BG Pulse Journal USA
ISSN:1947-2536 http://www.bgpulseusa.com/index.php/bg

USE OF ARTIFICIAL INTELLIGENCE AND PYTHON TECHNOLOGIES IN TEACHING PROBABILITY THEORY AND STATISTICS COURSES IN HIGHER EDUCATION

Omonova Gulandam Davlatovna
Teacher of the Department of Pedagogy and Psychology,
Angren University
E-mail: gulandomomonova@gmail.com, +998931150460

https://doi.org/10.5281/zenodo.20306814

Abstract: The article examines modern approaches to teaching probability theory and mathematical statistics courses in higher education institutions, particularly the methodological foundations of using artificial intelligence tools and the Python programming language. The study analyzes the challenges of mathematics education in the context of digital transformation, factors influencing students' learning outcomes, and possible solutions to these issues. It demonstrates the potential of developing students' analytical thinking, data processing skills, and professional competencies through the implementation of Python-based practical assignments.

Keywords: artificial intelligence, Python, probability theory, mathematical statistics, digital education, data analysis, competence, higher education.

In recent years, approaches to teaching mathematical disciplines in higher education institutions, including probability theory and mathematical statistics, have undergone significant modernization. This process is associated with the digitalization of science and the economy, as well as the need to develop modern digital competencies among students. Especially in the context of the rapid development of artificial intelligence and data analysis, updating the content of probability theory and statistics courses has become an urgent issue.

First of all, it should be noted that many factors currently create difficulties in teaching students. R. Damar and S. Zhao associate this tendency with the digitalization of science and the economy, as well as the necessity of forming universal digital competencies among students, especially important in the era of artificial intelligence and data analysis.

Dr. R. H. Abdulsahib of the University of Babylon identifies the following factors in his work: insufficient understanding of mathematical foundations, difficulties in visual and symbolic thinking, language barriers, and short-term memory limitations. In addition, he emphasizes that decreased motivation, inadequate mathematical preparation, misconceptions about the complexity of mathematics, excessive dependence on smartphones during distance learning, passive participation in lessons, and difficulties in understanding mathematical symbols further complicate the educational process.

The necessity of transforming undergraduate education has also been reflected at the national level. Harvard University professors J. P. Holdren and E. Lander highlight this issue in their studies. Mathematician P. Zorn and colleagues, in the book *"A Common Vision: Mathematics, Statistics, and the Future of Undergraduate Education,"* conclude that "the traditional mathematics-based statistics curriculum cannot keep pace with the growing demand for students who are able to understand and analyze data."

In the book *"Introduction to Statistical Investigations"* professor R. Gould and co-authors emphasize that teaching statistics should not be limited only to abstract formulas. Instead of traditional approaches, modern methods, including programming and data analysis, should be introduced. The study of mathematics should be reinforced through real data analysis and visualization of results.

Modern statistics and mathematics education should take into account the increasing role of data science and artificial intelligence and integrate practice-oriented skills into the learning process. One such initiative is EducateAI, within which the NSF has called upon educators to develop inclusive educational programs in artificial intelligence. These programs aim to integrate data analysis and programming into the curriculum from school education to undergraduate studies.

Within the framework of the TRIPODS (Transdisciplinary Research in Principles of Data Science) program, the NSF also supports a five-year initiative aimed at promoting innovation in data science. Through this program, universities and research centers implement interdisciplinary scientific and educational projects that combine mathematics, computer science, and statistics.

All these initiatives emphasize the practical and interdisciplinary nature of data analysis and encourage changes in traditional educational approaches.

In Russia, the idea of integrating digital technologies into mathematics education is also developing. This issue is discussed in the report *"Foundations of Mathematical Education in the Digital Age"* presented by academicians of the Russian Academy of Sciences. Today, the digital transformation of mathematics education is taking place not only in Russia but throughout the world.

According to B. Huntsyuan and co-authors, the Python programming language can serve as an effective tool for solving problems encountered in the study of mathematical disciplines. It increases students' engagement, develops critical thinking, and strengthens interdisciplinary connections.

In the study conducted by K. Zavez and O. Harel, more than 2,000 articles from the Scopus database were analyzed to examine computational tools used in teaching statistics. The results showed that nearly half of the articles used the R programming language.

Modern studies indicate that students face several challenges in mastering mathematics. These include insufficient understanding of mathematical foundations, difficulties in visual and symbolic thinking, language barriers, and memory-related problems.

Furthermore, decreased motivation, excessive smartphone dependence in distance learning conditions, and passive participation negatively affect educational effectiveness.

Researchers argue that traditional statistics courses cannot fully meet modern requirements. Teaching statistics should go beyond theoretical formulas and be enriched through real data analysis and visualization.

The Data Science Education and EducateAI initiatives supported by the NSF promote precisely this direction. These programs provide for teaching programming and data analysis from school education to higher education.

Due to its simple syntax and powerful libraries, Python has become widely used in scientific and educational environments. Libraries such as NumPy, Pandas, Matplotlib, SciPy, and Scikit-learn enable efficient solutions to mathematical and statistical problems.

Research demonstrates that Python:

increases student engagement;

develops critical thinking;

ensures interdisciplinary integration;

creates opportunities for individualized learning.

In addition, modern statistical thinking is closely connected with "thinking through programming."

The following assessment questions were provided for students:

If the probability of event A is 0.6, the probability of event B is 0.4, and their joint probability is 0.3, find the probability that at least one of them occurs;

Construct the distribution function for a given discrete random variable;

Determine the confidence interval for the mean under unknown variance conditions;

Calculate the Pearson correlation coefficient between two variables.

For example, the following problem was considered:

If the probability of event A is 0.6, the probability of event B is 0.4, and their joint probability is 0.3, then the probability that at least one event occurs is determined as follows:

$P(A \cup B)=P(A)+P(B)-P(A \cap B)=0.6+0.4-0.3=0.7$

P(A) 0,55

P(B) 0,13

P(A ∪ B 0,06

$P(A \cup B)=P(A)+P(B)-P(A \cap B) \approx 0,62$

The results showed that assignments completed with the help of Python deepen students' knowledge and improve their practical skills.

According to the research findings, integrating artificial intelligence tools and the Python programming language into probability theory and mathematical statistics courses:

increases educational effectiveness;

strengthens student motivation;

develops problem-solving skills for real-world situations;

forms modern professional competencies.

Therefore, the broad implementation of digital technologies in teaching mathematical disciplines in higher education is of great importance.

In the probability theory section, students studied combinatorics, probabilities, random variables, and their properties.

The practical assignments were aimed at consolidating students' knowledge and developing skills in working with real data.

For example, students were required to:

find all permutations of the set {1,2,3};

determine 2-element combinations;

identify combinations with repetitions;

determine permutations with repetitions.

References

1. Belov M. S., Ganicheva E. M. *The Use of Artificial Intelligence Tools and Python in the University Course of Probability Theory and Statistics* // Scientific-methodological electronic journal "Concept". – 2026. – No. 02. – pp. 117–132. – URL: https://e-koncept.ru/2026/261031.htm – DOI: 10.24412/2304-120X-2026-11031.

2. Shomova S. A., Kachkaeva A. G. *Between Fascination and Fear: Dialogue with the "Other." Experience in Analyzing AI Usage Practices in Professional and Everyday Life* // Monitoring of Public Opinion: Economic and Social Changes. – 2024. – No. 5. – pp. 3–17. – URL: https://doi.org/10.14515/monitoring.2024.5.2766.

3. Sberbank. *How Smile Payment Works at Cash Desks* [Electronic resource]. – URL: https://sberbank.promo.page/media/kak-rabotaet-oplata-ulybkoi-na-kassah67c8416436303074759c1c8c_0_0.

4. Tintle N. L., Chance B., Cobb G., Roy S., Swanson T., VanderStoep J. *Combating Anti-Statistical Thinking Using Simulation-Based Methods Throughout the Undergraduate Curriculum* // The American Statistician. – 2015. – Vol. 69(4). – p. 362.

5. Zhao C., Sheng L. *The Utilization of the Case Teaching Method in the Blended Instruction of Probability Theory and Mathematical Statistics* // SHS Web of Conferences. – 2023. – Vol. 179(3). – URL: http://doi.org/10.1051/shsconf/202317902024.

6. Python Software Foundation. *Python Official Website.* – URL: https://www.python.org/.

7. NumPy Developers. *NumPy Official Website.* – URL: https://numpy.org/