ROLE AND PLACE OF MATHEMATICAL STATISTICS METHODS IN PEDAGOGICAL RESEARCH

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Abstract. *In pedagogy, in addition to theoretical and empirical research methods, methods of static processing of the results obtained are also often used. The information base has a large amount of material, characterized by its complexity and specific connections between individual elements. Thanks to statistical methods, it is possible to form a complete and specific picture of the pedagogical processes and phenomena used.*

The following types of mathematical and statistical methods in pedagogy are distinguished.

Nominal variables, which include gender, personal data, etc. Arithmetic processes cannot be carried out on such data, since they have a rather specific character. They are usually divided into classes according to their distinctive features.

Data with a quantitative or ordinal scale of measurement. Also called ordinary variables. When analyzing this type, data is divided into subsamples, and ranking technologies are also used. Sometimes the parametric method is used.

Quantitative variables. They show the level of expression of the measured indicator, which includes academic performance and various assessment studies. When working with this type, all traditional types of analysis are used.

Keywords: *arithmetic, actions, additions, multiplications, divisibility, division, subtraction, equations, statistics, belief theory, research, pedagogy, psychology*

Probability theory is a special section of the higher mathematics course, engaged in the study of mathematical laws of mass homogeneous random phenomena. It should be especially emphasized that the methods of probability theory, by their very nature, do not make it possible to predict the outcome of an individual random phenomenon, but they make it possible to predict the average total result of a mass of homogeneous random phenomena.

Methods of probability theory are widely used in economics, reliability theory, information theory, queuing theory, decision theory, physics, astronomy and other disciplines. Probability theory underlies mathematical statistics, which, in turn, is used in planning and organizing production, in the analysis of technological processes, product quality control, etc. Mathematical statistics is the science of mathematical methods for systematizing and using statistical data to make scientifically based forecasts and practical recommendations.

In this regard, when studying, for example, economic phenomena, their simplified formal descriptions (economic models) are usually used. Examples of economic models are models of consumer choice, models of the firm, models of economic growth, models of equilibrium in commodity and financial markets, and many others. When constructing a model, essential factors that determine the phenomenon under study are identified and details that are not essential for solving the problem posed are discarded. By its definition, any economic model is abstract and, therefore, incomplete, since, while highlighting the most significant factors, it abstracts from the less significant ones, which together can determine not only deviations in the behavior of an object, but also its behavior itself. Thus, in the simplest demand model, it is believed that the amount of demand for a product is determined by its price and consumer income. In fact, the amount of

demand is also influenced by a number of other factors: the tastes and expectations of consumers, prices for other goods, the impact of advertising, fashion, and so on.

Therefore, any economic research always involves the combination of theory (economic model) and practice (statistical data). The main element of economic research is the study of the relationships between economic variables. The study of such relationships is complicated by the fact that they - especially in macroeconomics - are not strict, functional dependencies. Besides:

1. It is always very difficult to identify all the main factors influencing the effective attribute (the indicator under study);

2. often impacts are random, that is, they contain a random component;

3. Economists, as a rule, have a limited set of statistical observation data, which also contain various types of errors.

The use of methods of probability theory and mathematical statistics often makes it possible to simplify the construction of a mathematical model of an economic system, identify factors essential for its description and assess the reliability of the forecast values of the indicator of interest obtained on the basis of the model.

We can distinguish two types of models for describing objects in the surrounding world (in particular, economic ones). Deterministic models assume strict functional connections between the variables of the model (Example: with uniformly accelerated movement of a body from a state of rest, the distance traveled is proportional to the square of the movement time, or demand is inversely proportional to the price of the product). Stochastic ones allow for the presence of random influences on the indicators under study and use methods of probability theory and mathematical statistics to describe them.

Generally speaking, all observable events (phenomena) of the world around us can be divided into the following three types: reliable, impossible and random. An event that is certain to occur if a certain set of conditions is met is called certain. Example – ice melts at temperatures above zero.

Impossible is an event that certainly will not happen if a certain set of conditions is met. Example - ice cannot exist at 100 degrees Celsius, the Earth cannot stop its rotation without external influence.

A random event is an event that, when a set of conditions are met, may or may not occur. An example is the loss of a certain number of points when throwing a dice, a projectile hitting a target, the failure of a technical device, the receipt of a certain profit by a company, etc.

The objects of study of probability theory and mathematical statistics are precisely random events, quantities and functions that characterize the random phenomenon under consideration. A random event is characterized by a certain probability of its occurrence. Probability is a numerical measure of the degree of possibility of a given event occurring under certain conditions.

Each random event is a consequence of many reasons, the influence of which on the result is very difficult (and often impossible) to take into account. Therefore, the theory of probability does not set itself the task of predicting whether a single event will occur or not, but only reveals certain patterns of the appearance of any result in a large number of tests.

Sometimes it is difficult to draw the line between the impossible and the extremely unlikely event, for example, 1. can a person live to be 1000 years old? (Probability 1 divided by 10^10^35). The probability that when you pull out 25 letters (with return) of the split alphabet you will get the phrase “My uncle has the most honest rules” (probability $(1/32)^{25} = 2.35*10^{-38}$. Such events are called practically impossible. Count or no event is practically impossible, depends on how important consequences it can lead to. For example, the probability of losing a certain amount of money during a certain financial transaction, equal to 0.01, can be neglected (we can assume that

ruin is practically impossible), and that but the probability of the parachute not opening during a jump is impossible.

Mathematical statistics also operates with estimates of the laws of distribution of random variables, identifying such characteristics as the mathematical expectation (average value) and dispersion (scatter), and also deals with the solution of applied problems, which allow, in particular, to estimate the probability of a random variable in a certain range of values.

Mathematical statistics, using a special mathematical apparatus of regression and correlation analysis, helps to establish the form of dependence of the effective characteristic on the parameters and assess the degree of their importance and relationship. Extreme (limiting) cases in this regard are uncorrelated (unrelated) and functionally related quantities.

The emergence of probability theory as a science was determined by the need for practice. The formation of interest in problems related to probability occurred not only in connection with gambling with dice and cards (Pascal, Fermat). The problems of calculating probabilities were set by the insurance business that had begun to develop, and by services for the study of population statistics, which needed theoretically based methods for processing observations. Thus, at the beginning of the seventeenth century, under the influence of emerging new economic relations and new scientific problems, a science began to take shape that studied:

- special laws that govern random variables;

- properties of random mass events that can be repeated many times when a certain set of conditions are reproduced, etc.

Traditional methods of probability theory and mathematical statistics - the theory of estimation and hypothesis testing - form the basis of econometrics, which establishes and studies quantitative patterns and interdependencies in the economy. Econometrics allows you to build economic models and evaluate their parameters, test hypotheses about the properties of economic indicators and the forms of their interrelation, which serves as the basis for economic analysis and forecasting and creates the possibility of making informed economic decisions.

The implementation of the intended action, leading to a certain result, is called an experiment (experience). If, based on the conditions describing the experiment, its result is predictable, then such an experiment is deterministic. (Example: a stone thrown up will definitely fall down. An increase in the standard of living causes an increase in the consumption of goods. A breakdown of the system unit disables the computer.)

An experiment is considered random if it could end in any of a certain set of known results, but it is impossible to say which one before the experiment is carried out. Two events are called joint in a given experience if the occurrence of one of them does not exclude the occurrence of the other. Examples: hitting an indestructible target with two different arrows, getting the same number of points on two dice.

Two events are called incompatible (incompatible) in a given experiment if they cannot occur together during the same trial. Several events are called incompatible if they are pairwise incompatible. Examples of incompatible events: a) hit and miss with one shot; b) a part is randomly taken from a box with parts - the events “a standard part is taken out” and “a non-standard part is taken out” c) the ruin of the company and its profit.

In other words, events A and B are compatible if the corresponding sets A and B have common elements, and incompatible if the corresponding sets A and B do not have common elements.

When determining the probabilities of events, the concept of equally probable events is often used. Several events in a given experiment are called equally possible if, according to the conditions of symmetry, there is reason to believe that none of them is objectively more possible

than the others (the loss of heads and tails, the appearance of a card of any suit, the choice of a ball from an urn, etc.)

Mathematical processing of the results obtained during psychological and pedagogical diagnostics is one of the most important stages of scientific research. The conclusions and conclusions that the researcher comes to during the interpretation of data, based on the primary perception of the relationship between the phenomena being studied, even with the inclusion of speculative reasoning, are not true if they are not supported by mathematical statistics.

The facts and psychological and pedagogical phenomena studied by researchers must be verified from the point of view of their statistical significance, that is, meet the requirements of statistical reliability.

Any serious scientific research that claims to be a deep study of the psychological properties and states of an individual is impossible without qualified support in the form of mathematical data processing.

Practicing psychologists, primarily those who have contact with children, when preparing a conclusion about the child's mental state and issuing professionally verified recommendations to those in need, necessarily compare individual indicators with the existing norm using mathematical statistics methods.

The need to apply methods of mathematical statistics in many psychological and pedagogical phenomena is obvious.

For example, we are interested in whether two groups of students differ in their success in solving a new experimental problem. In the first group of 20 people, 12 people coped with it, and in the second sample of 25 people, 10. In the first case, the percentage of those who solved the problem will be 12/20•100%=60%, and in the second 10/25•100%= 40%. Are these percentages significantly different for given n1 and n2?

It would seem that even "by eye" one can determine that 60% is significantly higher than 40%. However, in fact, these differences with given n1 and n2 are unreliable.

Let's check this using Fisher's φ* criterion. Since we are interested in the fact of solving a problem, we will consider success in solving an experimental problem as an "effect", and failure in solving it as the absence of an "effect".

One can only sympathize with the researcher who considers significant differences 20% and even 10%, without checking their reliability using the φ* criterion. In this case, for example, only differences of at least 24.3% would be significant.

The educational and research work of students, in accordance with the requirements for their implementation, involves young researchers turning to the methods of mathematical statistics to verify the hypothesis put forward.

The correct use of statistics allows the educational psychologist to:

1) make sure of the validity and correctness of the application of research methods and techniques;

2) find dependencies between experimental data;

3) establish the effectiveness of training and corrective actions;

4) identify the presence or absence of significant differences between test groups; ours: experimental and control;

5) draw conclusions and conclusions based on the results of the psychological and pedagogical experiment.

This manual is intended to help students master all areas of activity related to the use of statistical operations.

The reference material is presented in the form of blocks of information containing the necessary information about statistical criteria.

• brief description and purpose
• application algorithm
• statistical tables

In the absence of a stable textbook and insufficient number of teaching aids on

In the discipline “Mathematical Foundations of Psychology”, studied by students majoring in “Pedagogy and Psychology”, this manual will be indispensable in the process of “manual” processing of empirical data.

The methodological basis of statistics is the theory of knowledge, which determines the scientific approach to the study of the boundaries and conditions of reliability of processes and phenomena of society and nature. That is, statistics analyzes socio-economic processes in their interaction, interconnection, movement, change and development, and not in a state of rest and immutability.

The ability to comprehend the subject, method and tasks of statistics as a science allows the scientific development of such categories as quantity and quality, necessity and chance, causality, regularity.

Statistics as a science has its own specific methods of study, depending on the characteristics of its subject. The combination of these techniques, with the help of which statistics studies its subject, forms a statistical methodology.

Statistical methodology is understood as a system of techniques, methods and methods aimed at studying quantitative patterns manifested in the structure, dynamics and interrelations of socio-economic phenomena [1].

When considering the issue and possibilities of using statistical methods for processing information obtained as a result of pedagogical research, we rely on scientists developing the methodological foundations of pedagogy (Gmurman V.E., Zagvyazinsky V.I., Kraevsky V.V., Novikov D.A. ., Ilyin V.S.), who established the trend of using methods of mathematical statistics in pedagogical research.

When analyzing the literature, it was discovered that theoretical prerequisites had been formed for solving the problem of applying statistical methods in pedagogical research. The use of statistical methods based on the structure of a pedagogical experiment raises the problem of adequate application of statistical methods in the experimental part of pedagogical research activities.

However, as McConnell says, statistics is primarily a way of thinking, and to apply it you just need a little common sense and a knowledge of basic mathematics. In everyday life, we are constantly engaged in statistics: planning a budget, assessing the effort that will be required to master a course, taking into account the grades received so far, assessing how this or that event will affect our personal or joint future. We constantly have to select, classify and organize information, connect it with other data so that we can draw conclusions that allow us to make the right decision.

All these types of activities differ little from those operations that underlie scientific research and consist in the synthesis of data obtained on various groups of objects in a particular experiment; in their comparison in order to find out the differences between them; in their comparison in order to identify indicators changing in one direction, and, finally, in predicting certain facts based on the conclusions to which the results obtained lead. This is precisely the purpose of statistics in the sciences in general, especially in the humanities. There is nothing

absolutely certain about the latter, and without statistics the conclusions in most cases would be purely intuitive and would not form a solid basis for interpreting data obtained in other studies.

Construction of a distribution is the division of primary data obtained from a sample into classes or categories in order to obtain a generalized, ordered picture that allows them to be analyzed.

There are three types of data:

Quantitative data obtained from measurements (for example, data on weight, dimensions, temperature, time, test results, etc.). They can be distributed along the scale at equal intervals. Ordinal data corresponding to the places of these elements in the sequence obtained by arranging them in ascending order (1st, ..., 7th, ..., 100th, ...; A, B, C....).

Qualitative data that represents some properties of elements in a sample or population. They cannot be measured, and their only quantitative assessment is the frequency of occurrence (the number of people with blue or green eyes, smokers and non-smokers, tired and rested, strong and weak, etc.).

Of these types of data, only quantitative data can be analyzed using parameter-based methods (such as the arithmetic mean). But even for quantitative data, such methods can only be applied if the number of these data is sufficient for a normal distribution to appear. So, to use parametric methods, in principle, three conditions are necessary: the data must be quantitative, their number must be sufficient, and their distribution must be normal. In all other cases, it is always recommended to use nonparametric methods.

Therefore, it is necessary to determine the role of statistical methods when conducting pedagogical research, taking into account the analysis of the features and problems of their application, as well as to study the possibilities of forming, based on the analysis, a methodology for using statistics in pedagogical research.

Mass observation method. The first stage of statistical research is statistical observation - a scientifically organized collection of information about the socio-economic processes or phenomena being studied.

The data obtained as a result of statistical observation are the source material for performing subsequent stages of statistical research. Statistics studies patterns that are identified through the study of numerous mass phenomena under the influence of the law of large numbers, therefore the method of mass observations is characteristic of this stage. Also, at this stage, the goals and objectives of observation are formed, research programs are developed in general and for the above stages, specific methods and techniques used at each stage of the research are determined, an organizational plan for its implementation is drawn up, the object and unit of observation are determined [2].

The data obtained, which characterize each unit of observation, are the result of statistical observation. Obtaining characteristics of the object of observation as a whole is the goal of the study, therefore the results of statistical observation represent only the initial statistical material.
The results obtained should be processed in a certain way in order to identify statistical data from the statistical data array. This processing mechanism is the next stage of statistical research after observation and is a summary of initial data to obtain general characteristics of the process or phenomenon under study, carried out using the method of groupings and tables.

Method of statistical groupings and tables. The second stage of statistical research is a set of sequential actions to generalize specific individual facts that form a set for the purpose of identifying typical features and patterns inherent in the phenomenon being studied as a whole. The most important characteristic method at this stage is the grouping method. The statistical summary displays the distribution of source data into groups that are qualitatively homogeneous in one or

more characteristics, as well as obtaining group results. The reliability of the conclusions obtained as a result of the study is significantly influenced by the choice of grouping characteristics. To correctly identify qualitatively homogeneous groups, you should select the main ones, the most significant for a given phenomenon or process signs. One of the stages of the grouping process is the construction of distribution series, i.e., grouping observation units by size or value of the attribute [2].

The results of statistical grouping and summaries are presented in the form of statistical tables, which are the most rational, systematized, compact and visual form of presenting mass data. Methods of analysis using general indicators. Statistical analysis is the final stage of statistical research.

Patterns of connections between social processes and phenomena are identified using correlation and regression analysis, as well as methods of multivariate statistical analysis. Also, the relationships between phenomena are studied by comparing parallel series, statistical groupings, constructing systems of interrelated indices, etc.

Graphical methods are used to visually present the results of statistical studies.

To create a statistical data base and their software processing, computerization of statistical research is of great importance for statistical methodology.

In pedagogical research, an important feature is both the practical part, which reflects the vast material of experimental observations, and the theoretical basis, which completes the generalization of the research results. The use of statistical methods of information processing is a key feature of pedagogical research.

Currently, researchers are interested in various methods of quantitative data analysis that emerge during psychological and pedagogical activities. The stage of processing these results, or rather their qualitative and comprehensive analysis, is considered important. Statistical methods provide the opportunity to draw correct conclusions from the research and find the advantages of a particular method. They will also help to show the general trend, to find evidence that the scientific assumption that is being tested was justified or became unsuccessful.

A correct analysis will help check how a certain action in pedagogy or the phenomenon that favored it took place. Will be able to indicate what the conditions were for conducting such a study and its impact on the process and results. It will help answer the question whether it is possible or impossible to use such a technique in the future.

REFERENCES

1. Afanasyev, V.N. History of statistical methodology of knowledge. Bulletin of OSU No. 8. Appendix “Statistical Research Methodology” Theory and practice"
2. Application of statistical methods and computers in pedagogical research. // Introduction to scientific research in pedagogy. / Under. ed. V. I. Zhuravleva. M., 1988, pp. 16-21
3. Theory of statistics: textbook. for students of economics specialties / ed. R. A. Shmoilova. - 3rd ed., revised. - M.: Finance and Statistics, 2000. – 560 With.
4. Gusarov, V. M. Theory of statistics [Text]: textbook. allowance / V. M. Gusarov. - M.: Audit: Unity, 1998. - 247 p.
5. Gurtovaya N.G. Who needs this rating // Specialist, 2002, No. 1 - pp. 19-20
6. Edge CG. Problems of using statistical methods in the experimental part of pedagogical research // “High technologies in the pedagogical process”: Proceedings of the V International Scientific and Methodological Conference of University Teachers, Scientists and Specialists. N. Novgorod: VGIPA, 2004, pp. 260 - 261

7. Gurtovaya N.G. Historical aspect and essence of application statistical methods in the experimental part of pedagogical research // “High technologies in the pedagogical process”: Proceedings of the V International Scientific and Methodological Conference of University Teachers, Scientists and Specialists. N. Novgorod: VGIPA, 2004, pp. 262 - 263