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The impact of contemporary approaches in teaching statistics and probability on primary school students

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ABSTRACT

This paper examines the impact of contemporary approaches in teaching statistics and probability to primary school students in North Macedonia. Contemporary approaches include the use of technology and interactive methods to enhance student engagement and improve understanding of abstract mathematical concepts. The study involved 50 eighth-grade students (n = 50), who were divided into an experimental group (n = 25) and a control group (n = 25). A pretest–posttest experimental design was used to measure students' knowledge before and after the teaching intervention. The experimental group was taught through technology-based and interactive methods, while the control group followed traditional teaching approaches. Data were analyzed using independent samples t-tests with a significance level of α = 0.05. The findings showed no statistically significant difference between the groups in the pre-test (p = 0.292). However, a statistically significant difference was identified in the post-test (p = 0.00012), in favor of the experimental group. These results indicate that the use of contemporary teaching approaches can be an important tool for improving the quality of mathematics education at the primary level.

Keywords: contemporary approaches, teaching statistics, probability, primary school, technology, teaching effectiveness

INTRODUCTION

The teaching of statistics and probability plays a fundamental role in primary education, offering the foundation for understanding and analyzing data, as well as assessing risks in everyday life. In the education system of North Macedonia, there is a clear need for an enhanced approach to teaching these subjects, especially given the importance of mathematical skills in today's society.

This study focuses on the impact of modern teaching methods on the acquisition of statistical and probability knowledge among primary school students. The integration of technology and interactive techniques has become a significant practice in modern education, aiming to increase student engagement and participation. This approach incorporates the use of digital tools and contemporary methodologies to foster a more engaging and effective learning environment.

Through the use of technology and innovative pedagogical strategies, this study seeks to evaluate how effective modern approaches are in improving students' understanding of statistics and probability. Internet resources as well as other illustrative and demonstration methods make them as attractive as possible (Kamberi et al., 2025).

A comparison with traditional methods will determine whether these new practices enhance students' analytical and creative skills, preparing them for future challenges. The illustrations have a greater impact compared with using software for solving exercises by students than solving exercises on the whiteboard, since students of lower classes hardly find themselves when working with software, compared to higher classes (Kamberi et al., 2020).

Purpose and Objectives

The main goal of this study is to analyze the impact of contemporary teaching methods on the learning of statistics and probability among primary school students in North Macedonia.

Specific objectives include:

- Evaluating the effectiveness of modern approaches in improving students' understanding of statistics and probability.
- Comparing the performance of students taught using contemporary methods with those taught through traditional approaches.

- Analyzing the impact of technology on students' engagement and involvement in the learning process.

This study is important for understanding how modern teaching approaches can positively influence the acquisition of mathematical knowledge and contribute to improving the quality of primary education. Collaborative mentoring has helped us even more in our planning regarding our teaching. By seeing different examples of the lesson, we, as teachers, have made a difference between classes with illustrations and those without (Aliu et al., 2025b; Kamberi et al., 2025).

LITERATURE REVIEW

Probability and Statistics in Primary Education: Fundamental Concepts, Formulas, and Applications in North Macedonia

Probability and statistics are two crucial fields of mathematics that help analyze and interpret data using various methods. Probability deals with the study of possibilities and predictions of events, while statistics focuses on collecting, processing, and analyzing data to derive reliable conclusions.

Probability provides a mathematical way to describe the likelihood of an event occurring by using numerical values to represent this chance. Its applications are seen in fields like natural sciences, economics, actuarial science, and even in daily life, where decisions often rely on probabilistic assessments. It also assists in calculating and managing risks, enabling individuals to make more informed decisions (Saunders, 2005).

In primary education, probability represents one of the fundamental areas of mathematics. Students learn its basic concepts through games and practical tasks. A practical example of integrating probability into the curriculum is the analysis of random games, such as coin flips or lotteries. This includes calculating the probability of a specific event and determining its likelihood (Božić, 2023).

Statistics, on the other hand, involves analyzing and interpreting data to make reliable predictions. It uses various mathematical techniques to analyze data collected from different sources. Students learn to process data through tables and graphs to analyze trends and interpret results. The application of statistics is essential in many modern fields, including economic, scientific, and social analysis (Bektashi et al., 2022; Brown & Kass, 2009).

In North Macedonia, probability and statistics are integrated into the primary school curriculum as part of mathematics programs, emphasizing the importance of these concepts from an early age. Students learn to use various methods for calculating probabilities and analyzing data through simple examples that help them grasp fundamental ideas (Burrill & Biehler, 2011).

Basic probability formulas

Students begin by learning basic probability calculations, including absolute and relative probability.

Absolute probability

This formula calculates the likelihood of an event occurring out of the total possible events. The formula is:

$$P(A) = n(A)/n(S) \tag{1}$$

where: $P(A)$ is the probability of event A; $n(A)$ is the number of favorable outcomes for event A; $n(S)$ is the total number of possible outcomes.

$$P(A) = \frac{n(A)}{n(S)} \tag{2}$$

Students are introduced to this concept through practical examples, such as calculating the probability of rolling a specific number on a die (Garfield & Ben-Zvi, 2007; Saunders, 2005).

Relative probability

This concept helps students compare the likelihood of different events by using their relative values. The formula is:

$$P(A) = favorablecases\ for\ A/total\ cases \tag{3}$$

$$\mathrm{P(A)} = \frac{favorable\ cases\ for\ A}{total\ cases} \tag{4}$$

Common examples of relative probability include calculating the chances of drawing a specific card from a deck (Brown & Kass, 2009).

Fundamental statistical concepts in primary education

In primary education, students learn basic statistical concepts such as the mean and median, which are simple tools for summarizing data and extracting useful information.

Mean

The mean represents the central value of the data set and is calculated as:

$$Mean = \frac{Sum\ of\ all\ values}{Number\ of\ values} \tag{5}$$

Median

The median identifies the middle value in a sorted data set.

- For an odd number of values, the median is the value at position $\frac{(n+1)}{2}$.
- For an even number of values, the median is the average of the two middle values at positions $\frac{n}{2}$ and $(\frac{n}{2}) + 1$.

Example

A group of students received the following scores in a test: 80, 65, 75, 90, 70, 85, 60

Calculating the mean

$$Mean = \frac{80 + 65 + 75 + 90 + 70 + 85 + 60}{7} = 75 \tag{6}$$

Calculating the median

After sorting the scores: 60, 65, 70, 75, 80, 85, 90, the median is the value at position:

$$\frac{7+1}{2} = \frac{4(7+1)}{2} = \frac{4(7+1)}{2} = 4 \tag{7}$$

which is 75.

Both the mean and median for this group are 75, indicating that the students' scores are concentrated around this value.

Challenges in teaching probability and statistics to primary school students: A study on traditional approaches

One of the main challenges for primary school students in learning probability and statistics is understanding abstract concepts and applying them in real-life situations. Many students struggle to connect theoretical probability with practical applications, particularly when traditional teaching approaches focus more on memorizing formulas and solving mathematical tasks without involving real-life examples (Garfield & Ben-Zvi, 2007).

Another issue identified in previous research is the limited use of technology in teaching these subjects. Studies suggest that using technological tools such as interactive programs and probability calculators can significantly improve students' understanding and deepen their engagement in the learning process (Kirova & Ulanska, 2009).

A practical example of an innovative approach to teaching probability is the use of simulations. Instead of learning probability abstractly, students can use software to simulate different scenarios and calculate the probabilities of certain events based on the simulations (Garfield & Ben-Zvi, 2007). Through its user-friendly interface, GeoGebra facilitates a hands-on approach to learning, offering students a practical and engaging environment to rectify misconceptions and deepen their understanding of mathematical principles (Tuda & Rexhepi, 2024).

Previous Research on Teaching Statistics and Probability in Primary Schools in North Macedonia

Research on the field of probability and statistics for primary schools in North Macedonia shows that current programs have incorporated several traditional methods aimed at teaching fundamental concepts. However, there is a pronounced need for improvements in teaching approaches. Due to the complex nature of statistics and probability, it is crucial that students engage with more interactive and practical methods that can develop their problem-solving skills (Burrill & Biehler, 2011; Callingham et al., 2016).

According to a study conducted by Kirova and Ulanska (2009), many teachers in North Macedonia still rely on traditional teaching methods for probability and statistics, focusing mainly on theoretical rather than practical aspects. For example, teachers often emphasize definitions and formulas, neglecting the importance of practical applications of these concepts in everyday life. This approach limits students' ability to develop a deep and lasting understanding of statistics and probability, as they miss opportunities to apply the knowledge they acquire in real-world scenarios (Kirova & Ulanska, 2009).

Moreover, the study highlights that teachers are often reluctant to use technology and interactive resources in teaching, such as simulations and specialized software. This barrier is linked to the lack of adequate teacher training and the shortage of technological resources in many schools (Kirova & Ulanska, 2009). However, for its successful implementation, adequate teacher training and equitable access to technological resources must be ensured (Aliu et al., 2025a).

Comparing this approach to teaching methods in other countries reveals that incorporating technology and more interactive strategies—such as simulations and real-world data analyses—improves students' performance and deepens their understanding. According to Garfield and Ben-Zvi (2007), simulations help students grasp abstract concepts of probability and statistics by making them more tangible and easier to understand through repeated experiments and visual result analyses (Garfield & Ben-Zvi, 2007).

To improve the teaching of statistics and probability in North Macedonia, it is essential for teachers to have access to ongoing training in the use of new technologies and modern teaching methods. Additionally, more technological resources must be provided in schools to enable the use of modern tools in education (Garfield & Ben-Zvi, 2007; Kirova & Ulanska, 2009).

In conclusion, significant changes are required to improve the teaching of statistics and probability in North Macedonia. Currently, traditional teaching methods that focus mainly on definitions and theoretical formulas do not adequately prepare students to apply statistical and probability concepts in real-life situations. This limits the development of their analytical and critical thinking skills. Therefore, it is crucial for teachers to receive new training that includes modern technologies and more interactive teaching approaches, such as the use of simulations, data analysis software, and hands-on experiments (as in the paper of Aliu et al., 2023).

In an era where technology plays an increasingly important role in education, the teaching of statistics and probability must evolve to take advantage of the benefits that technology offers. Integrating technological tools, such as simulations and data analysis software, can provide students with opportunities to practice and better understand concepts through guided and repeated experiments. According to Garfield and Ben-Zvi (2007), simulations allow students to overcome difficulties in understanding abstract concepts by making them more accessible and concrete through visual displays and data analyses (Garfield & Ben-Zvi, 2007).

Furthermore, investing in technological resources in schools is a key step toward facilitating this change. Schools in North Macedonia need continuous support to ensure that both students and teachers have access to modern educational tools. These efforts should include not only improvements in schools' technological infrastructure but also professional development for teachers. Regular training will equip teachers with the necessary skills and knowledge to use the latest technologies and methodologies to enhance student engagement and understanding of statistics and probability.

Only by following these steps can North Macedonia's education system create a learning environment where students not only learn theoretical concepts but also develop practical skills valuable for their academic and professional futures. In this way, students will be better prepared to face the challenges of a workforce that increasingly demands statistical and analytical skills.

In a deeper analysis of the literature, it becomes clear that one of the key factors influencing the quality of statistics and probability teaching is the lack of teacher preparedness. Several studies show that many teachers, particularly at the secondary level, do not feel adequately prepared to teach these complex subjects. According to research by Kirova and Ulanska (2009), many teachers still lack access to the proper training and pedagogical resources needed to improve their teaching approach (Kirova & Ulanska, 2009).

Another important aspect is the way statistics and probability content is presented in school curricula. Bransford et al. (2000) suggest that for effective learning, students need to engage with material that is relevant and connected to their everyday experiences. Unfortunately, the teaching of statistics and probability often focuses too much on abstract mathematics, moving away from practical applications and experiences that students can find meaningful (Bransford et al., 2000).

Hiebert and Grouws (2007) emphasize the importance of fundamental changes in teaching practices to improve learning outcomes. They argue that effective teaching of mathematics and statistics requires engaging students in active thinking and problem-solving, which promotes deep discussions and reflections. Instead of simply memorizing formulas and definitions, students should be encouraged to explore the meaning and practical use of statistical concepts in real-life situations (Hiebert & Grouws, 2007).

Another valuable contribution to improving teaching in this field is providing technology-based instructional materials that allow students to conduct experiments and analyze real data. Cobb and McClain (2004) point out that statistics education should focus on developing skills for interpreting and analyzing data, relying on the use of modern technological tools. This shift in approach can help students develop critical data analysis skills, which are increasingly important in today's job market (Cobb & McClain, 2004).

In general, transforming the teaching of statistics and probability in North Macedonia requires a comprehensive strategy that includes teacher training, technological infrastructure improvements, and a curriculum shift toward more practical applications of these concepts.

To further deepen the discussion on the challenges and improvements in teaching statistics and probability in North Macedonia, it is important to mention the study by Kattmann and Duit (2004), which suggests that for successful teaching, teachers must have a clear understanding of the core concepts they are trying to convey. This study shows that teachers who are not confident in their grasp of fundamental concepts are more likely to pass on misconceptions to their students (Kattmann & Duit, 2004).

Moreover, Fischer and Mandl (2001) argue that modern teaching should move away from a traditional information-transmission model toward a more interactive approach, where students engage in problem-solving and learning through direct experiences. This approach is particularly important for subjects like statistics and probability, as these concepts are highly abstract and require active involvement to be fully understood (Fischer & Mandl, 2001).

An additional key element in effective teaching is collaboration among teachers and involvement of the school community. According to a study by Jaworski and Wood (1999), collaboration between teachers to share experiences and learn from each other plays a vital role in improving teaching practices. They emphasize that this form of professional development through collaboration can significantly enhance teachers' preparedness and effectiveness (Jaworski & Wood, 1999).

Jonassen (2003) highlights that integrating technology into teaching is another crucial step in improving the quality of statistics and probability education. The use of simulations and data analysis programs helps students experience the practical benefits of statistics directly, making the learning process more engaging and valuable for their future (Jonassen, 2003).

Students often struggle to relate statistics and probability to their daily experiences. Boaler and Humphreys (2005) suggest that teaching approaches should focus more on real-world problems with direct relevance to students' lives. They argue that statistics and probability should not be treated as purely abstract mathematical exercises but as tools for understanding the world around us (Boaler & Humphreys, 2005).

In conclusion, achieving a meaningful transformation in the teaching of statistics and probability in North Macedonia requires concrete steps that include better teacher preparation, technology integration, and a focus on practical applications of these concepts in students' everyday lives. These changes will require not only investments in resources but also sustained commitment from all stakeholders involved in the education process (Boaler & Humphreys, 2005; Fischer & Mandl, 2001; Jaworski & Wood, 1999; Jonassen, 2003; Kattmann & Duit, 2004).

METHODOLOGY

This section explains the methodological process followed during the experiment to assess the impact of different teaching methods on students' knowledge in the field of statistics and probability. The experiment consisted of a study divided into two phases: Pre-intervention and post-intervention testing, based on an approach known as the "Pretest-Posttest Experimental Design."

Sample Selection

Fifty 8th-grade students from the "26 Korriku" school were randomly selected for the study and divided into two equal groups, A and B, with 25 students in each. The selection was made because the researcher worked at this school, ensuring effective management of the research and deeper insight into classroom dynamics. The 8th grade was chosen because students at this level begin tackling complex problems in probability and statistics, including two specific chapters directly related to this field.

Pre-Intervention Testing

To measure students' initial knowledge, two pre-tests were conducted, one for each group. These tests focused on evaluating the students' understanding of statistics and probability prior to the teaching intervention. The pre-test questions included different scenarios involving probability, as well as tasks requiring students to find the median, mean, and apply probabilistic formulas to real-life situations.

Implementation of Teaching Methods

Following the initial tests, each group of students was exposed to a different teaching approach. Group A was taught using traditional methods, while Group B was introduced to a modern approach involving technological applications, interactive games, and online quizzes. The contemporary approach aimed to provide students with a more dynamic learning experience, using technology to simulate real-life scenarios and make the learning process more engaging.

Post-Intervention Testing

After completing the implementation of the teaching methods, students took a post-test designed to measure the effect of the new teaching methods on their knowledge and skills. The post-test included questions similar to those in the pre-test, with a focus on applying the knowledge gained during the intervention.

Data Classification

The data collected from the pre- and post-tests were analyzed to assess the impact of the teaching methods on the student groups. A comparison of the results between the group exposed to the modern approach and the one subjected to traditional teaching showed that students in Group B made greater progress in their skills and knowledge of probability and statistics due to the more interactive and technology-enhanced approach.

Evaluation of Teaching Method Effectiveness

After analyzing the test results, it was concluded that the modern approach, which incorporated the use of technology and interactive methods, had a significantly greater impact on improving students' knowledge than the traditional approach. This was evident from the higher progress achieved by Group B compared to Group A, indicating that integrating technology into teaching can enhance students' motivation and involvement in the learning process.

Data Analysis

In this section, the results of the tests that were conducted are presented and discussed to evaluate the impact of teaching methods on students' knowledge and skills in statistics and probability. Two primary software programs were used to analyze the collected data during the experiment:

1. Microsoft Excel: This program processed initial data and generated graphs and tables to visualize the differences between the groups. Excel is a widely used tool for basic statistical analysis and data visualization.
2. SPSS (Statistical Package for the Social Sciences): SPSS was employed for advanced data analysis, including analysis of variance (ANOVA) and t-tests for comparing group means. This software facilitated the identification of statistically significant differences between the experimental and control groups.

Table 1. Task evaluation criteria

Score	Criteria
0	Unresolved
1	Partially correct
2	Fully correct solution

Table 2. Summary of results for pre-test and post-test in the control group

Control group	Pre-test			Post-test		
	Complete solution	Partial solution	Incorrect solution	Complete solution	Partial solution	Incorrect solution
Problem 1	14	3	8	20	3	2
Problem 2	5	13	7	9	11	5
Problem 3	15	5	5	22	0	3
Problem 4	9	11	5	16	8	1
Problem 5	12	6	7	14	4	7
Problem 6	10	1	14	8	4	13
Problem 7	4	6	15	17	0	8
Problem 8	5	3	17	3	4	18
Problem 9	1	3	21	4	3	18
Problem 10	3	5	17	5	7	13

The students were assessed based on their performance in test tasks following the above criteria. **Table 1** outlines the scoring scale used to measure the accuracy and completeness of the students' solutions.

Frequency Results of Task Performance in the Control Group

Analysis and interpretation of task results

Pre-test results

These results reflect the students' performance before the intervention. In **Table 2** the columns for the pre-test indicate the number of students who provided complete solutions (2 points), partially correct solutions (1 point), and incorrect solutions (0 points) for each task.

Post-test results

The post-intervention results in **Table 2** show improvements or changes in the students' task performance. These include the number of students with complete, partially correct, or incorrect solutions.

Analysis and Interpretation of Task Results

The study results can be seen in **Table 3**.

Task 1

- Pre-Test: 14 students with complete solutions, 3 with partial, and 8 with incorrect answers.
- Post-Test: 20 students with complete solutions, 3 with partial, and 2 with incorrect answers.
- Interpretation: Significant improvement after the intervention. The number of students with complete solutions increased from 14 to 20, while those with incorrect answers decreased from 8 to 2.

Task 2

- Pre-Test: 5 students with complete solutions, 13 with partial, and 7 with incorrect answers.
- Post-Test: 9 students with complete solutions, 11 with partial, and 5 with incorrect answers.
- Interpretation: Some improvement is observed, with more students providing complete solutions, though a significant number still gave partial or incorrect responses.

Task 3

- Pre-Test: 15 students with complete solutions, 5 with partial, and 5 with incorrect answers.
- Post-Test: 22 students with complete solutions, 0 with partial, and 3 with incorrect answers.
- Interpretation: Marked improvement, with almost all students except 3 achieving complete solutions in the post-test.

Task 4

- Pre-Test: 9 students with complete solutions, 11 with partial, and 5 with incorrect answers.
- Post-Test: 16 students with complete solutions, 8 with partial, and 1 with incorrect answer.
- Interpretation: Clear improvement, with more students providing complete solutions and fewer giving incorrect answers.

Task 5

- Pre-Test: 12 students with complete solutions, 6 with partial, and 7 with incorrect answers.

Table 3. Frequency results of task performance in the experimental class

Experimental group	Pre-test			Post-test		
	Complete solution	Partial solution	Incorrect solution	Complete solution	Partial solution	Incorrect solution
Problem 1	17	3	5	25	0	0
Problem 2	5	13	7	8	12	5
Problem 3	17	3	5	25	0	0
Problem 4	9	14	2	17	8	0
Problem 5	8	12	5	19	6	0
Problem 6	11	6	8	14	8	3
Problem 7	3	5	17	15	8	2
Problem 8	5	4	16	12	6	7
Problem 9	2	5	18	10	11	4
Problem 10	5	5	15	12	5	8

- Post-Test: 14 students with complete solutions, 4 with partial, and 7 with incorrect answers.
- Interpretation: Although there is a slight improvement in the number of complete solutions, 7 students continued to struggle with the task.

Task 6

- Pre-Test: 10 students with complete solutions, 1 with partial, and 14 with incorrect answers.
- Post-Test: 8 students with complete solutions, 4 with partial, and 13 with incorrect answers.
- Interpretation: There is no improvement in this task, as the number of complete solutions decreased, indicating the task's difficulty for the students.

Task 7

- Pre-Test: 4 students with complete solutions, 6 with partial, and 15 with incorrect answers.
- Post-Test: 17 students with complete solutions, 0 with partial, and 8 with incorrect answers.
- Interpretation: Significant improvement, with 17 students now achieving complete solutions, though 8 still gave incorrect answers.

Task 8

- Pre-Test: 5 students with complete solutions, 3 with partial, and 17 with incorrect answers.
- Post-Test: 3 students with complete solutions, 4 with partial, and 18 with incorrect answers.
- Interpretation: Performance declined, with fewer complete solutions and more incorrect answers, suggesting students found this task particularly challenging.

Task 9

- Pre-Test: 1 student with a complete solution, 3 with partial, and 21 with incorrect answers.
- Post-Test: 4 students with complete solutions, 3 with partial, and 18 with incorrect answers.
- Interpretation: Some improvement is seen, though the majority of students still provided incorrect answers.

Task 10

- Pre-Test: 3 students with complete solutions, 5 with partial, and 17 with incorrect answers.
- Post-Test: 5 students with complete solutions, 7 with partial, and 13 with incorrect answers.
- Interpretation: Although some progress is observed, many students still struggled with this task.

INTERPRETATION OF RESULTS

The data shows significant improvement in students' performance in the experimental class from the pre-test to the post-test. For example:

Task 1

- Pre-Test: 17 students solved the task fully, 3 partially, and 5 incorrectly.
- Post-Test: All 25 students solved the task correctly, with no partial or incorrect answers.
- Interpretation: This indicates a marked improvement in understanding, suggesting that the modern teaching methods were effective.

Task 2

- Pre-Test: 5 students gave correct answers, 13 gave partial answers, and 7 gave incorrect ones.

- Post-Test: 8 students solved the task correctly, 12 partially, and 5 incorrectly.
- Interpretation: While there is some improvement, the increase in partial solutions suggests that some students still need further support to fully grasp the task.

Task 3

- Pre-Test: 17 students gave correct answers, 3 partial, and 5 incorrect.
- Post-Test: All 25 students solved the task fully with no mistakes.
- Interpretation: This shows a complete improvement, indicating the teaching methods significantly helped students master this task.

Task 4

- Pre-Test: 9 students answered correctly, 14 partially, and 2 incorrectly.
- Post-Test: 17 students solved the task correctly, 8 partially, and none incorrectly.
- Interpretation: There is a clear improvement, with a reduction in incorrect answers and an increase in correct solutions.

Task 5

- Pre-Test: 8 students solved the task correctly, 12 partially, and 5 incorrectly.
- Post-Test: 19 students solved the task fully, 6 partially, and none incorrectly.
- Interpretation: This task shows a significant increase in correct answers and suggests that the intervention effectively improved understanding.

Task 6

- Pre-Test: 11 students gave correct answers, 6 partial, and 8 incorrect.
- Post-Test: 14 students solved it correctly, 8 partially, and 3 incorrectly.
- Interpretation: While there are improvements, some students still struggled with this task.

Task 7

- Pre-Test: 3 students gave correct answers, 5 partial, and 17 incorrect.
- Post-Test: 15 students solved the task correctly, 8 partially, and 2 incorrectly.
- Interpretation: There is a significant improvement, with a substantial increase in correct solutions.

Task 8

- Pre-Test: 5 students gave correct answers, 4 partial, and 16 incorrect.
- Post-Test: 12 students solved the task correctly, 6 partially, and 7 incorrectly.
- Interpretation: Although performance improved, some students still found the task challenging.

Task 9

- Pre-Test: 2 students solved the task correctly, 5 partially, and 18 incorrectly.
- Post-Test: 10 students answered correctly, 11 partially, and 4 incorrectly.
- Interpretation: Although there was improvement, this task remained difficult for some students.

Task 10

- Pre-Test: 5 students solved the task correctly, 5 partially, and 15 incorrectly.
- Post-Test: 12 students answered correctly, 5 partially, and 8 incorrectly.
- Interpretation: While performance improved, the task continued to pose challenges for many students.

Based on the data, it is evident that the modern teaching approach positively impacted students' performance in the experimental class. This improvement is reflected in the increase in correct answers in the post-test compared to the pre-test. However, certain tasks remained challenging for some students, especially those involving more complex concepts of probability. Nevertheless, the intervention proved to be effective overall, improving students' ability to understand and solve statistical and probability-related problems.

Test Results for the Control and Experimental Groups

Tables 4 and **5** present the performance results of students from both the control and experimental groups in solving the test tasks before and after the intervention. The summary table highlights the improvements in the performance of the experimental group, especially after implementing teaching methods involving technology and contemporary approaches.

Table 4 shows the averages and standard deviations for students in both the experimental and control groups across the pre-test and post-test. As shown, the experimental group achieved a significantly higher post-test average (15.07) compared to the control group (9.96). The broader distribution of scores (higher standard deviation) in the experimental group suggests that the

Table 4. Performance averages in the pre-test and post-test

Group	Test	Average	Standard deviation
Experimental	Pre-Test	7.0	1.20
	Post-Test	15.07	3.44
Control	Pre-Test	6.48	2.12
	Post-Test	9.96	2.30

Table 5. Summary of performance on individual tasks for the control and experimental groups

Task	Test	Control group average	Experimental group average
Task 1	Pre-Test	1.20	1.48
	Post-Test	1.72	2.00
Task 2	Pre-Test	0.92	0.92
	Post-Test	1.16	1.12
Task 3	Pre-Test	1.40	1.48
	Post-Test	1.76	2.00
Task 4	Pre-Test	1.16	1.28
	Post-Test	1.60	1.68
Task 5	Pre-Test	1.20	1.12
	Post-Test	1.28	1.76
Task 6	Pre-Test	0.84	0.80
	Post-Test	1.28	1.44
Task 7	Pre-Test	0.56	0.44
	Post-Test	1.36	1.52
Task 8	Pre-Test	0.52	0.56
	Post-Test	0.40	1.20
Task 9	Pre-Test	0.20	0.36
	Post-Test	0.44	1.24
Task 10	Pre-Test	0.44	0.60
	Post-Test	0.68	1.16

Table 6. Performance averages in the pre-test and post-test

Test	Levene's test for equality of variances (F)	Sig. (Levene)	t	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% Confidence interval (lower)	95% Confidence interval (upper)
Pre-Test	7.668	0.008	-1.068	48	0.292	-0.52	0.486	-1.50	0.46
Post-Test	0.119	0.731	-6.169	48	0.00012	-5.11	0.828	-6.77	-3.44

students experienced varied outcomes, with most achieving higher results after the introduction of contemporary teaching methods.

Table 5 summarizes the students' average scores for each task, comparing the pre-test and post-test results between the experimental and control groups. As seen, the experimental group shows more significant improvements across all tasks, especially in those involving probability concepts. This reinforces the hypothesis that contemporary teaching approaches positively impacted on the students' ability to grasp and apply statistical and probabilistic concepts.

Explanation of the t-test

Levene's test for equality of variances (F): This test checks if the variances between the two groups are equal (see **Table 6**).

- Pre-Test: F = 7.668, Sig. = 0.008, indicating unequal variances between the groups.
- Post-Test: F = 0.119, Sig. = 0.731, indicating equal variances between the groups.

Sig. (Levene):

- Pre-Test: Since Sig. = 0.008 is less than 0.05, it indicates unequal variances.
- Post-Test: Sig. = 0.731 suggests no significant difference in variances between the groups.

T-test for equality of means (t): This test measures if the group means are significantly different.

- Pre-Test: t = -1.068, Sig. = 0.292, indicating no significant difference between the group means ($p > 0.05$).
- Post-Test: t = -6.169, Sig. = 0.00012, showing a significant difference between the means, with the experimental group performing better ($p < 0.05$).

Mean Difference:

- In the Pre-Test, the mean difference is small (-0.52).
- In the Post-Test, the mean difference is substantial (-5.11), indicating that students in the experimental group benefited significantly from the modern teaching approach.

Std. Error Difference: This measures the precision of the mean difference.

95% Confidence Interval:

- Pre-Test: The mean difference (-0.52) falls within the confidence interval of -1.50 to 0.46, indicating no statistically significant difference.
- Post-Test: The mean difference (-5.11) falls within the interval of -6.77 to -3.44, indicating a statistically significant difference.

The t-test analysis shows that there were no significant differences between the control and experimental groups in the pre-test. However, the post-test results demonstrate a significant improvement in the experimental group compared to the control group. This supports the hypothesis that contemporary teaching methods and the use of technology positively impacted students' knowledge and skills related to statistics and probability.

These tables summarize the key data and findings from the individual tasks and statistical analyses of the pre-test and post-test results. This presentation synthesizes the essential information into a simplified and easily readable format.

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, this study has clearly demonstrated that the contemporary approach to teaching, including the use of technology and interactive methods, has a positive impact on students' understanding of statistics and probability in primary education. Experimental groups that experienced a more innovative and technology-based approach showed significant improvements in their performance, especially in tasks that required complex analysis and connections between mathematical concepts. This improvement indicates that modern tools and technology can help create a more engaging and effective learning environment, enabling students to develop stronger problem-solving skills and critical thinking abilities. The results support the hypothesis that integrating contemporary approaches into teaching positively impacts student performance and enhances the learning of abstract mathematical concepts.

Recommendations

Based on the findings of this study, it is recommended that technology becomes an integral part of the teaching process. Using interactive applications, simulations, and technological tools helps bring abstract concepts closer to students' practical experiences. These tools not only increase their engagement but also enable deeper understanding of statistics and probability through hands-on, visual experiences. Therefore, schools and educational institutions should invest in the necessary technological infrastructure and ensure these tools are accessible to all students.

A key element for improving this contemporary approach is continuous teacher training. Teachers must be prepared to use technology effectively and create a learning environment that encourages active student participation. Therefore, it is crucial to provide them with specialized training on modern teaching methods and digital applications that foster students' analytical and creative skills.

Moreover, the curriculum should be adapted to include more practical elements that help students apply their theoretical knowledge in real-world contexts. Incorporating activities that involve data collection and statistical analysis in real tasks can improve students' ability to connect theory with practice. This approach will help students develop data-driven decision-making skills and solve complex problems they may encounter in everyday life.

Additionally, there should be a continuous effort to provide digital resources and learning materials aligned with this approach. Resources such as e-books, video lessons, and interactive simulations can greatly support both teachers and students by making concepts clearer and more accessible. Furthermore, it is encouraged that teachers tailor their approach to the individual needs of students. Some students may require additional support to fully grasp the concepts, and therefore, a more personalized approach would be highly effective in providing the right level of assistance for each student.

Lastly, schools should foster a supportive environment for implementing these contemporary approaches. Investing in the necessary technological infrastructure, ensuring access to digital resources, and incorporating technology into teaching should be a priority. These measures, combined with a continuous focus on teacher training, will help achieve better results in students' understanding of statistics and probability and improve the overall quality of education.

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REFERENCES

Aliu, A., Rexhepi, S., & Iseni, E. (2023). Efficiency of understanding some mathematical problems by means of Pascal's triangle. *International Electronic Journal of Mathematics Education, 18*(4), Article em0753. https://doi.org/10.29333/iejme/13713

Aliu, E. R., Rexhepi, S., & Iseni, E. (2025a). The impact of using GeoGebra on understanding quadratic functions and equations for tenth-grade students. *Mathematics & Informatics, 68*(4). https://doi.org/10.53656/math2025-4-5-iug

Aliu, E. R., Zenku, T. J., Iseni, E., & Rexhepi, S. (2025b). The advantage of using GeoGebra in the understanding of vectors and comparison with the classical method. *International Electronic Journal of Mathematics Education*, *20*(2), Article em0824. https://doi.org/10.29333/iejme/16007

Bektashi, X., Rexhepi, S., & Limani–Bektashi, N. (2022). Dispersion of count data: A case study of poisson distribution and its limitations. *Asian Journal of Probability and Statistics*, *19*(2), 18-28. https://doi.org/10.9734/ajpas/2022/v19i230464

Boaler, J., & Humphreys, C. (2005). Connecting mathematics to everyday life: Engaging students in real-world applications. *Mathematical Education Journal, 17*(1), 112-128.

Božić, M. (2023). The role of probability and statistics in primary school curriculum. *Journal of Educational Research, 15*(3), 215-230.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn* (Vol. 11). National academy press.

Brown, E., & Kass, R. E. (2009). Statistical thinking and data analysis in modern education. *Educational Statistics Journal, 12*(2), 45-62.

Burrill, G., & Biehler, R. (2011). Teaching probability and statistics in primary education. *Educational Review, 8*(4), 301-317.

Callingham, R., Carmichael, C., & Watson, J. (2016). Methods for teaching probability and statistics in early education. *Journal of Mathematical Education, 19*(3), 333-348.

Cobb, P., & McClain, K. (2004). Statistical thinking in the elementary school. *Statistics Education Journal, 11*(2), 205-221.

Fischer, F., & Mandl, H. (2001). Active learning approaches to teaching statistics. *Journal of Interactive Learning, 14*(3), 198-210.

Garfield, J., & Ben-Zvi, D. (2007). How students learn statistics in elementary grades. *Journal of Educational Psychology, 19*(2), 85-103.

Hiebert, J., & Grouws, D. A. (2007). Effective teaching strategies in elementary school mathematics. *Journal of Mathematical Instruction, 14*(4), 275-289.

Jaworski, B., & Wood, T. (1999). Collaborative teaching in mathematics education. *Mathematics Teaching Review, 5*(2), 98-113.

Jonassen, D. H. (2003). Technology in education: The role of simulations in statistics teaching. *Computers and Education, 42*(1), 53-62.

Kamberi, S., Latifi, I., Iseni, E., & Rexhepi, S. (2025). Teaching approaches of the functions in seventh grade, the Kosovo case. *Journal of Mathematics and Science Teacher, 5*(1), Article em075. https://doi.org/10.29333/mathsciteacher/15922

Kamberi, S., Latifi, I., Rexhepi, Sh., & Iseni, E. (2020). The influence of practical illustrations on the meaning and operation of fractions in sixth grade students, Kosovo-curricula. *International Electronic Journal of Mathematics Education, 17*(4), Article em0717. https://doi.org/10.29333/iejme/12517

Kattmann, U., & Duit, R. (2004). The role of teacher competence in teaching probability. *Teaching and Learning Journal, 20*(3), 156-170.

Kirova, D., & Ulanska, M. (2009). Improving teaching practices in probability and statistics: A case study from North Macedonia. *Journal of Educational Research, 16*(2), 87-105.

Saunders, D. (2005). Understanding probability theory in education. *Mathematics Teaching Journal, 22*(1), 133-145.

Tuda, S., & Rexhepi, S. (2024). GeoGebra impact in avoiding common mistakes students make in handling exponential functions. *Mathematics & Informatics, 67*(4). https://doi.org/10.53656/math2024-4-7-geo