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# The Importance of Teaching Probability Theory and Mathematical Statistics Based on the "Applied-Professional Orientation" Concept in Developing Students' Economic Thinking

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**Abstract**
The training of future economists and the development of their professional competence are directly linked not only to the study of economic disciplines but also to mastering mathematical subjects, particularly probabilistic and statistical methods. This is because the outcomes of many economic processes depend on numerous random factors and uncertainties. Analytical conclusions are always assessed with a certain degree of probability, which determines the reliable boundaries of specific research results. Therefore, the theory of probability and mathematical statistics play a crucial role in fostering students' economic thinking. However, teaching this subject presents considerable challenges. This article substantiates the relevance of teaching probability theory and mathematical statistics based on the "applied-professional orientation" concept. It provides a practical mechanism for implementing this approach in the educational process, illustrated with a comprehensive system of examples and problems.

**Keywords:** Economic Thinking, Probability Theory, Mathematical Statistics, Applied-Professional Orientation, Professional Competence, Economic Tasks, Stochastic Methods, Problem-Solving Skills

## Introduction

The training of qualified economists in higher education institutions and the enhancement of their professional competence are inextricably linked to mastering mathematical disciplines, especially probabilistic and statistical methods. Numerous economic processes yield results that depend on a variety of random factors and inherent uncertainties. For instance, relationships between product quality, raw material consumption, and labor productivity, as well as daily sales revenue and income, are typically modeled using probabilistic and statistical analyses [1, 12].

Internal and external variations in economic processes are studied based on the variable characteristics of socio-economic phenomena. The laws governing their development are defined by the methods of probability theory and mathematical statistics, with analytical conclusions evaluated at a specific probability level, indicating the confidence intervals of research results.

Observing socio-economic phenomena reveals that the mathematical probability of an event manifests as a statistical regularity — a stable rate of relative repetition. This is a consequence of the law of large numbers, which applies to socio-economic phenomena under specific conditions. While probability theory designs the mathematical model of an economic process, mathematical statistics constructs models based on the influence of random factors, analyzing the aspects of interest. Thus, mathematical statistics aims to create a theoretical probabilistic model of the economic process under study. Both disciplines describe socio-economic phenomena and identify variation patterns within statistical data [2].

Despite its importance, teaching probability theory and mathematical statistics to future economists has several unresolved issues. The potential of the "applied-professional orientation of teaching" principle to foster professional competence has been insufficiently studied. The alignment of educational content and available methodological materials with specific economic specializations remains inadequate. Probabilistic-statistical models and applied professional problems are not systematically integrated into the mathematics curriculum. Consequently, students who master purely mathematical content often face difficulties analyzing economic processes, solving practical professional problems, and creating models.

In Uzbekistan, the theoretical and methodological foundations of teaching these subjects have been explored by researchers such as I.M. Gaysinskaya, X. Ochilova, J. Qudratov, D.V. Manevich, and U.X. Xonqulov [7, 11, 12, 16, 17]. X. Ochilova's work focused on developing probabilistic-statistical thinking in secondary school students, linking it to their prediction and assessment abilities. Studies by I.M. Gaysinskaya, D.V. Manevich, and J. Qudratov concentrated on selecting material and organizing elective courses in schools. U.X. Xonqulov advanced the idea of teaching stochastic elements based on interdisciplinary connections and internal integration, developing a special course on combinatorics, probability, and statistics for academic lyceums.

Regarding the professionalization of mathematics teaching for economics students, research has been conducted by N.V. Panina, A.G. Elenkin, Ye.V. Aleksandrova, I.N. Konovalova, S.O. Dolgopolova, R.Sh. Xusnutdinov, Yo. Abdullaev, N.M. Soatov, and others [9, 18, 19]. For example, N.V. Panina viewed applied orientation as a means of developing economic thinking through teaching probability and statistics. S.O. Dolgopolova's research clarified the theoretical and practical foundations for designing systems to cultivate statistical thinking in economics students. The works of N.M. Soatov, Yo. Abdullaev, Sh.Q. Formanov, and A. Abdushukurov explored methods for describing quantitative and qualitative aspects of socio-economic phenomena.

**Materials and Methods**

This study is based on a theoretical analysis of pedagogical, psychological, and methodological literature on teaching probability theory and mathematical statistics in economics programs. The core concept applied is the "applied-professional orientation" of teaching.

In pedagogical research, the "applied orientation of teaching" is often defined as the formation of knowledge, skills, and abilities to use mathematical tools for solving concrete practical problems through appropriately selected content and methodological connections [3, 9, 12].

Many sources use "applied orientation" and "professional orientation" practically interchangeably, considering them complementary. G.V. Dorofeev, L.V. Kuznetsova, and V.V. Firsov define professional orientation as directing the content, forms, and methods of teaching mathematics towards its use in specific professional activities, while applied orientation focuses on directing practical exercises towards solving production and professional tasks.

**The author's proposed definition:** *Applied-professional orientation of teaching* is a type of educational activity, content, form, and means designed to form professional competence through practical tasks, resulting in a well-rounded specialist capable of dynamically solving professional problems [5, 6].

For economics students, the content and structure of applied-professional problems must meet specific didactic and methodological requirements:

1. The probabilistic-statistical problem must correspond to the mathematical topic and incorporate current, profession-specific data.
2. The problem statement should be concise, clear, systematic, consistent, and aimed at solving real-world issues.
3. It must align with the tendency to form professionally relevant knowledge, skills, and abilities, fostering professional competence.
4. Calculations should allow for the use of technical tools and specialized software (Excel, MathCad, STATISTICA).

These problems should primarily deepen understanding of probabilistic-statistical concepts and facts, forming the ability to apply theoretical knowledge in professional practice, rather than focusing on large volumes of material.

Based on the method of presentation, problems in probability theory and mathematical statistics for economists can be classified into three types:

**Type 1: Purely Mathematical Problems**

These problems are solved using a strict algorithm, mathematical formulas, and concepts. Their solution methods are well-established and practically not profession-oriented.

*Example* (adapted for brevity): Find the probability of drawing two red or two blue balls from a box containing 10 red and 6 blue balls. **Solution**: Using combinations, the probability is:

$$P(A+B)=\frac{C_{10}^{2}+C_{6}^{2}}{C_{16}^{2}}=\frac{\frac{10\cdot 9}{2}+\frac{6\cdot 5}{2}}{\frac{16\cdot 15}{2}}=\frac{60}{120}=\frac{1}{2}$$

**Type 2: Applied-Professional Problems**

These are mathematical problems directly related to professional activities. The solution method is known, but applying it requires some intellectual effort. Solving such problems helps develop professional competence and automaticity in applying relevant formulas.

*Examples provided in the original (adapted for economics contexts)*:

- *Problem*: In a large advertising firm, 21% of employees earn high salaries. Women constitute 40% of the workforce, and 6.4% of all employees are high-earning women. Is there a basis for alleging gender discrimination? **Solution**: $P(\text{High Salary} \mid \text{Woman})=\frac{0.064}{0.40}=0.16$, which is less than 0.21, suggesting discrimination.
- *Problem*: If 4% of all products are defective, and 75% of non-defective products meet first-class standards, find the probability a randomly selected product is first-class. **Solution**: $P(Non-defective)=0.96$. $P(First-class \mid Non-defective)=0.75$. Thus, $P(First-class)=0.96\cdot 0.75=0.72$.

**Type 3: Problematic Applied-Professional Problems**

These problems are not stated in mathematical language but as a real-world dilemma. Solving them requires formulating the mathematical model through practical activities. These problems are most valuable for forming professional competence, starting from understanding the problematic situation.

*Examples from the original (rephrased)*:

- *Problem*: An entrepreneur can invest in one or two independent businesses. The probability of failure for each is 0.1. Is it better to invest all capital in one business or split it between two? **Solution**: Let A and B be success events for business 1 and 2. $P(A)=P(B)=0.9$. The probability of success for at least one business when splitting is $P(\text{at least one}) = 1 - P(\text{both fail}) = 1 - (0.1 \cdot 0.1) = 0.9$. This is greater than 0.9, so splitting is preferable.

- *Problem (Real data analysis)*: An entrepreneur sells sausages from "To'xtaniyoz ota" in Minimarket 1 and from "Sharshara" in Minimarket 2. Daily profit data for 30 days is given. Which supplier should the entrepreneur continue with to reduce transport costs? **Solution**: Calculation shows average daily profit is the same (159,000 sum), but the standard deviation and coefficient of variation are much lower for "To'xtaniyoz ota" (σ=18.7, v=11.76%) than for "Sharshara" (σ=82.5, v=51.89%), indicating more stable profit. Choosing "To'xtaniyoz ota" is more rational.

The study also involves discussing famous paradoxes (Monty Hall, St. Petersburg Paradox, Benford's Law) to illustrate economic decision-making under uncertainty.

The methodology for solving problematic applied-professional problems consists of three stages:

1. **Analysis:** Separating the problem's conditions and conclusions, clarifying the content, determining what needs to be found, and formulating the mathematical model.
2. **Planning:** Selecting a solution method, identifying necessary additional data, and creating a step-by-step solution plan.
3. **Execution and Verification:** Solving the problem according to the plan, checking for and correcting errors, and verifying the solution. This stage helps students understand the essence of professional problems through experimentation and practice.

## Results and Discussion

The application of the "applied-professional orientation" concept fundamentally changes the nature of learning probability theory and mathematical statistics for economics students. Moving beyond purely theoretical, abstract problems to include professionally relevant tasks (Type 2) and especially problematic tasks (Type 3) directly bridges the gap between mathematical knowledge and its practical application.

The classification system of problems (Types 1, 2, and 3) provides a structured pathway for students. They begin with mastering basic computational algorithms (Type 1), then apply these algorithms to simplified professional contexts (Type 2), and finally tackle complex, open-ended problems requiring full mathematical modeling (Type 3).

The provided examples demonstrate how probabilistic and statistical methods are essential tools for economic analysis. For instance, calculating conditional probabilities helps identify potential discrimination in salary distribution. Comparing means and measures of dispersion (variance, standard deviation, coefficient of variation) allows for rational decision-making between suppliers, focusing not only on average profit but also on its stability (risk). The Monty Hall paradox discussion teaches that when new information is revealed, revising an initial decision can increase the probability of a favorable outcome, a key insight in dynamic economic environments. The St. Petersburg paradox introduces concepts of expected utility and risk aversion, foundations of microeconomics and insurance.

Implementing the three-stage solution methodology for problematic tasks (Analysis → Planning → Execution/Verification) actively engages students in the entire problem-solving cycle, which mirrors real professional work. This process develops critical professional competencies:

- **Analytical skills:** Formulating real-world economic situations in mathematical terms.
- **Strategic planning:** Selecting appropriate statistical methods and identifying necessary data.
- **Practical application:** Performing calculations, interpreting results in an economic context, and making justified recommendations.

The integration of famous paradoxes adds a valuable theoretical dimension, showing the historical and conceptual depth of stochastic methods in economics and finance. Students learn that probability is not just a set of formulas but a powerful language for discussing uncertainty and strategic choice.

The didactic requirements outlined for applied-professional problems (relevance, brevity, comprehensibility, use of technical tools) ensure that the educational material remains engaging, feasible, and practically valuable. The emphasis on using software like Excel or STATISTICA prepares students for modern data-driven workplaces.

Several studies confirm the effectiveness of this approach. The work of Panina, Dolgopolova, and others in the Russian context, as well as Xonqulov in Uzbekistan, supports the idea that integrating professional content and active learning methods significantly improves the relevance and outcomes of mathematical training for economists. This study builds upon their work by proposing a specific, detailed classification of problems and a step-by-step teaching methodology within the "applied-professional orientation" framework.

## Conclusion

Teaching probability theory and mathematical statistics to economics students using the "applied-professional orientation" concept, particularly through problematic applied tasks, significantly enhances their economic thinking. This approach not only facilitates a deeper understanding of stochastic methods but also equips future specialists with the practical skills needed to solve real-world professional problems, plan economic activities, make forecasts, and draw valid conclusions under conditions of uncertainty.

The three-tiered problem classification system (purely mathematical, applied-professional, and problematic applied-professional) offers a structured and effective method for gradually developing professional competence. The three-stage solution methodology provides a clear framework for navigating complex, real-world scenarios.

Future research should focus on developing comprehensive banks of problematic applied-professional problems tailored to specific economic sub-disciplines (e.g., finance, marketing, logistics) and exploring the integration of more advanced statistical software and big data analytics into the curriculum.

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