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## THE USE OF STATISTICAL METHODS IN PEDAGOGICAL RESEARCH IN HIGHER EDUCATION

### *O USO DE MÉTODOS ESTATÍSTICOS NA PESQUISA PEDAGÓGICA NO ENSINO SUPERIOR*

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**Iryna Hrebnieva**

Kharkiv I.P. Kotlyarevsky National University of Arts, Kharkiv  
Ukraine  
Email: [yargrebne@gmail.com](mailto:yargrebne@gmail.com)

**Iryna Pakhnenko**

Sumy State Pedagogical University named after A. S. Makarenko, Sumy  
Ukraine  
E-mail: [pahnenko@gmail.com](mailto:pahnenko@gmail.com)

**Alla Melnyk**

Kharkiv I.P. Kotlyarevsky National University of Arts, Kharkiv  
Ukraine  
E-mail: [alusik@ukr.net](mailto:alusik@ukr.net)

**Yanina Lysenko**

M.Glinka Dnipropetrovsk Academy of Music, Dnipropetrovsk  
Ukraine  
E-mail: [lysenkoanina@gmail.com](mailto:lysenkoanina@gmail.com)

**Svitlana Tielietova**

Sumy State Pedagogical University named after A. S. Makarenko, Sumy  
Ukraine  
E-mail: [teletova@gmail.com](mailto:teletova@gmail.com)

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Iryna Hrebnieva  
Iryna Pakhnenko  
Alla Melnyk  
Yanina Lysenko  
Svitlana Tielietova

### **ABSTRACT**

In the article, based on the analysis of the state of the theory and practice of using statistical methods by teachers in pedagogical research, a research hypothesis is formulated: information and pedagogical support for the use of statistical methods in pedagogical research. The organizational-pedagogical and ethical-pedagogical conditions for designing information and pedagogical support for the use of statistical methods in pedagogical research are determined. The structure of information and pedagogical support for the use of statistical methods in pedagogical research has been developed. The stages are identified and the content of the system of information and pedagogical support for the use of statistical methods in pedagogical research by means of theoretical modeling is determined. The criteria of teachers' readiness to use statistical methods in pedagogical researches are revealed. The effectiveness of the system of information and pedagogical support for the use of statistical methods in pedagogical research has been proved.

**Keywords:** Higher education; Education system; Higher education; Education system, methodology and methods.

### **RESUMO**

No artigo, baseado na análise do estado da teoria e da prática do uso de métodos estatísticos por professores na pesquisa pedagógica, é formulada uma hipótese de pesquisa: informação e apoio pedagógico para o uso de métodos estatísticos na pesquisa pedagógica. São determinadas as condições organizacionais-pedagógicas e ético-pedagógicas para a concepção de informação e apoio pedagógico para o uso de métodos estatísticos na pesquisa pedagógica. A estrutura de informação e apoio pedagógico para o uso de métodos estatísticos na pesquisa pedagógica foi desenvolvida. As etapas são identificadas e é determinado o conteúdo do sistema de informação e apoio pedagógico para o uso de métodos estatísticos na pesquisa pedagógica por meio de modelagem teórica. São revelados os critérios de disponibilidade dos professores para o uso de métodos estatísticos em pesquisas pedagógicas. A eficácia do sistema de informação e do apoio pedagógico para o uso de métodos estatísticos na pesquisa pedagógica foi comprovada.

**Palavras-chave:** ensino superior, sistema educacional, ensino superior, sistema educacional, metodologia e métodos.

## Introdução

The relevance of the research problem. In any field of knowledge, the availability of relevant research by a specialist is a characteristic of his professional competencies. State tasks in the field of education and science necessitate the search for new approaches to the organization and support of scientific research. This means that each educational institution and teacher must independently examine the quality of students' knowledge.

There are systemic changes in professional and pedagogical activity, which require the teacher to master the methods of pedagogical research, analyze the mass data of pedagogical phenomena, compare control and experimental groups on any basis, study the dependence of one pedagogical phenomenon on others, classify and group phenomena. Almost every teacher becomes a teacher-researcher, since the system of constant electronic monitoring provides him with statistical data, the opportunity to understand statistically significant dependencies and use them to correct educational activities. Statistical methods are intended for these purposes.

Statistical methods are a tool with which you can perform a deeper and more thorough interpretation of the obtained experimental material, improve the quality and practical significance of the results of the experiment. When applying statistical methods in pedagogical research, one should not forget about their capabilities and limitations in pedagogy, about the use of optimal and correct statistical methods in each specific pedagogical research. Statistical methods do not replace other pedagogical research methods, they supplement, enrich and expand them, especially in matters of increasing evidence.

The degree of development of the research topic. Although the role of statistics in pedagogical research is quite large, it should be noted that there is an insufficient amount of modern literature related to the use of statistical methods in teacher-oriented pedagogy to accompany his professional research; inaccessibility of the presentation of the material for the teacher; insufficient development of the

methodology for selecting appropriate statistical methods for processing and evaluating the results of pedagogical research; the practical absence of academic disciplines, explicitly related to the use of statistical methods in pedagogy, in the curricula of master's and postgraduate studies; insufficient certainty of the boundaries of the use of statistical methods for the analysis of pedagogical phenomena; insufficient development of pedagogical conditions for the use of statistical methods. This does not contribute to the wide and conscious use of these methods in the experimental activities of the teacher, errors are made in the use of statistical methods in pedagogical research.

The presence of educational literature on mathematical statistics in itself does not solve the problem of the competent use of statistical methods by a teacher, since the examples and tasks given in them are formulated, as a rule, in mathematical language, rather serious mathematical training is required, which not every teacher possesses. Often a teacher does not have the need and opportunity to systematically study statistical courses in a specially organized training, he needs targeted support for his pedagogical research in accordance with the difficulties encountered in the data processing process.

The use of automated statistical data processing systems also requires preliminary pedagogical modeling and formulation of the task in a language understood by the program; a high information culture is necessary for their use by the teacher. Therefore, to ensure the effective use of statistical methods in pedagogical research, it is necessary to develop a system of information and pedagogical support using modern information technologies.

## **Literature review**

Research on innovations was started in the middle of the 20th century. and focused on theoretical substantiation, analysis of various aspects of innovative processes in the education and training system, developed practical recommendations for mastering, implementing, ensuring the optimal mode of

functioning of innovative projects and programs. Research in this scientific field is carried out by L. Vashchenko, L. Danylenko, I. Dychkivska, V. Kozakov, V. Palamarchuk, O. Popova, O. Savchenko. The interest in innovations of the world pedagogical community is manifested in the creation of information services (the Center for the Study of Innovations in Education under the auspices of UNESCO, the Asian Center for Pedagogical Innovations for the Development of Education), the initiation of programs for the implementation of pedagogical innovations, holding international conferences, activities of organizations summarizing pedagogical innovations in different countries of the world. In particular, the International Bureau of Education (France, Paris) publishes periodicals such as "Pedagogical Innovations", "Information and Innovation in Education" (Koris, Mato-Diaz & Hernández-Nanclares, 2021).

The Law of Ukraine "On Higher Education" stipulates that the purpose of higher education is the comprehensive development of a person as an individual and the highest value of society, the development of his talents, mental and physical abilities, the education of high moral qualities, the formation of citizens capable of conscious social choice, enrichment on this basis of the intellectual, creative, cultural potential of the people, raising the educational level of the people, providing the national economy with qualified specialists (Stoicheva, 2022).

## **Aims**

The Aim of the article: substantiation, development and testing of the system of information and pedagogical support for the use of statistical methods in pedagogical research.

The object of the research is the process of using statistical methods in pedagogical research.

The subject of the study is the information and pedagogical support of the process of using statistical methods by the teacher in pedagogical research.

## Materials and methods

To test the hypothesis put forward and solve the tasks set, the following research methods were used: theoretical (study and analysis of philosophical, scientific-pedagogical and methodical-mathematical literature on the research problem, system analysis, classification, modeling); empirical (pedagogical observation, survey, pedagogical experiment); statistical (selective method, summary and grouping of data of pedagogical observation, calculation of generalizing indicators, comparison, methods of descriptive statistics, correlation analysis).

## Results

The historical analysis of the use of statistical methods in pedagogy made it possible to determine that mathematical methods began to be used in psychological and pedagogical research at the end of the 19th century. At the beginning of the 20th century, a notable event was the emergence of experimental pedagogy, its representatives actively used statistical methods to process and interpret the empirical data obtained.

Depending on the degree of development of mathematics, statistics and cybernetics, four historical stages of the application of statistical methods in pedagogical research are distinguished based on the types of these methods: descriptive, parametric, nonparametric, informational (Silva, Arruda, Zwierewicz, Stefenon, Ferreira, Klaar & Yamaguchi, 2020).

The grounds on which it is possible to classify the statistical methods used in pedagogical research are determined: depending on the mathematical nature of the results of pedagogical

research, depending on the selected number of research elements, depending on the tasks of pedagogical research(Liu, Che & Zhu, 2022).

When classifying and describing the purpose of statistical methods, attention was paid to the typical mistakes of research teachers when using these methods. Consideration of dissertations on pedagogy revealed the following typical errors: hypothesis testing is based only on the comparability of relative or average data, and not on the use of statistical criteria (for example, criteria: Fisher, signs, etc.); the typicality of the average value of the indicators expressed in the ratio scale is not checked; the number of elements in the sample is not substantiated, mainly serial rather than random sampling is used; correlation analysis does not take into account how the pedagogical phenomenon is measured, as a result, the choice of the correlation coefficient may be erroneous (Koris, Mato-Diaz & Hernández-Nanclares, 2021).

The boundaries of the use of statistical methods in pedagogical research are defined: statistical methods are used in technological pedagogical research for pedagogical phenomena that can be quantified (they have certain units of measurement), identified or measured (for example, using well-known psychological tests). In humanitarian pedagogical research, statistical methods are used to study the similarities and differences in samples on any basis, to build classifications, groupings.

To determine the essence of the concepts "information and pedagogical support" and "information and pedagogical support for the use of statistical methods in pedagogical research", definitions, forms, prerequisites for the formation and development of pedagogical support and pedagogical support are considered (Bystrova, 2015).

(Liu, Liang, Onuma & Rithkerd, 2022).

As a result, we can conclude that today support as such is relevant in many areas of activity. Pedagogical support, in contrast to pedagogical support, is aimed at people who are quite mature, independent, who need minimal assistance from an accompanying teacher, these can be high school students, students, teachers. Pedagogical support is considered as a process that has a certain dynamics

(direction and extent). Ultimately, pedagogical support helps the accompanied person achieve their goals.

Based on the findings, definitions are given for the concepts of "information-pedagogical support" and "information-pedagogical support for the use of statistical methods in pedagogical research".

To build a system of information and pedagogical support for the use of statistical methods in pedagogical research, the features of the application of systemic and informational approaches to the use of these methods in pedagogical research are analyzed. It was revealed that both in the systemic and in the informational approaches to pedagogical research, the use of statistical means of cognition is considered from different positions. However, these approaches can and should be used in conjunction.

Information on the use of statistical methods in pedagogical research should be presented from the standpoint of a systematic approach (justified, structured, generalized, algorithmized), only in this case it will contribute to the effective use of these methods.

The pedagogical essence of the informational approach to the use of statistical methods in pedagogical research lies in the application of a system of pedagogical methods and means of providing the accompanied person with the necessary amount of various types of adapted information that contributes to his self-development and self-education in this direction. The totality of various pedagogical methods and means used by the teacher is a special type (form) of pedagogical activity - pedagogical support.

To develop a system of information and pedagogical support for the use of statistical methods in pedagogical research, information on the ethical and organizational aspects of the use of statistical methods in pedagogical research has been studied and summarized; as a result, ethical-pedagogical and organizational-pedagogical conditions have been formulated that contribute to effective information and pedagogical support for the use of statistical methods in pedagogical research (Vladimirova, 2018).



The basis of the methodological activity of the accompanying teacher is the generalization and systematization of information in the area under consideration, presented in a form understandable to the teacher (using schemes, models, algorithms), which will constitute the content of the educational and methodological complex on the use of statistical methods in pedagogical research, including a number of developments. This complex is posted on the author's website, created in the social network of educators.

Transformative activity in the developed system is a joint activity of the teacher accompanying the teacher conducting the research, and the researcher himself on the use of statistical methods.

The analytical activity of the accompanying teacher in the developed system of information and pedagogical support is intended for the effectiveness of the application and development of this system.

The subjects, types, principles, stages, structure and content of the system of information and pedagogical support for the use of statistical methods in pedagogical research are determined. Thus, the process of information and pedagogical support for the use of statistical methods consists of four stages: diagnostic, methodological, transformative, reflective.

The subjects of the system of information and pedagogical support for the use of statistical methods in pedagogical research are: an accompanying teacher - a specialist in the use of statistical methods, in the development and application of methodological materials on the use of statistical methods; accompanied teacher - a novice researcher in the field of pedagogy (teacher, senior student of the pedagogical field of study).

The types of information and pedagogical support for the use of statistical methods in pedagogical research are direct support and indirect support.

Information and pedagogical support for the use of statistical methods is based on the basic principles of systemic and informational approaches, as well as on the principles of pedagogical support: information content, priority of the

interests of the accompanied, plurality of forms, means and methods of support, development, independence, continuity of support, consistency, scientific character.

For a competent measurement of a pedagogical phenomenon and the application of appropriate statistical methods to its analysis, a definition is formulated and a classification of pedagogical phenomena is developed. A pedagogical phenomenon is understood as any special property or state of a pedagogical object; event or case in the educational process or socio-pedagogical system. It is possible to classify pedagogical phenomena according to the level of their existence, according to their relation to the main categories of pedagogy, and, if possible, measurement.

The structure of teachers' readiness to use statistical methods in pedagogical research is determined, which includes three components: content, which determines the theoretical readiness of teachers to use statistical methods; operational, taking into account practical preparedness for the use of statistical methods; motivational, which determines the motivation of the teacher to use statistical methods in pedagogical research, understanding the role, place, significance of the statistical methods used, the need for them. A questionnaire has been developed to determine the level of readiness of teachers to use statistical methods in pedagogical research.

To test the effectiveness of the developed system of information and pedagogical support for the use of statistical methods in pedagogical research, an experiment was conducted, the purpose of which is to determine the readiness of teachers and future teachers to use statistical methods before and after the introduction of this system.

Analyzing the structure of readiness to use statistical methods at the ascertaining stage of the experiment, it should be noted that the motivational component of students' readiness has the highest level. Thus, the timeliness of the developed system is confirmed.

In general, the level of readiness of teachers to use statistical methods after the introduction of the developed system of information and pedagogical support

increased from 26% to 75% (high level), among students - from 43% to 64% (medium level).

The readiness of all teachers to use statistical methods in pedagogical research after the introduction of this system (at the control stage of the experiment) was 70%, which corresponds to the average level of readiness (three teachers who have increased their level of readiness or 5% are not enough to a high level of readiness). Testing the hypothesis using the Fisher criterion confirmed the difference in the samples at different stages of the experiment.

The experimental work showed that if the developed system of information and pedagogical support for the use of statistical methods in pedagogical research is implemented, then there is the possibility of forming the readiness of teachers to use statistical methods in pedagogical research to solve professionally oriented problems, which confirms the effectiveness of the developed system.

The conducted research remains promising and allows continuing work in the following areas: creating a concept of information and pedagogical support for independent work of high school students, students of pedagogical universities; determination of the role of statistical methods in the research competence of the teacher.

## **Discussion**

1. In the process of using statistical methods in pedagogical research, four stages are distinguished: descriptive, parametric, non-parametric, informational.

The descriptive stage (late XIX - early XX centuries) is determined by the study of the intellect of children, their physiological and mental capabilities using tests, the emergence of experimental pedagogy and pedology; the parametric stage (20-30 years of the XX century) is characterized by the use of statistical methods (parametric) in processing the results of a pedagogical experiment, the development of pedagogical psychology, testology; the non-parametric stage (60-80 years of the 20th century) is characterized by the statistical planning of a pedagogical

experiment using non-parametric methods of statistics, the beginning of the development of cybernetics; the information stage (the end of the 20th - the beginning of the 21st centuries) is associated with the use of the possibilities of information technologies in the process of pedagogical research for the processing of statistical data (Kim, 2017).

2. Pedagogical conditions for effective information and pedagogical support for the use of statistical methods in pedagogical research are:

a) ethical and pedagogical conditions, which include:

- the teacher has a sufficient level of statistical culture, scientific ethics, the need to improve them and self-esteem;

- taking into account the subjectivity of measurements in pedagogical research and, in this regard, respect for the confidentiality of personal data, assessing the need for and ways to announce the results of the study;

- the use of verbal and non-verbal means of communication that contribute to the manifestation of professionally important personal qualities when interacting with the subjects of the study: when explaining the rules and tasks of testing, questioning, performing tasks and creative work, announcing the result of the study;

- the unity of the technological and humanitarian components of information and pedagogical support for the use of statistical methods, their significance for the development of the individual;

b) organizational and pedagogical conditions, which include:

- the need for a thorough analysis of the pedagogical phenomenon, its historical review, the study of mass practice in order to determine the criteria, features, statistical methods by which the phenomenon will be studied, the result will be evaluated;

- obtaining knowledge about the methodology for conducting pedagogical research, the types of statistical methods and the rules for their use in pedagogical research;

- the formation of an adequate scientific position among teachers to the choice of a statistical research method, including a critical approach to the analysis

of research methods in similar works, the use of logic and systemic scientific knowledge in this matter;

- on the basis of the acquired knowledge, independent determination of the methodology for measuring a quantitative pedagogical phenomenon using the developed teaching aids;

- the choice of the necessary statistical method of research, depending on the tasks of pedagogical research and the type of data of the pedagogical phenomenon;

- the use of statistical methods in conjunction with other research methods (historical, ethnographic, hermeneutic, group discussion methods, etc.);

- selection of information technologies accompanying the use of statistical methods in pedagogical research.

3. Information and pedagogical support is a form of partnership in which conditions are created for the person being accompanied for the independent and successful use of information in order to meet his personal and professional needs by identifying starting opportunities, the dynamics of the development of the person being accompanied, assisting and providing him, in accordance with the available level, various types of information and software and hardware in a particular area.

Information and pedagogical support for the use of statistical methods in pedagogical research is a form of partnership in which conditions are created for the independent and successful use of statistical methods in pedagogical research accompanied by a teacher by identifying his starting capabilities and development dynamics as a researcher, helping to form skills and abilities in the areas of using statistical methods, providing the accompanied, in accordance with the available level, various types of information and software and hardware in this area.

4. The model of information and pedagogical support for the use of statistical methods in pedagogical research includes three main activities of the accompanying teacher: methodical, transformative, analytical.

Methodological activity in the structure of the system of information and pedagogical support for the use of statistical methods in pedagogical research includes the activities of an accompanying teacher in developing a set of support

tools for the accompanied teachers-researchers in the field of using statistical methods. The transforming activity of the accompanying teacher includes a set of pedagogical techniques and methods for accompanying the teacher-researcher. The analytical activity of the accompanying teacher is aimed at improving the developed system. The components of the system are connected by the process of transferring information from the accompanying teacher to the accompanied one and vice versa.

5. The process of information and pedagogical support for the use of statistical methods consists of four stages: diagnostic, methodological, transformative, reflective.

At the diagnostic stage, the degree of mastery of the teacher-researcher with statistical methods and software is determined, the difficulties that he experiences are established, according to which the methods of pedagogical support are selected.

At the methodological stage, the development of pedagogical conditions for information support of the use of statistical methods, an individual program for accompanying teachers-researchers in accordance with the results of diagnostics, instructions for using a specific statistical method, tasks for accompanied teachers, individual research plans.

At the transformative stage, there is a direct implementation of the pedagogical conditions for information and pedagogical support for the use of statistical methods, the correction of the activities of the accompanied teachers-researchers in order to competently use statistical methods, providing them with assistance and support using various methods, forms and means of support.

The reflexive stage includes an assessment of the level of readiness of teachers to use statistical methods and a comparison of readiness levels before and after the implementation of information and pedagogical support, self-assessment of the achievements of the accompanied teacher.

6. To determine the effectiveness of the developed system, it is proposed to assess the readiness of teachers to use statistical methods.

The structure of teachers' readiness to use statistical methods in pedagogical research includes three components: content, the criterion of which is to determine

the theoretical readiness of teachers to use statistical methods; operational, the criterion of which is practical preparedness for the use of statistical methods in pedagogical research; motivational, the criterion of which is the motivation of the teacher to use statistical methods in pedagogical research, understanding the role, place, significance of the statistical methods used, the need for them.

## Conclusions

Thus, in the article:

- information and pedagogical support is singled out as a new direction in the study of pedagogical support and pedagogical support;

- the author's interpretation reveals the concepts: "information and pedagogical support", "information and pedagogical support for the use of statistical methods in pedagogical research";

- the ethical-pedagogical and organizational-pedagogical conditions are determined that contribute to the effective information and pedagogical support of teachers when using statistical methods in pedagogical research;

- a system of information and pedagogical support for the use of statistical methods in pedagogical

- research, contributing to the expansion of knowledge about the process of applying statistical methods by the teacher for effective management;

- a methodology for evaluating the effectiveness of the developed system based on assessing the readiness of teachers to use statistical methods was proposed: the structure, criteria and signs of readiness to use statistical methods were developed.

Theoretical significance of the study:

- the historical stages of the use of statistical methods in pedagogical research are determined: descriptive, parametric, non-parametric, informational, directions for the use of statistical methods in pedagogy at each stage are identified;

- the bases for the classification of statistical methods used in pedagogical research are highlighted: depending on the mathematical nature of the results of pedagogical research, depending on the selected number of research elements, depending on the tasks of pedagogical research;

- a definition of the concept of “pedagogical phenomenon” is given, a classification of pedagogical phenomena is developed, which allows avoiding errors in the application of statistical methods depending on the type of pedagogical phenomenon;

— the boundaries of the use of statistical methods for various types of pedagogical research (technological and humanitarian) are determined;

- generalized and structured knowledge on the rules for the use of statistical methods in pedagogical research, depending on the objectives of the study, which will allow the teacher to choose statistical methods that correspond to the objectives of his research;

- a system of information and pedagogical support for the use of statistical methods in pedagogical research has been modeled, the structure and content of this system have been developed and described, pedagogical conditions for the effective use of this system have been determined, a methodology for diagnosing the level of readiness of teachers to use statistical methods in pedagogy has been proposed.

The practical significance of the study lies in the development and implementation of a set of information and pedagogical support tools for the use of statistical methods in pedagogical research, designed for teachers, contributing to their effective support and independent application of statistical methods in pedagogical research; in adapting algorithms for pedagogical research using various statistical methods using software; in disclosing the content of the process of information and pedagogical support for the use of statistical methods in pedagogical research, designed for the effective activity of accompanying teachers.



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Iryna Hrebnieva  
Iryna Pakhnenko  
Alla Melnyk  
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