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FORMATION AND DEVELOPMENT OF PROBABILISTIC AND STATISTICAL THINKING STYLE OF MATHEMATICS STUDENTS

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Abstract. For a fairly long period of time, probabilistic and statistical knowledge remained outside of training. The rapid development of probability theory and mathematical statistics in the XIX-XX centuries, the expansion of the boundaries of their application, awareness of the importance of stochastic knowledge for modern society made it possible to talk about the possibility of including probability-theoretical knowledge in the content of general, secondary and higher education. Prominent figures of science and education have participated in the discussion of this issue for many years. The coming of the XXI century. It was characterized by the inclusion of elements of probability theory, mathematical statistics and combinatorics in the content of the mandatory minimum of mathematical training. As the main purpose of introducing the stochastic component in the course of mathematics, a number of researchers see familiarization with statistical patterns, patterns of a broader type than those that make up classical determinism, noting that the education of probabilistic thinking as the antipode of deterministic thinking is of paramount importance for teaching [1].

Currently, the inclusion of probability theory and mathematical statistics in the content of mathematical education is primarily due to "the meaning and place of stochastic concepts and facts in the system of knowledge and ideas of modern man, their applied and practical significance in the world." The application of probability theory and mathematical statistics in various fields of science and technology is becoming increasingly important: in sociology, linguistics, literature, models are being built using probabilistic and statistical methods; biology, physics, chemistry, give numerous reasons to talk about statistical patterns encountered in the study of natural phenomena, in the implementation of chemical reactions, in the study of the molecular structure of matter [2].

Keywords: probability theory, mathematical statistics, thinking, methodology, analysis, development, formation, students, teaching, university.

Introduction

Probability theory– the science that studies patterns in random phenomena, occupies a special place among the mathematical sciences. It is characterized by a special methodology, a special approach to phenomena, a special nature of statements and predictions, a special - probabilistic type of thinking. The research of the formation and development of probabilistic-statistical representations and thinking in children is devoted to the work of both domestic and foreign scientists, who note an important feature of human memory - the ability to probabilistic forecasting. Forecasting the development of events and planning your own actions to achieve the desired results are integral moments of any human activity.

Basic provisions

Analysis of the currently existing dissertation research on the search for methodological ways to implement the stochastic component in the course of mathematics has shown that the work is mainly carried out in the following areas [3], [8], [10]:

- development of methods for the formation of stochastic representations among students in the process of learning the basics of probability theory and mathematical statistics at the primary and secondary school level (V. Bolotyuk, L. Bychkova, S. Vorobyova, D. Manevich, V. Selyutin, etc.);

- strengthening of the applied and practical orientation of the study of stochastic mathematics is due to the formation of a set of practical skills relating to the application of stochastic knowledge in the process of solving problems arising in practice (E. Bunimovich, S. Dvoryadkina, O. Troitskaya, A. Ploski, V. Firsov, S. Shcherbatykh, etc.);

- development of methods of stochastic preparation of teachers of mathematics (A. Anurin, D. Manevich, V. Selyutin, etc.).

Despite the achievements made by both domestic and foreign methodologists in the field of teaching probability theory and mathematical statistics, a number of questions remain open. We are talking about the development of a methodology for teaching stochastics in higher education.

Teaching mathematics in high school has a number of features. The course of mathematics at this stage of training should reflect the profile, i.e. show the possibilities of using mathematical apparatus in future professional activity, which is especially important for representatives of those areas of specialization for which mathematics is not among the core subjects. Familiarity with the elements of the stochastic component opens up ample opportunities to illustrate the importance of mathematics in solving applied problems, which contributes to students' understanding of the necessity and universality of mathematics and its methods [4], [5], [6].

However, the lack of time devoted to studying mathematics in groups of non-mathematical profiles, the weak reflection of the applied potential of stochastics in textbooks and textbooks leads to the fact that probability and statistics courses are often formal, contain only a set of algorithms without their justification, which, in turn, does not achieve the goals of thinking development.

Thus, at present there are contradictions between the need for the formation and development of probabilistic thinking of students as the main goal of introducing probabilistic and statistical lines in the course of mathematics and the insufficient level of its development among graduates; as well as the huge applied potential of stochastics and its insufficient implementation in the course of mathematics.

Description of materials and methods

The hypothesis is that learning stochastics in groups of humanities and natural sciences within the elective course will contribute to the development of probabilistic thinking if the following conditions are taken into account:

- implementation of an applied orientation, through the inclusion in the learning process of a system of tasks and exercises of an applied nature, which

allows demonstrating the capabilities of mathematics as an apparatus for solving problems that arise in the field of future professional interests;

- taking into account the individual characteristics of thinking and abilities of representatives of each profile [7], [9].

To solve the problem of research and verification of the validity of the formulated hypothesis, it is necessary to solve the following tasks:

1) on the basis of theoretical data analysis, to determine the psychological and pedagogical foundations for the formation and development of probabilistic thinking;

2) to analyze existing textbooks and textbooks that implement the probabilistic-statistical line from the point of view of reflecting the applied potential of stochastics in them;

3) to select the stochastic content and identify the main ways to implement the applied orientation of stochastic teaching [10], [13], [14].

To solve the tasks, the following research methods were used: analysis and systematization of data from psychological, pedagogical, methodological and educational literature; theoretical and experimental substantiation of the effectiveness of the developed methodology.

The need to include probability-theoretic knowledge in general education is currently due to a number of reasons:

1) high level of scientific development (natural sciences, humanities and technical sciences are largely based on statistical concepts and widely use probabilistic and statistical methods);

2) socio-economic needs of society;

3) the processes of European and world integration, inextricably linked with the mutual rapprochement of countries and peoples, including in the field of education (the stochastic line is present as an independent content line in mathematics courses in almost all developed countries of the world).

The analysis of the teaching of the probabilistic-statistical line of a number of foreign countries (England, France, Japan, USA, etc.) allowed us to identify two main features – the implementation of the applied orientation of teaching stochastics, as well as the correspondence of the program to the direction of specialization of students [11].

Currently, the school is switching to specialized training focused on individualization of training and socialization of students, including taking into account the real needs of the labor market. Profile differentiation is based on individual psychological characteristics of students. In this connection, teaching mathematics in groups of different profiles has its own specifics [12].

Based on the analysis of existing approaches to the concept of "probabilistic thinking", we distinguish the following components:

1) logical (when solving probabilistic problems, students form the basic techniques of logical thinking, such as comparison, analysis, synthesis, abstraction and generalization);

2) combinatorial (the most characteristic feature of combinatorial thinking is the ability of the subject to determine, consider and take into account all possible combinations of any signs or events);

3) probabilistic-statistical (the ability of students to operate with the concept of "probability", navigate in situations of uncertainty, analyze statistical information).

Introducing students to the ideas and methods of stochastics, most of which is abstract, as well as demonstrating the application of these ideas and methods in various fields of knowledge allows you to create a holistic picture of the world, teach them to compare generalized conclusions with specific phenomena, develop their own assessment of phenomena.

Results and discussion

The study of elements of probability theory and mathematical statistics is one of the main means of implementing the applied orientation of teaching mathematics. Their ideas and methods are widely used in various fields of knowledge.

In our opinion, the applied orientation of stochastic training consists in purposeful activity on the application of stochastic ideas and methods to the description of real-world processes, as well as to the analysis and resolution of a number of problems and tasks arising in future professional activity.

Applied tasks act as a leading component of the implementation of the applied orientation of stochastic learning. The analysis of modern textbooks and textbooks implementing the probabilistic-statistical line showed a weak reflection of the applied potential of stochastics: applied tasks are presented in minimal quantity or absent at all, the same can be said about the presence of applied examples illustrating the application of ideas and methods of stochastics in people's practical activities.

The main method of solving applied problems is the method of mathematical modeling, which includes 3 stages:

1) formalization – the construction of a mathematical model;

2) the solution of the problem within the constructed model;

3) interpretation – the interpretation of the resulting solution.

Learning to solve problems using modeling activates the mental activity of students, helps them understand the problem, independently find a rational way to solve it, establish a suitable method of verification, determine the conditions under which the task has (or does not have) decision.

Based on the theoretical analysis of the basic requirements for applied tasks, we have identified a number of principles (both general didactic and special) that must be adhered to when selecting applied problems in probability theory and mathematical statistics:

- the principle of accessibility (applied tasks should lie in the sphere of age-related interests and reflect issues that take place in a real situation; if additional facts of mathematical theory are required to consider individual examples, then they should be accessible to understanding and can be considered separately);

- the principle of scientific character (the applications and tasks used should be mathematically complete; the condition and result of solving applied problems

should contribute to the expansion of scientific horizons, contain theoretical information about modern scientific achievements in the field of knowledge on which they are based);

- the principle of consistency and interconnection (applied tasks should be an integral part of the system of tasks and exercises in the basic course of combinatorics, probability theory and mathematical statistics);

- the principle of integration of disciplines (stating applied issues and offering practical tasks, it is necessary to emphasize the connection of stochastics with other sciences);

- the principle of practical significance (the content of applied tasks should carry meaningful practical information that is understandable to students either by virtue of their knowledge or based on their life experience and intuitive ideas);

- the principle of activity (when analyzing specific real situations, performing laboratory, practical work and conducting experiments, they take an active position, actively interact when working in small groups, imitating real dependencies, generate ideas);

- the principle of subjectivism (transfer from the object of learning to the subject. Independent work on the compilation of applied problems, the selection of examples of the use of ideas and methods of stochastics in various fields of human activity is important, which significantly expands the horizons, promotes the development of creative thinking);

- the principle of motivation (the motivating potential of stochastics is the formation of cognitive interest: students' awareness of how abstract mathematical concepts and facts can be effectively applied in their profile discipline);

- the principle of profile orientation (tasks and applications of probability theory and mathematical statistics should be selected in accordance with a specific training profile).

Note also that when learning stochastics, it is advisable to use not individual tasks, but a system of tasks, to which we make the following requirements:

1) the tasks included in the system must meet the main educational objectives of training;

2) in the system of tasks, it is necessary to identify tasks of a preparatory nature, on the example of which students work out the basic techniques and methods used to solve the remaining tasks of the system;

3) the content of the applied tasks included in the system should correspond to reality, be clear, concise, interesting, understandable, and the solution should be of practical significance;

4) to create a system of tasks, it is necessary to take into account level and profile differentiation. So, among the ways of "profiling" stochastic problems, one can distinguish: the use of data or terms from the field of future professional interests in the formulation of an ordinary stochastic problem; the formulation of tasks in the form of professional situations, the solution of which is possible only with the involvement of knowledge from specialized subjects and knowledge of stochastics; setting tasks for students to independently formulate tasks based on the material of the profile discipline in the process of performing laboratory and practical work;

5) the system must include tasks for independent collection, presentation and processing of information (collection of statistical data, compilation and reading of tables, charts and graphs);

6) the system should include tasks that stimulate active cognitive activity, as well as tasks aimed at conducting independent scientific research;

7) the system should include tasks both for the analysis and interpretation of probabilistic models, and for students to independently build models of real situations arising in the field of future professional interests.

Conclusion

The problems put forward in connection with the research hypothesis have been solved and the following results and conclusions have been obtained: Theoretically and using concrete examples, it is proved that the stochastic apparatus is one of the most important components of the general intellectual and professional culture of a person living in modern society, the mastery of which is possible through showing the practical significance of the basic ideas and methods of the probabilistic-statistical component of the mathematics course. The analysis of psychological and pedagogical approaches to the formation and development of probabilistic thinking of students allowed us to establish that ideas about randomness and probabilistic thinking develop within the framework of the operational theory of intelligence development. The analysis of the historical path of introducing the probabilistic-statistical line into the mathematics course, as well as the analysis of textbooks and textbooks created to date, showed a weak and unbalanced reflection of the applied potential of stochastics, whereas it is the applied orientation that acts as a means of developing students' probabilistic thinking. The methodology of teaching probabilistic and statistical content in the conditions of profile differentiation is based on the idea of implementing the applied orientation of stochastic teaching, carried out by including applied questions and a system of applied problems based on material from various specialized disciplines (biology, chemistry, literature, linguistics, economics, psychology, etc.) in the course on combinatorics, probability theory and mathematical statistics.

The conducted research is not exhaustive, but reveals a range of problems that require further reflection and resolution. In the future, it is advisable to continue the research in terms of developing and improving methods of teaching the basics of probability theory and mathematical statistics, taking into account current trends in the modernization of the content of mathematical education, computerization of the educational process.

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МАТЕМАТИКАЛЫҚ СТУДЕНТТЕРДІҢ ЫҚТИМАЛДЫ-СТАТИСТИКАЛЫҚ ОЙЛАУ СТИЛІН ҚАЛЫПТАСТЫРУ ЖӘНЕ ДАМЫТУ

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Аңдатпа. Ұзақ уақыт бойы ықтималдық және статистикалық білім оқу шеңберінен тыс қалды. XIX-XX ғасырлардағы ықтималдық теориясы мен математикалық статистиканың қарқынды дамуы, оларды қолдану шекараларының кеңеюі, қазіргі қоғам үшін стохастикалық білімнің маңыздылығын түсіну теориялық-ықтималдық білімді жалпы, орта және жоғары білім мазмұнына қосу мүмкіндігі туралы айтуға мүмкіндік берді. Көрнекті ғылым және білім қайраткерлері көптеген жылдар бойы осы мәселені талқылауға

қатысып келеді. XXI ғасырдың басталуы ықтималдық теориясы, математикалық статистика және комбинаторика элементтерін математикалық дайындықтың міндетті минимумының мазмұнына қосумен сипатталды. Математика курсына стохастикалық компонентті енгізудің негізгі мақсаты ретінде бірқатар зерттеушілер классикалық детерминизмді құрайтындарға қарағанда статистикалық заңдылықтармен, кең типтегі заңдылықтармен танысуды көреді, бұл ықтималды ойлауды детерминистік ойлаудың антиподы ретінде тәрбиелеу оқу үшін өте маңызды екенін атап өтті.

Қазіргі уақытта ықтималдықтар теориясы мен математикалық статистиканың математикалық білім беру мазмұнына қосылуы, ең алдымен, "қазіргі адамның білімі мен идеялары жүйесіндегі стохастикалық ұғымдар мен фактілердің мәні мен орны, олардың әлемдегі қолданбалы және практикалық маңызы". Ғылым мен техниканың әртүрлі салаларында ықтималдық теориясы мен математикалық статистиканы қолдану барған сайын маңызды бола түсуде: әлеуметтануда, лингвистикада, әдебиетте модельдер ықтималдық пен статистикалық әдістерді қолдана отырып құрылады; биология, физика, химия табиғи құбылыстарды зерттеуде, химиялық реакцияларды жүзеге асыруда, заттың молекулалық құрылымын зерттеуде кездесетін статистикалық заңдылықтар туралы айтуға көптеген себептер береді.

Тірек сөздер: ықтималдықтар теориясы, математикалық статистика, ойлау, әдістеме, талдау, даму, қалыптасу, студенттер, оқыту, университет.

ФОРМИРОВАНИЕ И РАЗВИТИЕ ВЕРОЯТНОСТНО-СТАТИСТИЧЕСКОГО СТИЛЯ МЫШЛЕНИЯ СТУДЕНТОВ-МАТЕМАТИКОВ

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Аннотация. В течение довольно длительного периода времени вероятностные и статистические знания оставались за рамками обучения. Стремительное развитие теории вероятностей и математической статистики в XIX-XX веках, расширение границ их применения, осознание важности стохастических знаний для современного общества позволили говорить о возможности включения теоретико-вероятностных знаний в содержание общего, среднего и высшего образования. Видные деятели науки и образования уже много лет участвуют в обсуждении этого вопроса. Наступление XXI века характеризовалась включением элементов теории вероятностей, математической статистики и комбинаторики в содержание обязательного минимума математической подготовки. В качестве основной цели введения стохастического компонента в курс математики ряд исследователей видят ознакомление со статистическими закономерностями, закономерностями более широкого типа, чем те, которые составляют классический детерминизм, отмечая, что воспитание вероятностного мышления как антипода детерминированного мышления имеет первостепенное значение для обучения.

В настоящее время включение теории вероятностей и математической статистики в содержание математического образования обусловлено в первую очередь "значением и местом стохастических понятий и фактов в системе знаний и представлений современного человека, их прикладной и практической значимостью в мире". Применение теории вероятностей и математической статистики в различных областях науки и техники приобретает все большее значение: в социологии, лингвистике, литературе модели строятся с использованием вероятностных и статистических методов; биология, физика, химия дают множество поводов говорить о статистических закономерностях, встречающихся при

изучении природных явлений, при осуществлении химических реакций, при изучении молекулярной структуры вещества.

Ключевые слова: теория вероятностей, математическая статистика, мышление, методология, анализ, развитие, становление, студенты, преподавание, университет.

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