted to the group of pupils with a well-defined purpose, and the pupil with his different personality both in terms of character, temperament and of psychic processes is the main object on which these technologies are trained.

In the process of Mathematics teaching-learning-assessment, there will be used various modern educational technologies, based on the principle of motivation. Thus, the pupils' interest in the studied material and in all the activities that take place during a lesson. At the same time, the role of the teacher will be not only to clarify the moments misunderstood by the pupils but also to organize cognitive activities, where the main character is the pupil [9, p. 90].

Among the most relevant and frequently used modern educational technologies in Mathematics lessons we can mention: differentiated instruction technology; group training technology; problematized training technology; technology of the development of critical thinking; project-based learning technology; game-based learning technology; information and communication technologies (ICT) [apud 9, p. 91].

The use of these modern educational technologies in the training process of pupils' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers) will contribute to a certain extent to increasing the level of motivation for studying Mathematics, the methodology of Mathematics teaching, but also the elementary Mathematics course.

The peculiarities of the professional training/training of the future primary school teacher to teach Mathematics to pupils of small school age, in our opinion, consists in: establishing a unique basis for the formation of scientific concepts from different fields of knowledge, in knowing the psychological characteristics related to the formation and the development of early

school age pupils. Knowing the psychological laws of the process of assimilating the knowledge taught, the didactic and methodological principles related to: teaching Mathematics to primary school pupils, the ability to handle the multitude of TEM in the professional activity and not least of the future primary school teacher's desire to constantly self-develop, self-improve and self-train.

The TEDS-M international study highlights the fact that the future primary school teacher in his activity of teaching Mathematics should possess the following professional knowledge:

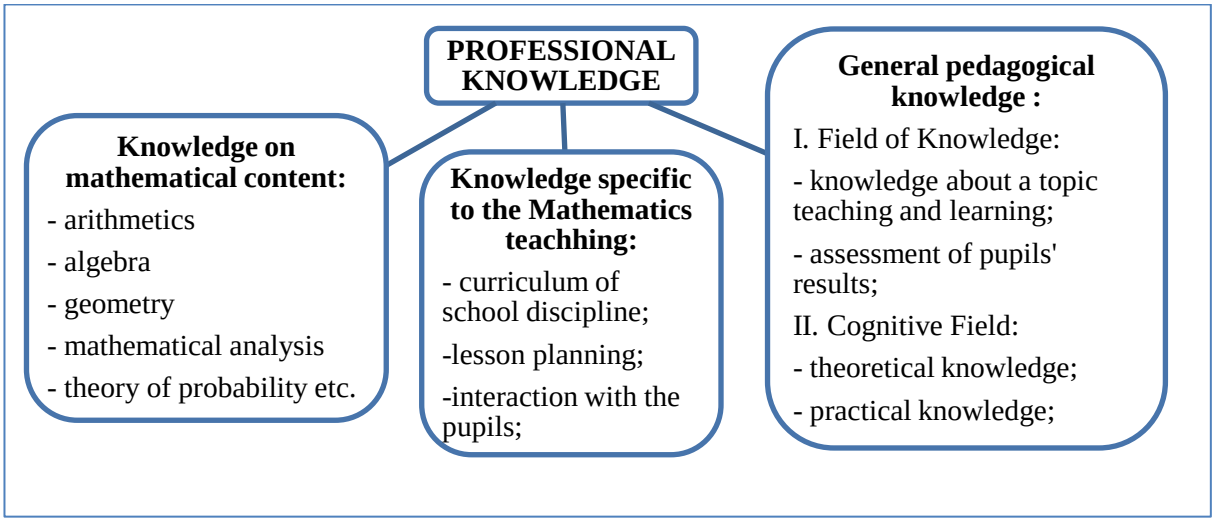


Figure 3. The TEDS-M Model of professional knowledge of the future primary school teacher

The mathematical competence of the future primary school teacher supposes the presence of a set of mathematical knowledge and the experience of independent activities based on this knowledge, i.e. focused on two basic aspects: knowledge of the discipline itself and the ability to master didactic tools and teaching methods.

The structure of the process of forming the mathematical competence of future primary school teachers' was determined by taking into account the traditional structure of the educational process, as well as some aspects of the projective block and the training block of the model developed by H. A. Gluzman as well as some aspects of the training tools of methodical-mathematical competence described in O. A. Borzenkova's model.

Thus, we deduce that the pedagogical model of training/development of the primary school teacher must be dynamic, periodically adjusted, reflect the development of individual sciences and different fields of knowledge, at the same time reflect the trends necessary to solve the problems related to the construction of educational process. Based on the above, the pedagogical Model of the formation of pupils' mathematical competence in post-secondary non-tertiary technical professional education (future primary school teachers) was developed through the use of modern educational technologies.

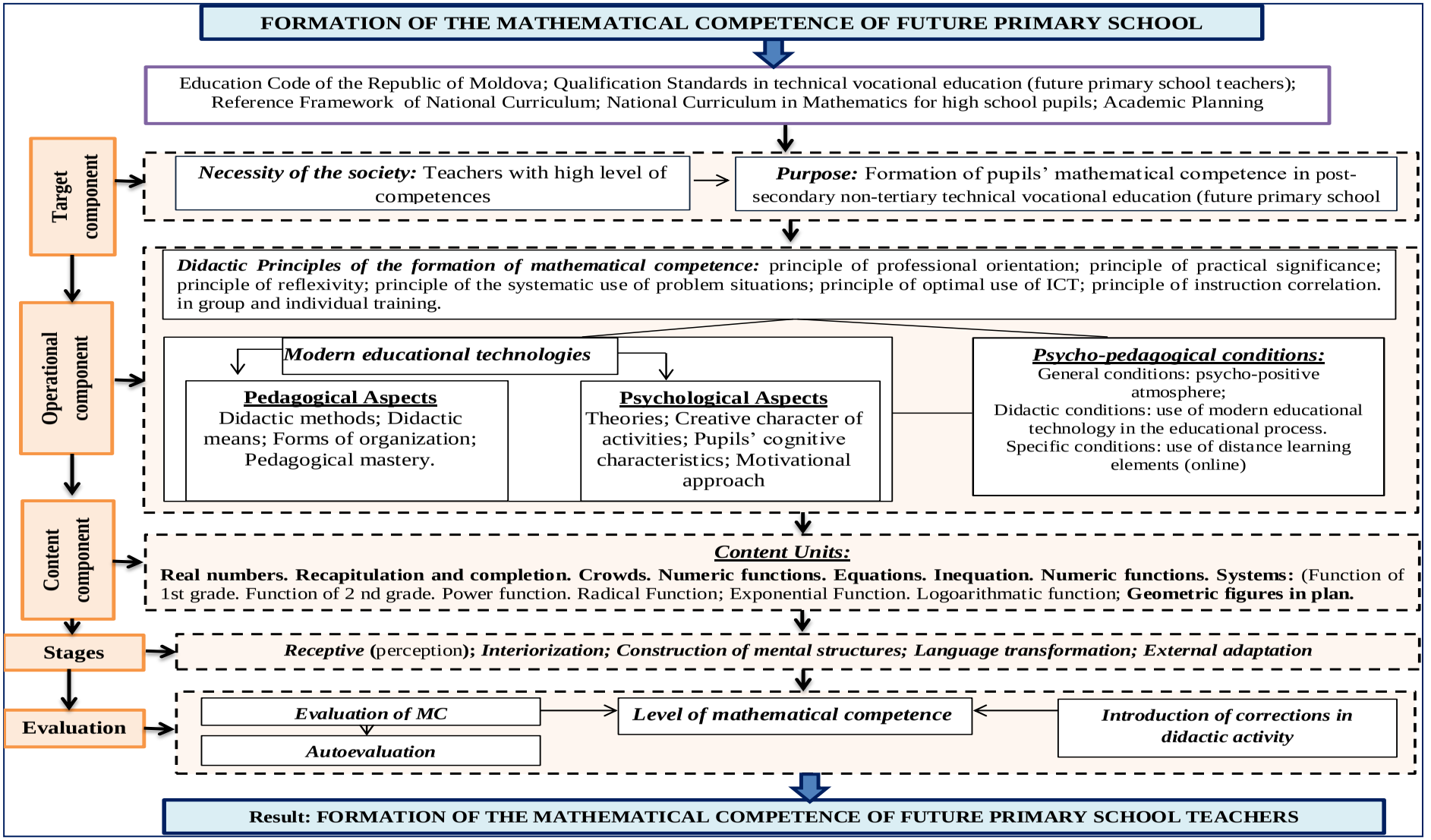


Figure 4. Pedagogical Model of the formation of pupils' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers)

The pedagogical Model of the formation of pupils' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers) differs from other models primarily by the fact that it highlights the use of modern educational technologies, referring not only to their pedagogical dimension, but also to the psychological one, where special emphasis is placed on the pupils' psychological characteristics at the age of adolescence and on the motivational approach, as a basic component in the structure of the mathematical competence.

The elaborated Model meets the following requirements: it is built in accordance with the professional demands proposed to the future primary school teacher in a constantly changing information society and is based on the main criteria for professional competence as an indicator of the professional training of the future primary school teacher.

In the process of developing the pedagogical Model of the formation of pupils' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers), the starting point was the Education Code of the Republic of Moldova, where it is stipulated that in these educational institutions it is carried out the specialists' training in various fields according to **ISCED** levels 4 and 5 (Article 63). Also, another document on which the elaboration of the pedagogical Model was based was the normative act regarding the Qualification Standards in technical vocational education, the field of vocational training: Staff training for primary institutions, the Reference Framework of the National Curriculum as well as the National Curriculum at Mathematics for grades X-XII, which describes learning conditions and performance expressed in competences and units of competence designed in Mathematics. The education plan for the specialty 11310-Primary education, qualification: Teacher, characteristic for all colleges with a pedagogical profile (General field - Education) which also includes the high school component of the education plan for the years of study, is another document that encouraged the development of the pedagogical Model.

A. The target component of the Model contains the learning goal, which is the basic feature of the Model, established by the society's need for highly qualified teachers with a high level of competences.

B. The operational component of the Model is represented by the didactic principles of the mathematical competence formation as didactic rules that are applied in the teaching-learning-evaluation activity, it is represented by modern educational technologies delimited by pedagogical and psychological aspects, as well as the psycho-pedagogical conditions of the mathematical competence formation of the future primary school teachers.

C. The content component of the developed pedagogical Model refers to the integration of all the content units provided in the National High School Curriculum for the humanities profile.

According to the Reference Framework of the National Curriculum, the content units represent the way or means through which the curricular outcomes can be achieved in the teaching-learning process. The respective contents designate the subject on which action will be taken, calling on various didactic strategies, in order to accumulate a certain level of performance by achieving the designed outcomes.

The integration of these contents is reflected in any long-term didactic planning that every Mathematics teacher is obliged to develop. Thus, in our research, there was developed the operational Model of building long-term planning in Mathematics for pupils in post-secondary non-tertiary technical vocational education (future primary school teachers) in order to form the mathematical competence:

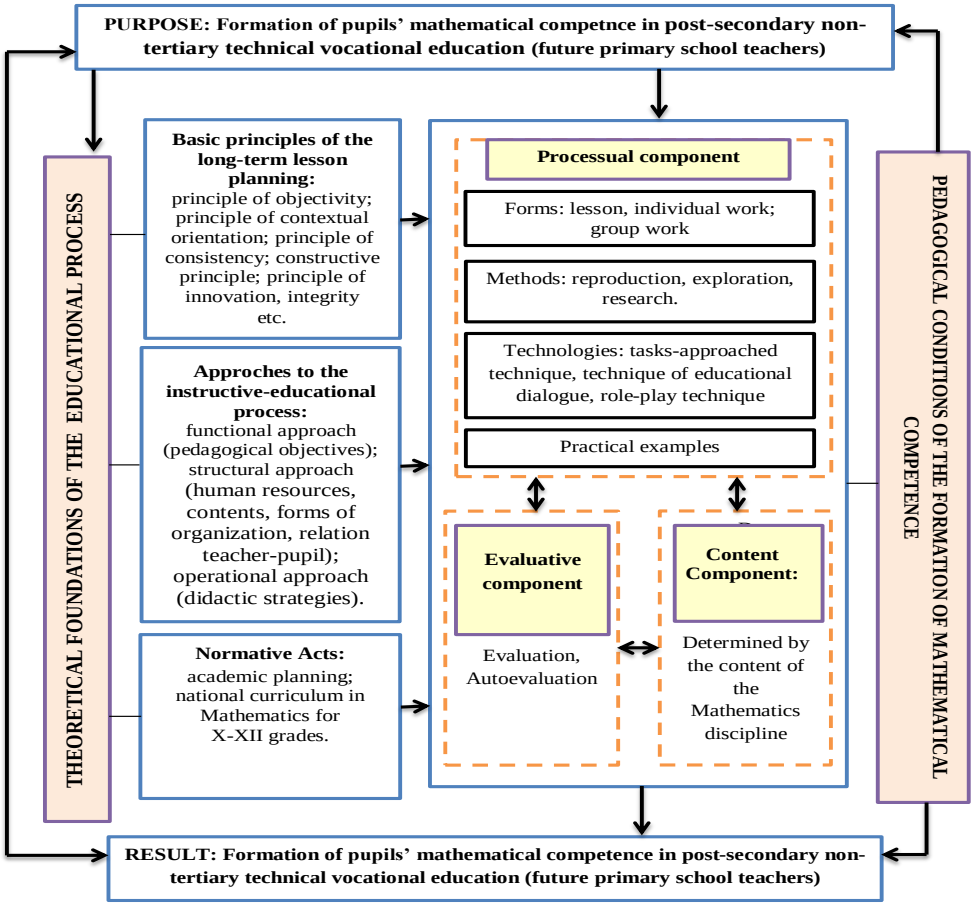


Figure 5. Structural Model of the integration of the term-long planning in the formation of pupils' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers)

E. *Evaluation.* The evaluative component of the elaborated pedagogical Model actually refers to the stated goal: "The formation of the mathematical competence of future primary school teachers" and it is based on the self-evaluative component, which aims at the self-control and self-analysis of the pupils' own mathematical activities, as well as the awareness of the importance of

the mathematical competence for self-development. Also, this component emphasizes the ***evaluation*** of the didactic process carried out by the teaching staff through various evaluation techniques, including the final evaluation (Semester Thesis) of the ***level of the mathematical competence***. In order to increase the pupil's level of the mathematical competence, the evaluative component also reflects the aspect of correction, which is introduced into the educational process by the teacher.

Chapter 3, **"EXPERIMENTAL APPROACH TO VALUATION OF THE PEDAGOGICAL MODEL OF THE FORMATION OF PUPILS' MATHEMATICAL COMPETENCE IN POST-SECONDARY NONTERTIARY TECHNICAL VOCATIONAL EDUCATION (FUTURE PRIMARY SCHOOL TEACHERS)"** - reflects the three stages of the pedagogical experiment: the ascertainment stage, the formation stage and the validation stage of the Model and the methodology of using the elaborated Model. This chapter also includes the statistical analysis of the results of the pedagogical experiment, which was carried out with the help of SPSS and MS Excel applications. To demonstrate the research hypotheses, there were applied parametric tests and non-parametric tests.

The purpose of the first stage of the experiment (ascertainment) was to determine the level of pupils' competence in post-secondary non-tertiary technical vocational education (future primary school teachers) and to determine the motivation towards studying Mathematics. Based on the purpose of the discovery experiment, the objectives of this stage were formulated:

- Determining the motivation of future teachers towards studying Mathematics, as a compulsory study subject in both general and high school education, but also as a subject to be taught to pupils of low school age;
- Determining the level of pupils' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers);
- Establishing the causes and shortcomings of the work regarding the formation of pupils' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers);

The ascertainment experiment was carried out in two phases: (1) determining the methodological benchmarks for the application of modern educational technologies in the didactic process in Mathematics classes, carried out in the 2019-2020 academic year; (2) selecting the experimental and control samples by checking the homogeneity of these samples, during the study years 2020-2021 and 2021-2022.

Initially, a questionnaire of 27 questions was applied with the aim of determining the future primary school teachers' motivation for studying Mathematics. The questionnaire was applied to

highlight the categories of motives underlying the influence of mathematical educational activity, such as: the cognitive reason; the reason for training the professional activity; the reason for achieving success; the reason for personal self-affirmation; the reason for emotional satisfaction; the reason for social self-affirmation; the socio-emotional reason; the socio-moral reason; the reason for involvement/professional employment. Each category of reasons comprises 3 questions, (each question having 4 answer options: "Not at all", "A little", "A lot", "Very much"), which are arranged randomly and formulated differently, which provides objectivity in the results analysis.

Thus, following the application of this questionnaire and data processing in SPSS (Statistical Package for the Social Sciences), it was found that there is a statistically significant positive correlation between "Cognitive reason" and "Professional training reason", $r(163) = 0.696$, $p < 0.001$, as the coefficient *r* is an effect size, according to Cohen (1988), it follows that the relationship between cognitive motivation and that of preparation for professional activity is strong. On the other hand, there is also a statistically significant negative correlation with regard to "Reason of emotional satisfaction" and "Reason of professional involvement", $r\ (163) = 0.696$, $p < 0.001$, in the sense that pupils with high scores on the motivation of emotional satisfaction they score low on the motivation of professional involvement and vice versa. It was also found that there is a statistically significant positive correlation in terms of the "Cognitive Reason" in relation to Mathematics and the "Success Reason" of the first year pupils in post-secondary non-tertiary technical vocational education, r (163)=0.775, $p< 0.001$, in the sense that pupils who show a cognitive interest in Mathematics tend to have higher motivation to achieve success in this discipline and vice versa.

The results regarding the pupils' initial assessment from the 2020-2021 academic year highlighted the following:

The results of the t-Student test: $F(77) = 0.109$ and the significance threshold $0.923 \geq 0.05$ which denotes that the condition of homogeneity of variances is realised. In this context, it was found that $t(79) = 0.664$, and $p = 0.509 \geq 0.005$, meaning that there are no significant differences between Math averages (difference between averages: 0.29506).

Results of the non-parametric Mann-Whitney test: the ranks average of the experimental sample does not exceed that of the control sample; since $Z = -0.821$, $p = 0.412 \geq 0.05$, then there are no significant differences between the two groups in terms of the averages accumulated at the Initial Assessment.

The results regarding the pupils' initial assessment from the 2021-2022 academic year highlighted the following:

Student's t-test results: F(28)=0.269 and significance threshold 0.848≥0.05, which denotes that the condition of homogeneity of variances is realized. In this context, it was found that $t(82) = 0.214,$ and $p = 0.831 \geq 0.005,$ meaning that there are no significant differences between the averages (difference between averages: 0.08333).

The results of the non-parametric Mann-Whitney test: the ranks average of the experimental group does not exceed that of the control group, and $Z = -0.222$ and $p = 0.8243 \geq 0.05$, which proves to us that there are no significant differences between the two groups regarding the mark accumulated in the initial assessment.

The realization of the training/formation stage within the pedagogical experiment had a natural character, taking place within the professional training process in the college. The purpose of this stage of the experiment was to implement the pedagogical conditions identified and theoretically substantiated for the effectiveness of the pedagogical Model for the formation of the mathematical competence of the future primary school teachers.

To achieve this goal, there were identified several tasks:

- formation of the pupils' control group and the experimental group to participate in the experiment;

- determination of different combinations of selected pedagogical conditions for their further implementation;

- equal natural conditions of the educational process for all participants in the experiment;

Based on the results of the training/formation experiment for analysis, there were taken the results of the summative evaluations and the final evaluation for each sample separately and there applied the simple ANOVA method with repeated measures. The purpose of this method was to follow the argumentation of the hypothesis, namely: whether or not there was academic success from one assessment to another for the experimental and control samples.

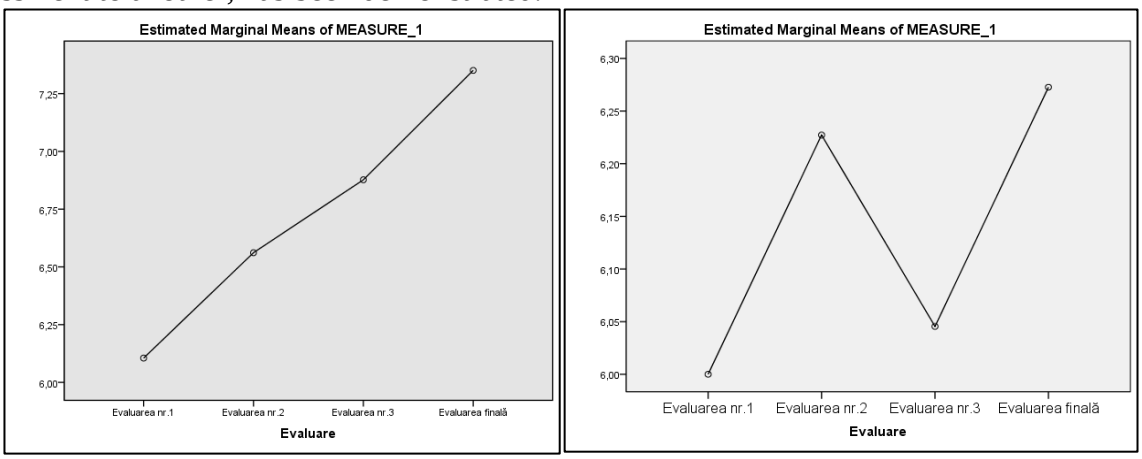
The results of the ANOVA test for each sample (experimental, control) of the academic year 2020-2021 display the following averages: Evaluation no.1- 6.1053, Evaluation no. 2- 6.5614, Evaluation no. 3- 6.8772, Final evaluation - 7.3509. The table Mauchly test of sphericity, indicates that $W = 0.908$ and $p = 0.385 \geq 0.05$, which proves that the condition of sphericity is met, a necessary condition of the ANOVA method. *The Within-Subjects Effects table* (Table 1) is the main table in the output file, containing the results of the overall F tests. We note that the value of $F\ (3.168) = 50.507,\ p = 0.000 \leq 0.05$ is statistically significant and identical for all indicated conditions, therefore there are significant differences between the results of the four evaluations.

Table 1. Overall results of F (*Test of Within-Subjects Effects*) for the experimental sample, academic year 2020-2021

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Evaluare	Sphericity Assumed	47,066	3	15,689	50,507	,000
	Greenhouse-Geisser	47,066	2,840	16,575	50,507	,000
	Huynh-Feldt	47,066	3,000	15,689	50,507	,000
	Lower-bound	47,066	1,000	47,066	50,507	,000
Error(Evaluare)	Sphericity Assumed	52,184	168	,311		
	Greenhouse-Geisser	52,184	159,013	,328		
	Huynh-Feldt	52,184	168,000	,311		
	Lower-bound	52,184	56,000	,932		

For the control sample from the same year of studies, there were obtained the following results: the value of $F(3.63) = 1.252$, for $p = 0.298 \geq 0.05$ is identical for all indicated conditions. Therefore, there are no significant differences between the results of the four tests. According to the data in the table regarding the results of the *Tests of Whithin-Subjects Contras*ts for the control sample it is observed that $F(1,21) = 1.201, p = 0.285 \geq 0.05$; $F(1,21) = 2.100$, $p = 0.162 \geq 0.05$; $F(1,21) = 2.419$, $p = 0.135 \leq 0.05$, which allows us to conclude that between the first three evaluations the differences are insignificant, and between Evaluation no. 3 and the Final Evaluation the difference is significant.

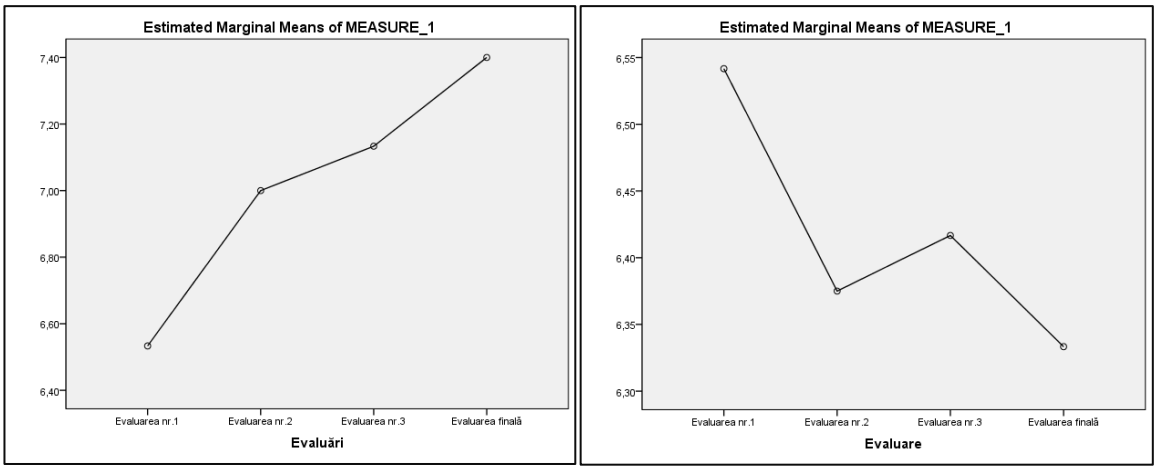
The obtained results are also accompanied by a graphic displayed in the output file. The graph in figure 6 highlights the tendency of the averages to increase from one assessment to another. Therefore, the hypothesis regarding the registration of academic success from one assessment to another, has been demonstrated.



Experimental sample ***Control sample***

Figure 6. Graphical illustration of ANOVA test results, experimental sample and control sample, academic year 2020-2021

This hypothesis is also confirmed by the results of the repeated experiment in the academic year 2021-2022, whose graphs of the ANOVA test results are illustrated in figure 7.



Experimental sample ***Control sample***

Figure 7. Graphical illustration of ANOVA test results, experimental sample and control sample, academic year 2021-2022

Next we will present the results of the t-test and the Mann-Whitney U-test regarding the results obtained in the final assessment for the academic year 2020-2021 and 2021-2022.

The t-test for independent samples from the academic year 2020-2021, illustrates the following results:

Table 2. Statistics of the groups, academic year 2020-2021

	Samples	N	Average	Standard Deviation	Average standard error
Final Evaluation	Experimental Sample	57	7,3509	1,23189	,16317
	Control Sample	22	6,3636	1,25529	,26763

Table 3. T- test for independent samples, academic year 2020-2021

		Levene Test of variances		*T* Test of averages homogeniety						
		F	Sig.	T	df	Sig. (2-tailed)	Difference between averages	Standard error of the difference	95% confidence interval for the difference	
									From below	From above
Final Evaluation	Equal variances are supposed	,099	,754	3,176	77	,002	,98724	,31081	,3683	1,6061
	Equal variances are not supposed			3,150	37,567	,003	,98724	,31345	,3524	1,6220

Table 3 includes the results of Levene's test, where $F(77) = 0.099, p = 0.754$, which is insignificant (≥ 0.05), thus satisfying homogeneity of variances. The results for the t-test show us that $t(77) = 3.176$, and $p = 0.002 \leq 0.05$, which means that there are significant differences between the averages. Also in this table we find that the difference between the averages is

0.98724. For the Mann-Whitney U test from the same academic year we obtain the following results:

Table 4. Ranks, academic year 2020-2021

	Samples	N	Ranks average	Ranks sum
Final Evaluation	Experimental Sample	57	44,43	2532,50
	Control Sample	22	28,52	627,50
	Total	79		

Table 5. Statistic tests, academic year 2020-2021

	Final evaluation
Mann-Whitney U	374,500
Wilcoxon W	627,500
Z	-2,834

In the *Statistical Tests table* there are indicated the values of the Mann-Whitney U, Wilcoxon W tests, the transformation of the U value into Z score and the associated significance threshold. According to the data in the table, we notice that $Z = -2.834$, and p-0.005≤0.05, which indicates that there are significant differences between the two groups regarding the results from the final evaluation. The ranks average of the experimental sample is 44.43 and that of the control sample is 28.52, which indicates that the pupils in the experimental group achieved better results. Next we will calculate the size of the effect of the independent variable (group of pupils) on the dependent variable (pupils' performance). It is given the formula $r = \sqrt{z^2/n}$, where value $Z = 2.834$ and $n = 79$, which are taken from the tables above. $r = \sqrt{2.834^2/79} = \sqrt{0.101665} = 0.32$, which according to Cohen's criteria (1988), $0.30 \leq r = 0.32 \geq 0.50$, shows that the effect of the group variable on the performance variable is modest to moderate.

It is carried out the same statistical processing on the samples from the 2021-2022 academic year. The results for the t-test are $t(82) = 4.856$, and $p = 0.000 \leq 0.05$, which means that there are significant differences between the average of the samples involved in the experiment, this difference being 1.06667, and the confidence interval with a probability of 95% covers this difference. Since this interval does not contain the value 0, then it is demonstrated again that the difference between the averages is a significant one.

The results of the Mann-Whitney U test illustrate that $Z = -4.469$, and $p = 0.000 \leq 0.05$, this means that there are statistically significant differences between the two samples regarding the academic performance, i.e. the grade accumulated in the final assessment. In order to make a conclusion regarding the significant difference, we note that the ranks average in the experimental sample is 49.57 and in the control sample it is 24.83, from which it follows that the pupils in the experimental group achieved higher results. The size of the effect of the independent variable (group of pupils), on the dependent variable (pupil performance, manifested by the grade),

for $Z = 4.469$ and $n = 82$ will be: $r = \sqrt{4.469^2/82} = \sqrt{19.971961/82} = \sqrt{0.2435605} = 0.49$. According to Cohen's criteria, where $0.30 \leq r = 0.49 \geq 0.50$, the effect of the group variable on the performance variable is moderate to strong, this completely confirming the research hypothesis.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

Modern educational technologies represent the necessary scientific basis for the instructional-educational content, the style of the teacher's pedagogical activities, as well as the pupils' individual characteristics, the joint activities of the teacher and the pupil in planning, organizing and implementing the educational process, ensuring training effectiveness. Their critical analysis, in the context of the formation of pupils' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers), caused the formulation of the research problem as well as its objectives.

The major impact that modern educational technologies have on the formation of the mathematical competence allowed the determination of the **theoretical importance** of the research, and the problem of the formation of the mathematical competence of future primary school teachers through the prism of studying Mathematics, as a compulsory discipline, led to the achievement of the research objectives, highlighting in this context the **practical importance** of the research.

The analysis of the obtained results allows the synthesis of the following conclusions:

1. Through the analysis of the theoretical approaches to the concept of mathematical competence and the mathematical competence of the primary school teacher, we made a distinction between the pupil's mathematical competence in high school and the pupil's mathematical competence in post-secondary non-tertiary technical professional education (future primary school teachers) which includes in its structure a set of components: the motivational-evaluative component, the conceptual-cognitive component, the operational-technological component, the reflexive component and the integrative component.

2. The analytical-investigative approach allowed the description of each component separately, specifying both knowledge, attitudes and mathematical skills necessary for the future primary school teacher. Also there was identified the TEDS-M model of professional knowledge of the future primary school teacher that he should have in his future work, which includes:

- Knowledge of mathematical content: arithmetic, algebra, geometry, mathematical analysis, probability theory, etc.
- Knowledge specific to teaching Mathematics: the school curriculum of the subject, long-term lesson planning, didactic planning of the lesson, interaction with the class of pupils.

- General pedagogical knowledge: Domain of Knowledge (knowledge about teaching/learning a topic, evaluating pupils' results); Cognitive Domain (theoretical and practical knowledge).

3. The approach from a structural perspective of the mathematical competence allowed the analysis of the pupils' motivation in post-secondary non-tertiary technical vocational education for the study of the academic discipline Mathematics, thus finding that the level of motivation is low and the educational process requires new approaches, such as the approach through modern educational technologies.

4. The formation of the mathematical competence is the result of the use in the educational process of various modern educational technologies. For this purpose, we have identified the specifics of the educational technology used post-secondary non-tertiary technical vocational education were identified, proposing our own definition of this concept. At the same time, it was established the need to use educational technologies in classes, through which pupils are encouraged, motivated, stimulated to study Mathematics and to be aware of the importance of this discipline, not only as an academic discipline, but also as a discipline to be taught to pupils in primary school.

5. In order to increase the quality of the educational process in the discipline of Mathematics, the principles, factors and pedagogical conditions for the formation of the mathematical competence were determined, which allowed the development of the pedagogical Model and its methodology, centered on the implementation of modern educational technologies in the didactic process, oriented towards the formation of pupils' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers).

6. Among the didactic/pedagogical conditions identified in the operational component of the pedagogical Model, we highlight the modern educational technologies with their pedagogical aspect:

- The set of didactic methods: teaching methods, methods of fixing knowledge, verification and assessment methods, which allowed a better understanding of the subject taught, as well as an increase in the level of pupils' training, facilitating in this context the motivation towards studying Mathematics, making pupils' independent activity more efficient;
- The set of educational means: informative-illustrative means, practice/training means, time rationalization means, which contributed to obtaining better academic results in the experimental groups;

- Forms of training (full-time training and part-time training) and forms of organization (frontal, individual, group), which allowed the involvement of the entire group of pupils in learning activities, increasing their activism.
- Pedagogical mastery that allowed the teacher as well as the group of pupils to display their professional qualities by implementing didactic methods and means in the didactic process.

7. It was argued that the approach to the educational process of Mathematics discipline can be carried out based on the developed pedagogical Model.
8. Through the pedagogical experiment carried out in two stages (2020-2021, 2021-2022), the following conclusions were synthesized based on the statistical analysis made, namely:

- The effectiveness of the developed pedagogical Model, focused on the valorization of modern educational technologies in the process of studying Mathematics as a discipline, and the conditions for its implementation were proven in the experimental verification process, by recording better results in the experimental groups compared to the control groups;
- There was identified a direct dependence between didactic methods and didactic means with their integration in the development and implementation of modern educational technologies in the educational process and the increase of pupils' performance level when studying Mathematics.

9. The theoretical-experimental research allowed the achievement of the proposed objectives, but also the solution of the research problem: the determination of theoretical benchmarks and the elucidation of modern educational technologies that allow the formation of pupils' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers).

The conclusions described above generate the following **recommendations:**

For the teaching staff:

- In order to improve the professional activity of the teaching staff and to increase the pupils' motivational level in post-secondary non-tertiary technical vocational education, by implementing modern educational technologies in the educational process, it is necessary to use the already existing educational tools according to the requirements of the proposed pedagogical Model.
- Application of the pedagogical Model and its methodology for the purpose of forming the mathematical competence.

- Adaptation of modern educational technologies to Mathematics lessons depending on pupils' individual and psychological characteristics.

For the authors of textbooks and teaching materials:

- The development and publication of theoretical, methodological and practical materials for training both pupils' mathematical competence in post-secondary non-tertiary technical vocational education and pupils' mathematical competence in higher education institutions (future primary school teachers), in the context of ensuring the highest quality training required by the market work and employer.

For students and masters of study programs in the field of Sciencs of Education:

- The use of the results obtained in the process of training pupils' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers) and the analysis of new researches for the purpose of completing bachelor's and master's theses.

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ADNOTARE

Hajdeu Mihaela. **Impactul tehnologiilor educaționale moderne în formarea competenței matematice la elevii din învățământul profesional tehnic postsecundar nonterțiar (viitori învățători). Teză de doctor în științe ale educației, UPS „I. Creangă", Chișinău, 2022.**

Structura tezei: introducere, trei capitole, concluzii generale și recomandări, 129 pagini de text de bază, bibliografie din 170 de titluri, 16 anexe, 22 figuri și 40 tabele.

Publicații la tema tezei: Rezultatele obținute sunt publicate în 16 lucrări științifice.

Cuvinte-cheie: tehnologii educaționale moderne, tehnologii informaționale și comunicaționale, competență matematică, proces educațional, cunoștințe, aptitudini, atitudini, motivație, principii didactice, model pedagogic.

Scopul cercetării constă în determinarea reperelor teoretice și metodologice de valorificare a tehnologiilor educaționale moderne în formarea competenței matematice la elevii din învățământul profesional tehnic postsecundar nonterțiar (viitori învățători).

Obiectivele cercetării: analiza abordărilor teoretice despre conceptul de competență matematică la general și competență matematică a elevilor din învățământul profesional tehnic postsecundar nonterțiar (viitori învățători); analiza și caracterizarea tehnologiilor educaționale moderne utilizate în predarea-învățarea-evaluarea matematicii; determinarea principiilor, factorilor și condițiilor pedagogice de formare a competenței matematice la elevii din învățământul profesional tehnic postsecundar nonterțiar; diagnosticarea nivelului de dezvoltare a competenței matematice la elevii din învățământul profesional tehnic postsecundar nonterțiar; elaborarea și validarea modelului pedagogic de formare a competenței matematice la elevii din învățământul profesional tehnic postsecundar nonterțiar; interpretarea rezultatelor cercetării.

Noutatea și originalitatea științifică rezidă în: analiza abordărilor teoretice despre competența matematică la general și competența matematică a viitorului învățător prin specificarea structurii acesteia; elaborarea modelului pedagogic de formare a competenței matematice la viitorii învățători prin implementarea tehnologiilor educaționale moderne în procesul de studiere a matematicii; descrierea metodologiei de utilizarea a modelului pedagogic elaborat, care include utilizarea tehnologiilor educaționale moderne în scopul dezvoltării motivației elevilor pentru studierea matematicii și pentru predarea acesteia în clasele primare.

Rezultatele obținute care au contribuit la soluționarea problemei științifice importante rezidă în conceptualizarea modelului pedagogic de formare a competenței matematice la elevii din învățământul profesional tehnic postsecundar nonterțiar prin studierea matematicii, ceea ce a contribuit la formarea competenței matematice la elevi.

Semnificația teoretică a cercetării constă în precizarea specificului și structurii competenței matematice a viitorului învățător din învățământul profesional tehnic postsecundar nonterțiar; argumentarea necesității formării competenței matematice la viitorii învățători prin utilizarea tehnologiilor educaționale moderne în procesul educațional.

Valoarea aplicativă a cercetării rezultă din elaborarea și implementarea cu succes a modelului pedagogic de formare a competenței matematice la elevii din învățământul profesional tehnic postsecundar nonterțiar (viitori învățători) în procesul de studiere a disciplinei *Matematica*, axat pe implementarea tehnologiilor educaționale moderne.

Implementarea rezultatelor științifice a fost realizată în cadrul experimentului pedagogic, desfășurat pe eșantioane experimentale și de control, care au cuprins 163 de elevi ai anului I, ai specialității 11310 - Învățământ primar, calificarea - Învățător, din cadrul Instituției Publice Colegiul „Alexei Mateevici" (IPCAM) din Chișinău și din cadrul Instituției Publice Colegiul „Mihai Eminescu" din Soroca.

ANNOTATION

Hajdeu Mihaela. **The impact of modern educational technologies on the formation of pupils' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers). PhD thesis in Sciences of Education. "I. Creangă" State Pedagogical University, Chisinau, 2022**

Structure of the thesis: introduction, three chapters, general conclusions and recommendations, 129 pages of basic text, Bibliography of 170 titles, 16 appendices, 22 figures and 40 tables.

Publications on the topic of the thesis: The obtained results are published in 16 scientific works.

Keywords: modern educational technologies, information and communication technologies, mathematical competence, educational process, knowledge, skills, attitudes, motivation, didactic principles, pedagogical model.

The aim of the research consists in substantiating the theoretical and methodological benchmarks for capitalizing on modern educational technologies in the formation of pupils' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers).

Research objectives: analysis of theoretical approaches on the concept of mathematical competence and pupils' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers); analysis and characterization of modern educational technologies used in post-secondary non-tertiary technical vocational education in Mathematics lessons; determining the principles, factors and pedagogical conditions for the formation of pupils' mathematical competence in post-secondary non-tertiary technical vocational education; diagnosing the level of the development of pupils' mathematical competence in post-secondary non-tertiary technical vocational education; elaboration and validation of the pedagogical Model of the formation of pupils' mathematical competence in post-secondary non-tertiary technical vocational education; interpretation of research results.

The novelty and scientific originality of the research lies in: the analysis of theoretical approaches on mathematical competence and the mathematical competence of the future primary school teacher by specifying its structure; the development of the pedagogical Model for the formation of the mathematical competence of the future primary school teachers by implementing modern educational technologies in the process of studying Mathematics; description of the implementation methodology of the elaborated pedagogical Model, which includes the use of modern educational technologies in order to develop pupils' positive motivation for studying Mathematics and for teaching it in primary school.

The theoretical significance of the research consists in specifying the specifics and structure of the mathematical competence of the future primary school teacher in non-tertiary post-secondary technical vocational education; arguing the need for the formation of pupils' mathematical competence through the use of modern educational technologies in the educational process.

The applied value of the research results from the development and successful implementation of the pedagogical Model for the formation of pupils' mathematical competence in post-secondary non-tertiary technical vocational education (future primary school teachers) in the process of studying Mathematics, focused on the implementation of modern educational technologies.

The implementation of the scientific results was carried out within the pedagogical experiment, carried out on experimental and control samples, which included 163 students of the first year, of the specialties 11310 - Primary education, qualification – Primary School Teacher, from the "Alexei Mateevici" Public Institution (IPCAM) from Chisinau and within the "Mihai Eminescu" College from Soroca.

АННОТАЦИЯ

Хаждеу Михаела. **Влияние современных образовательных технологий на формирование математической компетентности у учеников послесреднего нетретичного профессионально-технического образования (будущих учителей). Докторская диссертация в области педагогических наук, ГПУ им. „И. Крянгэ", Кишинев, 2022 г.**

Структура диссертации: введение, три главы, общие выводы и рекомендации, 129 страниц основного текста, библиография 170 названий, 16 приложений, 22 рисунков и 40 таблиц.

Публикации по теме диссертации: Полученные результаты опубликованы в 16 научных статьях.

Ключевые слова: современные образовательные технологии, информационно-коммуникационные технологии, математическая компетентность, учебнный процесс, знания, умения, установки, мотивация, дидактические принципы, педагогическая модель.

Цель исследования заключается в обосновании теоретико-методологических ориентиров использования современных образовательных технологий в формировании математической компетентности у учеников послесреднего нетретичного профессионально-технического образования (будущих учителей).

Задачи исследования: анализ теоретических подходов к понятию математической компетентности и математической компетентности учеников послесреднего нетретичного профессионально-технического образования (будущих учителей); анализ и характеристика современных образовательных технологий, используемых в послесреднем нетретичном профессионально-техническом образовании на уроках математики; определение принципов, факторов и педагогических условий формирования математической компетентности у учеников послесреднего нетретичного профессионально-технического образования; диагностика уровня развития математической компетентности у учеников послесреднего нетретичного профессионально-технического образования; разработка и апробация педагогической модели формирования математической компетентности у учеников послесреднего нетретичного профессионально-технического образования; интерпретация результатов исследования.

Научная новизна и оригинальность заключается**:** в анализе теоретических подходов к математической компетентности и математической компетентности будущего учителя путем уточнения ее структуры; в разработке педагогической модели формирования математической компетентности будущих учителей путем внедрения современных образовательных технологий в процессе изучения математики; в описании методики реализации разработанной педагогической модели, включающей использование современных образовательных технологий с целью формирования мотивации учащихся к изучению математики и преподаванию ее в начальных классах.

Полученные результаты, способствовавшие решению важной научной проблемы, заключаются в концептуализации педагогической модели формирования математической компетентности у учеников послесреднего нетретичного профессионально-технического образования путем изучения математики, что способствовало формированию математической компетенции у учащихся.

Теоретическая значимость исследования заключается в уточнении специфики и структуры математической компетентности будущего учителя послесреднего нетретичного профессионально-технического образования; аргументируя необходимость формирования математической компетентности у будущих учителей путем использования современных образовательных технологий в процессе обучения.

Практическое значение исследования обусловлено разработкой и успешной реализацией педагогической модели формирования математической компетентности у учеников послесреднего нетретичного профессионально-технического образования (будущих учителей) в процессе изучения учебной дисциплины «Математика», ориентирован на внедрение современных образовательных технологий.

Внедрение научных результатов осуществлялось в рамках проведенного педагогического эксперимента в котором участвовали 163 учеников первого курса, специальности 11310 - Начальное образование, квалификация – Учитель, из Государственного Учреждения Колледжа «Алексей Матеевич» (IPCAM) из Кишинева и Государственного Учреждения Колледжа «Михай Еминеску» из Сорок.

HAJDEU MIHAELA

THE IMPACT OF MODERN EDUCATIONAL TECHNOLOGIES ON THE FORMATION OF PUPILS' MATHEMATICAL COMPETENCE IN POST-SECONDARY NON-TERTIARY TECHNICAL VOCATIONAL EDUCATION

(future primary school teachers)

SPECIALITY 532.02 SCHOOL DIDACTICS ON LEVELS AND DISCIPLINES

Summary of PhD Thesis in Sciences of Education

Approved for publishing: 01.09.2022	Paper format 60×84 1/16
Paper offset. Type offset	Print run 50 ex.
Pattern printed sheet: 2.0	Order nr. 0109

Typography UST, 5 Gh. Iablocikin street, Chisinau, MD-2069