Enhancing the Preparation of Future Mathematics Teachers in a Digital Learning Environment

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***Abstract*—Digital education is transforming the modern education system, influencing teaching methodologies and student engagement. In a digital learning environment, fundamental mathematical knowledge equips individuals with logical reasoning, analytical skills, and problem-solving abilities, enabling them to actively participate in society. Mathematics plays a crucial role in developing these competencies, making it essential for future mathematics teachers to integrate digital technologies, tools, and pedagogical strategies into their instructional practices. This study aims to enhance the professional training of future mathematics teachers by exploring the impact of digital technologies on mathematics education and identifying effective strategies for developing their digital pedagogical competencies. Through a mathematical-statistical analysis of survey data, the study highlights the growing necessity of equipping future educators with digital teaching skills, which are essential for improving teaching effectiveness, student engagement, and overall educational quality. The findings emphasize the need for targeted training programs and continuous professional development to ensure that future mathematics teachers can successfully adapt to digital educational environments.**

***Keywords*—digital education, future mathematics teachers, digital technologies, mathematics**

I. Introduction

Digital education is one of the components of a complex multi-faceted education system designed to provide education to everyone at all levels through digital technologies and digital products based on them [1]. Today, digital services in education are an effective and convenient way to provide information and communication services, digital resources to educational entities [2].

Digital learning environments play an important role in modern education systems, especially in the training of future mathematics teachers. The integration of digital technologies into the learning process, the digitization of teaching aids and resources have a significant impact on the development of digital pedagogical competencies of future mathematics teachers.

Digital technologies make the learning process interactive and ensure active participation of students. Digital tools help to deepen students' mathematical understanding. They also allow teachers to improve their teaching methods and increase students' cognitive abilities through the integration of digital technologies [3].

The integration of digital technologies in mathematics education is effective in improving the learning process and student outcomes. Viberg, Grönlund, and Andersson [4] prove that the integration of digital tools into the learning process increases students' interest in mathematics and improves learning outcomes.

Digital technologies enable the acquisition of mathematical concepts and enrich the learning experience. Research by Abar and Lavicza [5] confirms the importance of digital technologies in the educational process and their role in increasing the cognitive activity of students.

Digital technologies are of great importance in mathematics education. The use of digital technologies helps students to understand mathematics more deeply, develop practical skills, and increase abstract thinking abilities [6].

In the modern educational landscape, digital education serves as a key driver in developing technological proficiency among both students and educators. By incorporating digital literacy, information processing, and communication skills, digital learning environments prepare individuals for the evolving demands of the 21st-century workforce [7]. Digital education is not merely a supplementary tool but an integral part of contemporary teaching methodologies, offering dynamic and adaptive learning opportunities across various academic levels [8]. In mathematics education, the adoption of digital technologies fosters a more engaging and interactive learning experience. The use of visual representations, dynamic simulations, and interactive digital resources enables students to explore mathematical concepts more intuitively, bridging the gap between theoretical knowledge and practical application. Studies have shown that such integration enhances student comprehension, critical thinking, and overall academic performance in mathematics [9, 10].

Recent studies emphasize that digital pedagogical competencies are crucial for mathematics educators to effectively implement technology-driven teaching strategies. The integration of learning management systems, digital simulations, and virtual laboratories provides new opportunities for differentiated instruction and real-time assessment. However, despite the growing accessibility of digital tools, many pre-service mathematics teachers face challenges in effectively utilizing these resources in classroom settings.

Therefore, study the use of digital technologies in the training of future mathematics teachers will allow organizing the educational process in a new format, increasing the interest of students, as well as developing their mathematical skills.

This study aims to use digital technologies in the training of future mathematics teachers to answer the following research questions:

- What is the impact of the digital educational environment on the professional training of future mathematics teachers?
- What tools and resources can be used to effectively use digital technologies in mathematics lessons?
- What is the impact of digital technologies and innovative teaching methods on the effectiveness of mathematics lessons?

II. Literature Review

Marín and Castañeda [11] found that integrating digital literacy into education is essential for aligning the learning process with modern technological advancements. Their study highlights that developing digital skills enables students to navigate the digital world effectively and enhances their ability to adapt to evolving educational and professional requirements. They propose strategies for embedding digital literacy into the education system to better prepare students for the digital economy. Karunanayaka & Weerakoon [12] emphasize that digital education plays a crucial role in enriching students' learning experiences, expanding educational access, and optimizing the use of modern instructional tools. Their research demonstrates that students with strong digital literacy skills are more capable of engaging in digital learning environments and utilizing technology for academic and professional development. Alabdulaziz [13] examines how the use of digital technologies in mathematics education enhances students' digital literacy and interest in learning. The study reveals that students' perceptions of digital tools significantly influence their ability to use technology effectively in mathematics learning. Furthermore, the research identifies key areas for improving mathematics education through targeted integration of digital tools, ensuring that students gain practical skills for problem-solving and analytical reasoning. Rusli *et al.* [14] analyze the relationship between digital literacy and students' motivation in online learning environments, demonstrating that higher levels of digital literacy contribute to academic success in mathematics education. Their findings indicate that students who effectively utilize digital tools experience enhanced engagement and improved learning outcomes, reinforcing the importance of strengthening digital competencies in mathematics teacher training. Building upon these findings, the present study aims to identify effective strategies for integrating digital technologies in mathematics teacher education and demonstrate how digital tools contribute to the professional development of future educators. The research seeks to address key challenges in digital education and explore innovative approaches for enhancing digital pedagogical competencies in mathematics instruction.

III. Materials and Methods

To enhance transparency, the study included a diverse population of mathematics students enrolled in teacher training programs within a digital educational environment. A total of 80 students participated in the research, selected through random sampling to ensure representation across different academic levels. The sample size was determined based on G*Power calculations, ensuring statistical validity and reliability of the findings. The survey targeted students' perceptions, engagement levels, and the effectiveness of digital teaching methodologies. The collected data were analyzed using meta-analysis techniques and statistical hypothesis testing, allowing for a comprehensive evaluation of the impact of digital education on the pedagogical and professional competencies of future mathematics teachers.

The studies were sourced from Scopus, Web of Science, IEEE Xplore, ERIC, and Google Scholar, using keywords such as "digital education," "future mathematics teachers," "digital technologies," and "mathematics." The initial dataset underwent duplicate removal, abstract screening, and full-text review, ensuring relevance and quality.

To improve the methodological clarity of scientific research and the accuracy of the results, the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) declaration was taken into account, and the literature review process was carried out in accordance with this declaration. Only high-quality and relevant studies were selected. The selected scientific works during the analysis were taken from international journals related to the topic of training future mathematics teachers in a digital educational environment.

To assess the body of data from the literature, a meta-analysis method was used, which allowed us to combine the results of various studies on the topic of training future mathematics teachers in a digital educational environment and draw common conclusions. First, we determined the standardized mean difference effect size, which is shown in Eq. (1).

$$Standardized\ difference = \frac{\overline{X_1} - \overline{X_2}}{S} \quad (1)$$

where S is the most important parameter in determining the mean, the common standard deviation. It is obtained by subtracting the standard deviations of the two results, as shown in Eq. (2).

$$S = \sqrt{\frac{(n_1-1){S_1}^2 + (n_2-1){S_2}^2}{n_1+n_2-2}} \quad (2)$$

We enter the necessary data into the Comprehensive Meta-Analysis 4.0 program and obtain the results of the meta-analysis. We used Microsoft Office Excel (Ms-Excel) 2010 to calculate the prediction interval of the data.

At the next stage of the research process, a survey was conducted to determine the views of students regarding the training of future mathematics teachers in a digital educational environment. The survey questions were aimed at determining the effectiveness of the teaching methodology, students' interest in the subject, and the practical importance of teaching through digital technologies. The collected survey data were processed using mathematical and statistical analysis methods. These analysis methods allowed us to systematize the data obtained from the survey and quantitatively assess their significance. As a result of this analysis, conclusions were drawn about the opinions of students regarding teaching in a digital educational environment and the effectiveness of their teaching. The survey questions are shown in Table 1.

Students answered the questions on a scale of 1 to 5.

The G*Power software was used to test the hypothesis

during the study. This tool determines the statistical data necessary to prove or disprove the hypothesis regarding the topic of training future mathematics teachers in a digital educational environment. The program helped to ensure the accuracy and reliability of the research results and allowed to assess the validity of the hypothesis according to the data obtained.

H01: the digital educational environment does not affect the professional preparation and pedagogical abilities of future mathematics teachers.

H02: the digital educational environment contributes to the improvement of the professional training of future mathematics teachers, as well as increases the effectiveness of teaching methods.

Table 1. List of survey questions

№	List of survey questions	Evaluation				
1	Do you think that digital learning environments make it easier to study a mathematics course?	1	2	3	4	5
2	Do you think the use of digital technologies increases interest in teaching mathematics?	1	2	3	4	5
3	Do you think digital education methods can help develop mathematical knowledge in a creative and innovative way?	1	2	3	4	5
4	Do you believe that performing practical work with digital technologies deepens your understanding of mathematics?	1	2	3	4	5
5	Do you think digital education makes it easier to connect math courses with everyday life?	1	2	3	4	5
6	Do you think that using digital technologies will increase your ability to apply your knowledge of mathematics to other fields of science?	1	2	3	4	5
7	Do you believe that digital education methods make it easier to understand complex concepts in mathematics?	1	2	3	4	5
8	Do you think studying a mathematics course in a digital learning environment will be useful in your future professional career?	1	2	3	4	5
9	Do you believe that the use of digital technologies increases the effective use of technological tools and programs in the learning of mathematics?	1	2	3	4	5
10	The use of digital tools (e.g., interactive whiteboards, software) increases student engagement.	1	2	3	4	5
11	Do you think working with digital technologies will increase the creative potential of your students?	1	2	3	4	5
12	Do you believe that the digital educational environment has a positive impact on the development of professional competencies of future mathematics teachers?	1	2	3	4	5

IV. Result

The results of the study's analysis of scientific papers that examined the effectiveness of training future mathematics teachers in a digital educational environment are shown in Table 2.

Table 2. Results of the analysis of the literature using the PRISMA method

Article title	Results obtained	Authors	Name of the publication and date of publication
Evaluation of a 3-D learning game to increase mathematics achievement and motivation in middle school students [15]	Investigating the impact of a 3-D learning game on middle school students' mathematics achievement and motivation, it highlights the important role of digital educational technologies.	Bai, H., Pan, W., Hirumi, A., & Kebritchi, M.	British Journal of Educational Technology (2012)
The different effects of learning games on math skills [16]	The results of the study prove that educational games are an effective tool for improving students' math skills.	Chang, M., Evans, M. A., Kim, S., Norton, A., & Samur, Y.	Educational Media International (2015)
Effects of a tablet game on addition and subtraction skills in first graders [17]	The study results prove that the group using the tablet games showed significant improvements in addition and subtraction skills.	Frauke, V., Segers, E., Takashima, A., & Verhoeven, L.	Computers in Human Behavior (2017)
Learn with educational games: A study of factors influencing learning performance [18]	The results of the study show that educational games play an important role in increasing students' learning performance.	Giannakos, M. N.	Computers & Education (2013)
The impact of digital game-based learning on students' self-confidence, motivation, anxiety, and achievement in mathematics education [19]	The results of the study show that digital game-based learning methods can help improve students' achievement in mathematics, as well as increase their self-confidence, motivation, and reduce anxiety.	Hung, C. M., Huang, I., & Hwang, G. J.	Journal of Computers in Education (2014)
Mathematical problem solving and learning in epistemic play on the theme of architecture [20]	The results of the study show that epistemic games on the topic of architecture significantly improve students' mathematical problem-solving skills.	Ke, F.	Educational Technology Research and Develop ment (2019)
The impact of modern mathematical computer games on mathematics achievement and classroom motivation [21]	Research results confirm that computer games significantly improve students' mathematical achievement and motivation in the classroom.	Kebritchi, M., Hirumi, A., & Bai, H.	Computers & Education (2010)
The impact of game-based learning on mathematical performance in a virtual	Research results show that game-based learning significantly improves math performance.	Kim, H., & Ke, F.	Interactive Learning Environments (2017)

environment supported by the OpenSim platform [22]			
Gamebased remedial instruction in mastery learning for upper-primary school students [23]	According to the results of the study, the game-based learning method had a positive impact on students' learning outcomes. In addition, games increased students' interest and ensured their active participation in the learning process.	Lin, C. H., Liu, E. Z., Chen, Y., Liou, P., Chang, M., Wu, C., & Yuan, S.	Educational Technology & Society (2013)
A computerbased game that promotes mathematics learning more than a conventional approach [24]	The results of the study showed that computer game-based learning is more effective than traditional teaching methods. Game-based learning increased students' interest and improved their ability to solve mathematical problems.	McLaren, B. M., Adams, D. M., Mayer, R. E., & Forlizzi, J.	International Journal of Game-Based Learning (IJGBL) (2017)
The effect of using computer games in teaching mathematics on the development of number sense in fourth grade students [25]	Research results show that using computer games significantly improves students' numerical sense.	Nejem, K. M., & Muhanna, W.	Educational Research and Reviews (2013)
Supporting primary students' learning of fraction conceptual knowledge through digital games. [26]	Learning with digital games resulted in higher student engagement and interest than with traditional methods.	Zhang, L., Shang, J., Pelton, T., & Pelton, L. F.	Journal of Computer Assisted Learning (2020)
The effects of educational computer games on students' attitudes towards mathematics course and educational computer games [27]	Computer games increased students' positive attitude towards mathematics. Students' motivation increased, their interest in lessons increased, and their activity increased.	Çankaya, S., & Karamete, A.	Procedia - Social and Behavioral Sciences (2009)

As a result of the analysis of scientific works, the collection of data on the training of future mathematics teachers in a digital educational environment made it possible to conduct a meta-analysis.

A. Results of a Meta-Analysis of Selected Scientific Literature

Meta-analysis is a research method designed to systematically combine and synthesize the results of multiple quantitative studies in a research area [28].

Data from the scientific literature were summarized in tabular form (Table 3).

We can draw conclusions by entering the obtained results into the Comprehensive Meta-Analysis 4.0 software. First of all, the conclusion was determined using a funnel plot on the topic of training future mathematics teachers in a digital educational environment. Funnel plots are a necessary parameter for investigating possible publication bias in meta-analyses. The funnel plot obtained based on our scientific literature data is shown in Fig. 1.

Table 3. Data from scientific literature

№	Study name	Std diff means	Standard error
1	Bai *et al*. (2012)	0.74	0.1
2	Chang *et al*. (2015)	0.057	0.29
3	Chang *et al*. (2015)	0.486	0.185
4	Chang *et al*. (2015)	0.236	0.239
5	Frauke *et al*. (2017)	0.65	0.202
6	Giannakos (2013)	0.234	0.314
7	Hung *et al*. (2014)	0.704	0.304
8	Ke (2019)	0.988	0.287
9	Kebritchi *et al*. (2010)	0.85	0.154
10	Kim and Ke (2017	1.161	0.188
11	Lin *et al*. (2013)	0.455	0.257
12	McLaren *et al*. (2017)	0.842	0.169
13	Nejem & Muhanna (2013)	0.703	0.229
14	Zhang *et al*. (2020)	0.451	0.251
15	Çankaya *et al*. (2009)	0.135	0.067

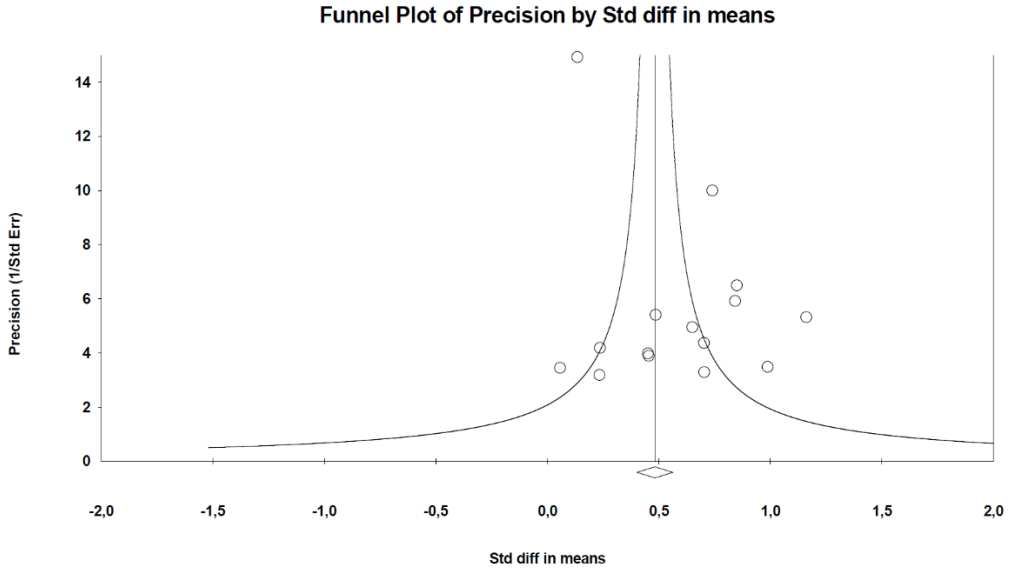

Fig. 1. The result of possible deviations from the publication.

We can obtain the results of a meta-analysis of the results of scientific works using the Forest plot tool. Forest plots are an important graphical method in meta-analyses used to display the results of individual studies and pooled analyses on the topic of training future mathematics teachers in a digital educational environment. In addition to testing

hypotheses, the results of the Forest plot allow us to obtain other important results (Fig. 2). These results allow us to get one step closer to the goal of our study.

Model	Study name	Statistics for each study							Std diff in means and 95% CI
		Std diff in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	-1,00 -0,50 0,00 0,50 1,00
	Bai et al.	0,740	0,100	0,010	0,544	0,936	7,400	0,000	
	Chang et al.	0,057	0,290	0,084	-0,511	0,625	0,197	0,844	
	Chang et al.	0,486	0,185	0,034	0,123	0,849	2,627	0,009	
	Chang et al.	0,236	0,239	0,057	-0,232	0,704	0,987	0,323	
	Frauke et	0,650	0,202	0,041	0,254	1,046	3,218	0,001	
	Giannakos	0,234	0,314	0,099	-0,381	0,849	0,745	0,456	
	Hung et al.	0,704	0,304	0,092	0,108	1,300	2,316	0,021	
	Ke (2019)	0,988	0,287	0,082	0,425	1,551	3,443	0,001	
	Kebritchi et	0,850	0,154	0,024	0,548	1,152	5,519	0,000	
	Kim and Ke	1,161	0,188	0,035	0,793	1,529	6,176	0,000	
	Lin et al.	0,455	0,257	0,066	-0,049	0,959	1,770	0,077	
	McLaren et	0,842	0,169	0,029	0,511	1,173	4,982	0,000	
	Nejem &	0,703	0,229	0,052	0,254	1,152	3,070	0,002	
	Zhang et al.	0,451	0,251	0,063	-0,041	0,943	1,797	0,072	
	Cankaya	0,135	0,067	0,004	0,004	0,266	2,015	0,044	
Random		0,588	0,101	0,010	0,390	0,787	5,809	0,000	
Pred Int		0,588			-0,153	1,330			

Fig. 2. Graphical representation of meta-analysis results from data.

1) Overview

The analysis is based on 15 studies. The effect size index is the standardized mean difference (d).

2) Statistical model

A random-effects model was used for the analysis. The studies included in the analysis are treated as a random sample from the broader population of potential studies, and this analysis is intended to generalize to that population.

3) Average effect size

The average effect size is 0.588, with a 95% confidence interval ranging from 0.390 to 0.787. Within the broader population of comparable studies, the average effect size could take any value within this interval.

4) Z-value

The Z-value tests the null hypothesis that the average effect size is zero. The Z-value is 5.809, with $p < 0.001$. Using an alpha threshold of 0.050, we reject the null hypothesis and conclude that the average effect size in populations similar to those analyzed is significantly different from zero.

5) Q-test for heterogeneity

The Q-statistic tests the null hypothesis that all studies share the same effect size. If all studies shared the same true effect size, the expected value of Q would equal the degrees of freedom (number of studies minus 1). The Q-value is 65.894 with 14 degrees of freedom, $p < 0.001$. Using an alpha threshold of 0.100, we reject the null hypothesis, indicating that the true effect sizes in these studies are not all the same.

6) I-squared statistic

The I-squared statistic is 79%, indicating that 79% of the observed variation in effect sizes is due to true variation in effect sizes rather than sampling error.

7) Tau-squared and tau

Tau-squared, the variance of true effect sizes, is 0.108 in units of dd. Tau, the standard deviation of true effect sizes, is 0.328 in units of dd.

Based on the results provided by the Comprehensive Meta-Analysis 4.0 software, we can conclude the following: The meta-analysis results demonstrate the high effectiveness of preparing future mathematics teachers in a digital learning environment. This approach contributes to the development of research, creativity, and problem-solving skills by integrating students' theoretical knowledge with practical skills. Therefore, it is recommended to widely implement and utilize digital education programs.

B. The Impact of Training Future Mathematics Teachers in a Digital Educational Environment

A t-test was used for a single-sample survey to assess the effectiveness of digital technologies for learners. The survey results are shown in Table 4.

Table 4. Data results

Category	n	M	SD	SEM	df	t	p
	80	4.235	1.2	0.134	79	9,2051	0.0001

**M-arithmetic mean; SD-standard deviation; SEM-standard error; df-degrees of freedom; Mean difference is significant at p ≤ 0.05;*

The statistical significance of the survey results according to the opinions of the students was determined: $t(79)=9.2051$. $p < 0.05$, which indicates that there are sufficient grounds to reject the null hypothesis. In order to reliably reject the null hypothesis, a test was performed using the G*Power software.

When using the G*Power program, a t test was selected for a single survey (one sample case) and the A priori: Compute required sample size – given $\propto$, power, and effect size method was used. Using the survey results data, an effect size was calculated, resulting in an effect size of 1. By entering the effect size into the program, the critical value of the t test was determined. The graph is presented in Fig. 3.

To test the hypotheses, we compare the results of the critical value and the statistical value. The critical value of t is 1.68023. The result of the survey is t statistical value is 9.2051. This means that $t_{cr}(1{,}68023) < t_s(9{,}2051)$. We can show that there is sufficient evidence to accept the null hypothesis.

In addition, the G*Power program shows a graph of the power and impact (at three levels) of the results of training future mathematics teachers in a digital educational environment. The graph is presented in Fig. 4.

Using G*Power software, it is possible to reliably determine the significant impact of digital technologies in training future mathematics teachers in a digital educational environment.

Digital educational resources and tools allow future teachers to combine theoretical knowledge with practical experience, which improves their skills in teaching mathematics.

Digital platforms and tools make the learning process interactive, increase students' interest in the subject, and encourage active participation.

The use of digital technologies will develop future teachers' research skills and strengthen their ability to solve problems creatively.

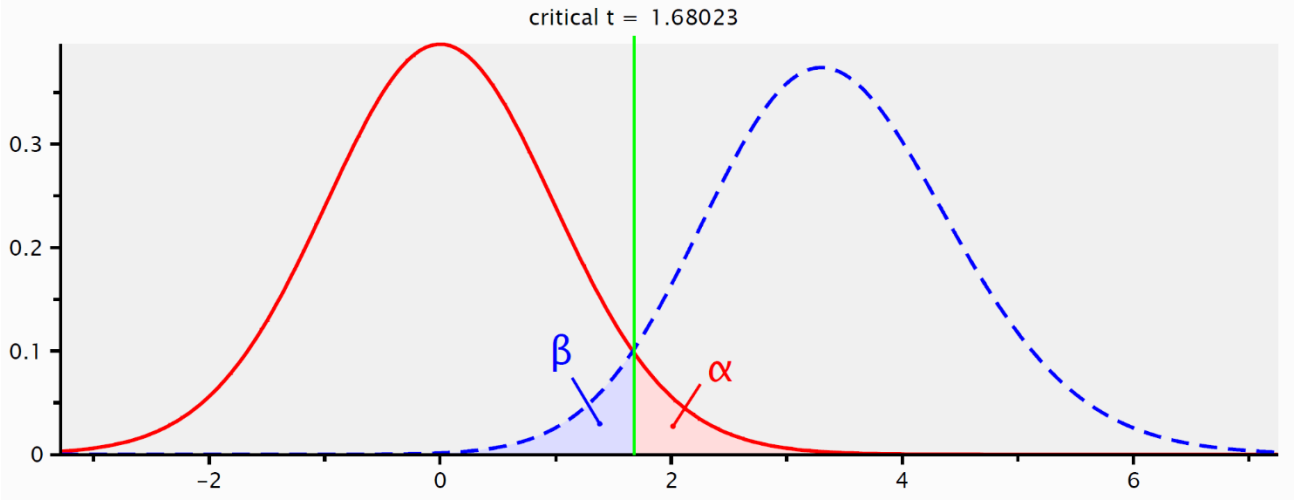

Fig. 3. Conclusion of hypotheses using the G*Power program.

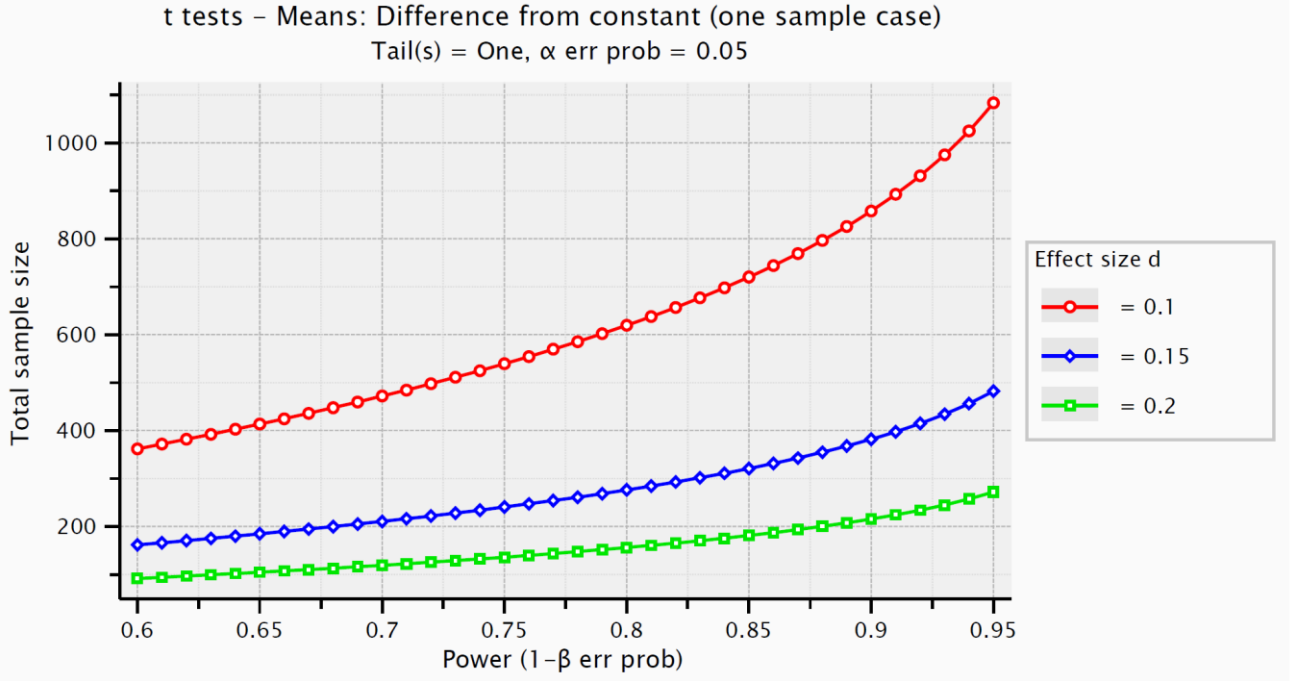

Fig. 4. Graph of the relationship between post-study power level and effect size.

The digital educational environment allows future teachers to master modern pedagogical methods and technologies, and effectively use courses and resources aimed at professional development.

Collecting and analyzing learning outcomes through digital technologies allows future teachers to obtain the information they need to improve their learning process.

In conclusion, we have made sure that the training of future mathematics teachers in a digital educational environment is highly effective. The integration of digital technologies allows for a new organization of the educational process, combining theoretical knowledge with practical skills of students, as well as developing their research, creativity and problem-solving skills. In this regard, the widespread introduction and use of digital educational programs is important, as this will increase the professional competence of future teachers and improve the quality of education.

V. Discussion

The training of future mathematics teachers in the digital learning environment is one of the important directions in the modern education system. This study demonstrated that the use of digital technologies contributes to the enhancement of future teachers' pedagogical skills, improves the

effectiveness of their teaching methods, and enhances the overall educational process. By comparing the obtained results with previous studies, new scientific conclusions were made. The results of the study proved that the use of digital technologies in teaching mathematics improves students' mastery of the subject and increases their interest in the learning process. This conclusion aligns with the findings in the research by Yusri Wahyuni, Jamaris, & Solfema. In their work, they highlighted the importance of digital tools in developing students' mathematical skills [29]. Additionally, the research by Engelbrecht & Borba showed that the use of digital technologies positively affects academic achievements [30]. Our study supports these conclusions, demonstrating that digital teaching methods are effective in preparing future teachers. Research by Putrawangsa & Hasanah identified that the use of digital technologies increases students' learning motivation and enhances their interest in the subject [31]. The results of our study align with this finding, as students actively engage in learning and are motivated to learn independently when working with digital tools. Furthermore, Gqoli's research explored the importance of digital technologies in higher education systems in rural areas. This study showed how the use of digital platforms affects the development of students' mathematical thinking [32]. Our research also proves that the use of digital tools allows future teachers to improve their professional competencies. The results of the study showed that the use of digital technologies contributes to improving the quality of teacher preparation. Digital tools help organize the learning process effectively, develop students' self-learning skills, and form their professional competencies. In this regard, deeper integration of digital technologies into the education system is an essential factor in enhancing future teachers' professional skills.

VI. Conclusion

The effectiveness of digital technologies in the training of future mathematics teachers will contribute to their understanding of interdisciplinary connections, increase their scientific literacy, and develop creative and research skills. In addition, the implementation of digital educational programs will improve the pedagogical competence of teachers and increase the quality of education.

However, to effectively organize teaching in a digital educational environment, it is important for teachers to improve their digital skills and master innovative methods and tools. In this regard, one of the main tasks is to integrate digital technologies into pedagogical training programs, train teachers in the use of digital learning resources, and introduce them to modern educational methods.

Thus, training future mathematics teachers in a digital educational environment will increase the efficiency of the educational process, arouse students' interest in mathematics, and improve their learning outcomes. Continuing work in this direction, updating pedagogical practices, and the widespread use of digital technologies will undoubtedly contribute to the progressive development of the education system.

Future research should focus on improving the methods of using digital platforms and evaluating their impact on the teaching process. In particular, the application of adaptive learning systems, AI-based teaching tools, and virtual laboratories should be studied to determine how they contribute to future teachers' mastery of interactive teaching methods and the development of research skills. Additionally, it is essential to explore the possibilities of adapting digital education programs and pedagogical methodologies to various educational levels and subject areas. Implementing these recommendations will enhance the professional training of future mathematics teachers, strengthen their pedagogical competencies, and ensure the adaptation of the education system to modern requirements. In conclusion, the widespread integration of digital technologies into teacher training systems will facilitate future educators' adaptation to innovative teaching processes and contribute to the overall improvement of education quality.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Y. Tuyakov served as the corresponding author, ensuring communication with the journal. He provided information on the questionnaire development and wrote the "Introduction" and "Discussion" sections. A. Duisebayeva and A. Abylkassymova prepared the literature review and developed the structure of the article. B. Kossanov and A. Ardabayeva were responsible for the research design and data analysis. All authors approved the final version of the article.

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