

METHODOLOGY FOR DEVELOPING PROBABILISTIC-STATISTICAL THINKING IN STUDENTS BASED ON ARTIFICIAL INTELLIGENCE

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Abstract

This article examines the methodological foundations of developing probabilistic-statistical thinking in students through the use of artificial intelligence (AI) technologies. Probabilistic-statistical thinking is an essential component of modern education because it enables students to analyze data, evaluate uncertainty, identify patterns, and make evidence-based decisions. The article discusses the educational potential of AI-based learning environments, adaptive learning systems, statistical modeling tools, and interactive simulations. Particular attention is paid to teaching methods that encourage independent reasoning, critical thinking, and practical application of statistical knowledge. The proposed methodological approach aims to improve students' understanding of probability theory and statistics by integrating AI-supported activities into the learning process.

Keywords: Artificial intelligence, probabilistic-statistical thinking, educational technology, probability theory, statistics, data analysis, adaptive learning, mathematical education, statistical modeling, digital learning.

Introduction

The rapid development of digital technologies and artificial intelligence has created new opportunities for improving the quality of education. In contemporary society, students need not only theoretical knowledge but also the ability to analyze information, interpret statistical data, evaluate risks, and make informed decisions under conditions of uncertainty. These abilities are closely associated with probabilistic-statistical thinking. Probabilistic-statistical thinking refers to the ability to understand random events, estimate probabilities, interpret statistical indicators, recognize patterns in data, and draw reasonable conclusions based on evidence. It plays an important role in mathematics, economics, medicine, engineering, computer science, and other fields. Traditional teaching methods sometimes focus primarily on memorizing formulas and solving standard exercises. However, the development of statistical thinking requires students to investigate real-life situations, formulate hypotheses, analyze data, and evaluate different possible outcomes. Artificial intelligence can support this process by providing interactive tasks, personalized explanations, automated feedback, and opportunities for data-based experimentation [1].

Therefore, developing an effective methodology for forming probabilistic-statistical thinking through AI-supported education is an important direction in modern pedagogical research. Artificial intelligence can transform the teaching of probability theory and statistics by making learning more interactive, personalized, and practice-oriented. AI-based educational systems can analyze students' responses, identify difficulties, and recommend exercises appropriate to their current level of understanding. For example, when students study probability distributions, they can use digital simulations to observe how random outcomes change as the number of experiments increases. Such activities help learners understand the relationship between theoretical probability and observed frequency. AI tools can also assist students in organizing datasets, calculating statistical indicators, visualizing distributions, and interpreting the results of statistical investigations. Another important advantage of AI-supported learning is immediate feedback. When students make mistakes, an educational system can provide explanations, additional examples, and step-by-step guidance. This approach encourages independent learning and helps students recognize the reasons behind incorrect answers [2].

Nevertheless, AI should not replace the teacher or students' independent reasoning. Its primary function is to support the educational process, create opportunities for exploration, and facilitate the development of analytical skills. Students must learn to verify AI-generated results, assess the reliability of information, and explain their conclusions independently. The first stage is the motivational and introductory stage. At this stage, students are introduced to practical problems involving uncertainty, probability, and statistical information. Examples may include weather forecasting, medical test accuracy, sports performance, population statistics, and economic indicators. These examples demonstrate the relevance of probabilistic-statistical knowledge in everyday life. The second stage is the conceptual learning stage. Students study fundamental concepts such as random events, probability, random variables, probability distributions, mean, median, variance, and standard deviation. AI-supported educational resources can provide explanations and examples adapted to students' learning needs. Visual representations and interactive demonstrations help learners connect mathematical concepts with real-world phenomena [3].

The third stage is the practical and analytical stage. Students work with datasets, conduct virtual experiments, formulate hypotheses, and interpret statistical results. For instance, they may simulate repeated coin tosses, compare experimental frequencies with theoretical probabilities, or analyze changes in a dataset. AI tools can assist with calculations and visualizations, while students remain responsible for interpreting the findings and justifying their conclusions. The fourth stage is the reflective and evaluative stage. Students explain their solutions, compare alternative interpretations, identify possible sources of error, and evaluate the reliability of their conclusions. Teachers assess not only the correctness of calculations but also the students' ability to reason logically, interpret uncertainty, and support decisions with evidence.

The integration of artificial intelligence into probability and statistics education can contribute to the development of several important competencies. Students may improve their ability to interpret statistical data, understand random phenomena, construct and evaluate hypotheses, and apply mathematical knowledge to practical problems. AI-supported activities can also strengthen critical thinking, digital literacy, independent learning, and problem-solving skills.



However, these outcomes depend on the quality of instructional design, the relevance of learning tasks, and the teacher's guidance. Effective implementation requires a balanced combination of theoretical instruction, practical exercises, collaborative discussion, and independent analysis [4].

The effectiveness of the proposed methodology can be evaluated through diagnostic tests, practical assignments, project-based activities, and comparisons of students' performance before and after instruction. Assessment should consider conceptual understanding, accuracy of statistical interpretation, quality of reasoning, and the ability to explain uncertainty. Such evaluation makes it possible to identify learning difficulties and improve the instructional process.

Conclusion

Developing probabilistic-statistical thinking is an important objective of contemporary education because it prepares students to interpret information, evaluate uncertainty, and make evidence-based decisions. Artificial intelligence offers valuable opportunities to improve the teaching of probability theory and statistics through personalized learning, interactive simulations, automated feedback, and data visualization. The proposed methodology combines conceptual instruction, practical experimentation, statistical analysis, and reflective evaluation. Its successful implementation requires teachers to use AI purposefully while preserving students' independent thinking and responsibility for their conclusions. A systematic integration of AI-supported learning activities can create favorable conditions for developing students' mathematical reasoning, statistical literacy, and analytical competence.

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