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The Formation of Human Movement and Sports Skills in Processing Sports-pedagogical and Biomedical Data in Masters of Sports

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Abstract Purpose: The urgent task of higher education is the formation of skills of processing sports-pedagogical and biomedical data in masters of physical education and sports. Recently, sufficient attention to the question of verifying the subordination of empirical data to the normal distribution law in biomedical and sports pedagogical studies was not paid. The purpose of the article is to increase the level of theoretical knowledge and practical skills in statistical data processing in masters of physical education and sports by the example of testing the hypothesis about the normal law of distribution of observed values. Methodology: Methods used at studying process are studying, analysis, systematization of scientific and special literature, generalization of scientific, educational and practical experience, pedagogical experiment. Findings: Methodological techniques that ensure the improvement of the quality of mathematics and statistical training of masters in physical education and sports have been highlighted. The use of professionally directed tasks, the presentation of a step-by-step algorithm for solving them along with the automation of computational procedures creates the conditions for the effective assimilation of educational material. There is the scheme of a practical class on the formation of skills to assess the normality of the empirical distribution. Contribution and Recommendation: Mathematical statistics is a powerful tool for studying patterns, and the use of statistical methods in sports-pedagogical and biomedical research ensures the development of sports sciences. It proves the versatility of proposed methods.

Thus, this research contributes to all elements, both sports and education.

Keywords Management, Process, Research, Statistics, Analysis, Form, Curve, Normality, Distribution

1. Introduction

Modern sports-pedagogical and biomedical research involves the processing of significant amounts of data in order to identify causal relationships and patterns and obtain reliable conclusions. A highly qualified specialist is distinguished by the ability to highlight those factors that have the greatest influence on the result of his activity, as well as the ability to analyze the consequences of such influences to determine the optimal strategy for his activity [1-2].

Thus, in the process of training masters of physical education and sports, it should be pointed that they must have not only the skills of pedagogical control over the state of physical development, the level of development of physical abilities, the degree of mastering of sports equipment, etc. [3-5], but also be able to correctly process and interpret obtained data in the course of professional activity [6].

At the same time, for future specialists in the social and humanitarian sciences, the application of statistical methods is often an extremely complicated and overwhelming task, and the processing of the results of their experimental activities often remains at an unsatisfactory level [7]. Since the automation of calculations greatly simplifies the perception of students of educational material and opens up great opportunities for the application of statistical methods without taking into account the level of mathematical preparation of students [8], the methodology for developing masters of physical education and sports in the processing of sports-pedagogical and biomedical data should be based on minimization of theoretical materials and application of information technology.

Currently, scientists are paying attention to the formation of the ability of future specialists in physical education and sports to act effectively and professionally under conditions of significant influence of random factors. So, ways to solve the problems of using the methods of mathematical statistics in sports and educational studies of masters of physical education and sports are highlighted [9], an algorithm for analyzing personal data in sports and pedagogical studies is presented [10], a methodology for preparing students of higher education in physical education institutions to apply the method of expert assessments is proposed [11].

However, many issues related to the mathematical and statistical training of highly qualified specialists in the field of physical education and sports still remain unresolved. In particular, the problem of improving the methodology for their preparation for data analysis continues to be relevant and requires further research in this direction.

The purpose of the article – to increase the level of theoretical knowledge and practical skills in statistical data processing in masters of physical education and sports by the example of testing the hypothesis of the normal law of distribution of observed values.

Research tasks

To prove necessity of increasing the level of mathematical and statistical training at analysis and processing of sport and pedagogical, medical and biological data for masters of physical education and sport.

To stress methods that help to form masters' skills of processing sport and pedagogical, medical and biological data.

To make model of practical class about forming skills of normality of empirical distribution and check effectiveness of proposed methods during masters learning process.

In the process of generalization practical experience, we proposed the following *hypotheses*: if, during the formation of skills of evaluation disnormality we use created method, we will get increasing the effectiveness of control process of mathematical and statistic training among the masters of physical education and sport. In this case, the level of their learning mathematical and statistical disciplines and readiness to use received knowledge will raise. In addition, we will get increasing level of skills to analyze the results of researches. This method involves avoiding the details of mathematical and statistical evidence, highlighting a number of criteria and available methods for estimating the form of distribution of variables using IT and presenting a clear algorithm for the implementation of calculations in MS Excel

2. Material and methods

Research methods:

- empirical: questionnaire, pedagogical experiment. Pedagogical experiment continued during the year. At constant stage, we used questionnaire, where students had to evaluate the level of their motivation to learning of mathematical and statistical disciplines and readiness to use mathematical and statistical methods of data processing for results of their own researches. As a result of questionnaire, we found out that masters of physical education and sport have decreased motivation and are not ready to do analysis of research data individually.

The formative experiment was used to determine the effectiveness of the proposed approach to the formation of

skills of analysis and processing of sports-pedagogical and medical-biological data in masters of physical education and sports. Masters were divided into 2 groups. Control group (CG) included 34 people; experimental group (EG) had 33. Masters of CG studied discipline "Analysis and processing of scientific researches in watering kinds of sport/track and field using informational communication technologies" in traditional way, masters of EG did practical tasks that were made according to the proposed scheme. At the same time, this method was used in the process of training at other higher establishments and other specialties. After learning discipline, according to the results of stage control, we checked the level of students' skills and did repeated questionnaire.

- methods of statistical of data processing: frequency analysis, we did comparing of particles using Fisher's test, that depends on realization conditions of using ratio test. Empirical processing data was handled at computer program MS Excel.

3. Results

It is known that the use of a large number of statistical methods suggests that the data to be processed are distributed normally. Indeed, often empirical data do not deviate from the normal distribution law (otherwise, the Gauss law) in the analysis of sports-pedagogical and biomedical information, when the average values of the studied indicators dominate in the distribution, and extreme values are quite rare. The main feature that distinguishes the normal distribution law among others is that it is a limiting law, which other distribution laws approach if they are widespread [12]. It is proved that the sum of a sufficiently large number of independent quantities subject to arbitrary distribution laws is approximately distributed according to the normal law, and this condition is fulfilled the more precisely the more variables are added.

Any statistical analysis of data should begin by testing the statistical hypothesis that the empirical data is subject to the normal distribution law. However, the question of checking data for the degree of deviation from the normal distribution law often remains unattended by specialists in sports pedagogical and biomedical research [13]. It indicates the need to find ways to improve the quality of mathematical and statistical training of future physical education specialists and Sports while studying in the higher educational establishments.

A characteristic feature of the process formation skills for assessing the normality of the empirical distribution masters of physical education and sports is the minimization of theoretical exposition regarding the mathematical basis for assessing the form of distribution of indicators, which are widely represented in the scientific literature [14-17]. But they are often inaccessible without appropriate mathematical or technical training. Pedagogical experience shows that a detail learning of the theoretical material about the parameters of the normal distribution, their properties and the detailing of mathematical and statistical statements may cause students' reluctance to further study of the theme. On the other hand, the use of professionally directed tasks and the presentation of a step-by-step algorithm for solving them along with the automation of computational procedures creates the conditions for the effective mastering of educational material and thereby ensures the improvement of the quality of mathematics and statistical training in masters of physical education and sports.

As a result of the systematization of special and scientific and methodological literature [18-19] and the generalization of our own pedagogical experience, we proposed a practical class for the formation skills to test hypotheses about the normal law of distribution of observed values for masters of physical education and sports (Fig. 1).

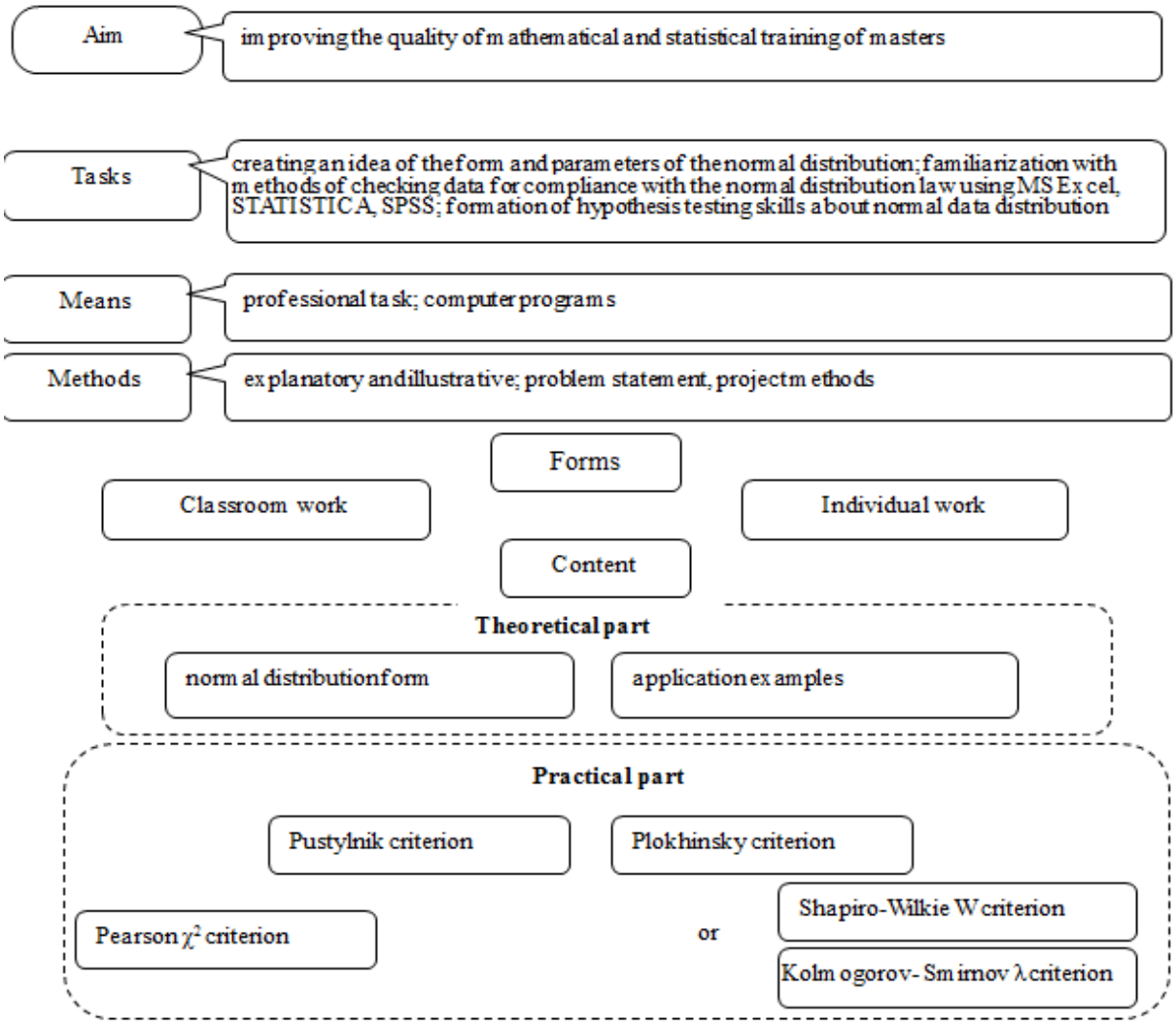

Figure 1. Scheme of a practical class of the formation skills for assessing the normality of empirical distribution

We give an example of the application of the selected teaching methods in the course of the classroom work of the masters of physical education and sports on the topic "Testing of statistical hypotheses. The normal law of distribution" in the course "Analysis and processing of scientific researches in watering kinds of sport/track and field using informational communication technologies".

First of all, we focus students that choosing a particular statistical criterion depends on the nature of the distribution and the processing of experimental data should always begin with an assessment of the nature of their distribution. We also inform that the variation in the homogeneous group is characterized by a normal curve, and if you visualize the density curve of the normal distribution, then it has a symmetrical hill shape.

We point that there are specific methods, which are used to check the normality of the distribution (Pustylnik and N.A. Plokhinsky criteria), and universal methods that are used to solve other statistical problems (Pearson χ^2, Shapiro-Wilkie W, Kolmogorov- Smirnov λ criteria).

Propose to do task. Establish empirical data subject to the normal law of distribution.

Given: information on the results of the assessment of mental performance by the total number of scanned marks of 19 students.

Decision. We enter the data into the MS Excel table and use the COUNT () function to calculate the sample size.

We introduce a custom formula using formulas that give an approximate estimate of the distribution form. When entering the formula, we rely on the presented algorithm (Fig. 2).

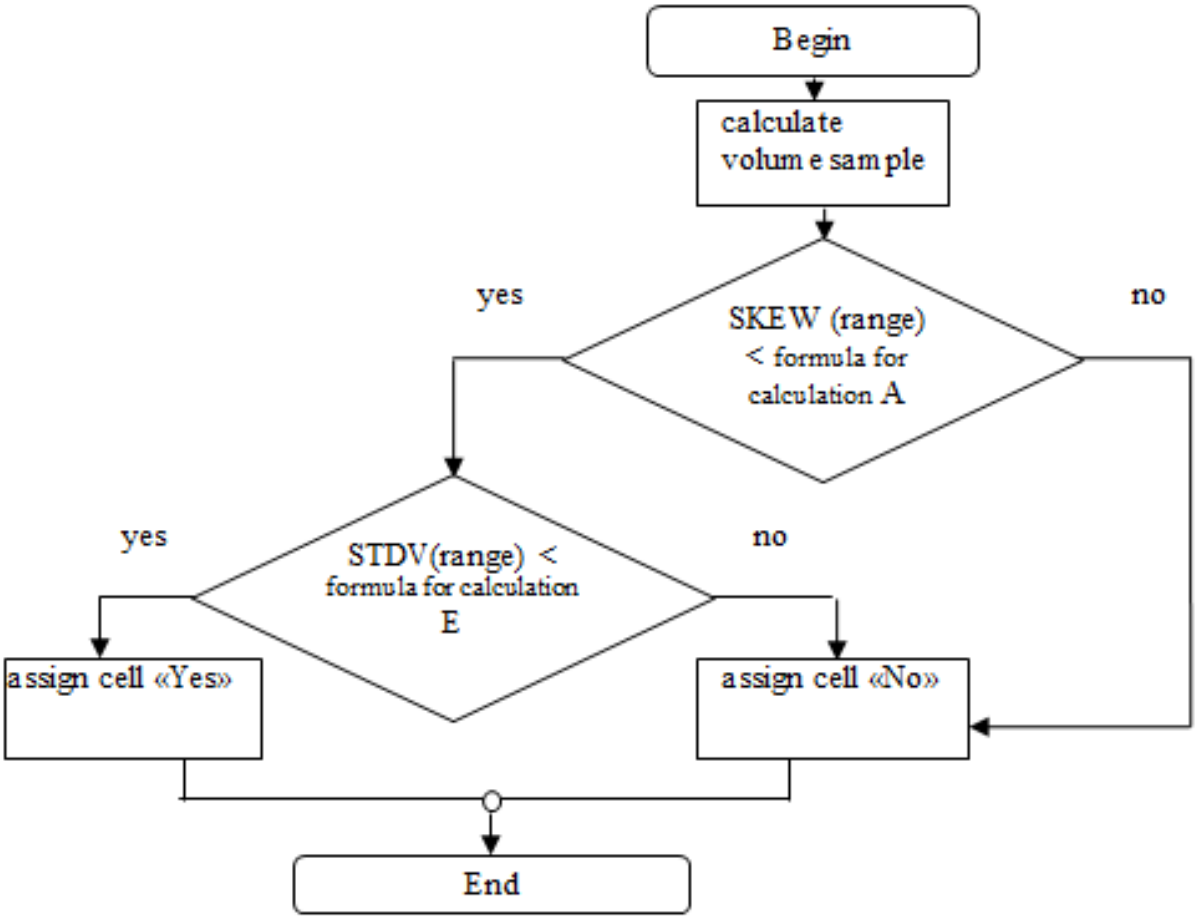

Figure 2. Algorithm of inputing formula for approximate estimation of normality distribution

As a result, we received an answer to the posed question: the first sample, "The sum of the considered characters" is subject to the normal distribution law.

We suggest students to check the normality of the distribution of the source data using the Plohinsky criterion and compare the results.

In the second part of the practical class, we evaluate the normality of the distribution by the Pearson criterion χ^2. We emphasize that this criterion is the most powerful criterion. It is used for comparing two or more distributions and applicable to both numerical and nominative data [20]. We formulate the statistical hypothesis H_0: "The distribution under study does not differ from the normal one."

We present an algorithm for evaluating the normality of an empirical distribution by the Pearson χ^2 criterion:

I. Enter the source data in the MS Excel table and organize them in a convenient form.
II. Using the standard function AVERAGE () we find the average value of the sampled data.
III. Using the standard function STDEV () we find the standard deviation.
IV. Using the Histogram of the Data Analysis add-in procedure, we find the frequencies of the interval series.

Note! If you do not specify the boundaries of the interval, the program automatically calculates the step of the interval series k.

V. Using the NORMDIST () function, we find the value of the theoretical frequency $n\ p_i$ of the hit of the sample elements in the *i-th* grouping interval for the accepted hypothesis about the normal distribution of the population, where p_i is the theoretical probability of the hit of the sample elements to the interval, and it is calculated by the formula

$$p_{i=\mathrm{P}(x_{i-1}<\mathrm{X}<\mathrm{X}^i)=\mathrm{F}}(x_i) - F(x_{i-1}), \quad (3)$$

there is a difference between the values of the considered and preliminary values of theoretical normalized values

Note! The formulas for calculating the theoretical probability of falling of the first and last values in a given interval have the form

$$p_{i=\mathrm{P}(-\infty<\mathrm{X}<\mathrm{X}^1)=\mathrm{F}}(x_i), \quad (4)$$

$$p_{i=\mathrm{P}(x_{i-1}<\mathrm{X}<+\infty)} = 1 - F(x_{i-1}) \quad (5)$$

VI. We find the theoretical frequencies by the formula, multiplying each value of the theoretical probability by the sample size.

Note! The sum of all theoretical frequencies is 1.

VII. We calculate the Pearson criterion χ^2 by the formula

$$\chi^2_{\text{розр}} = \frac{\sum_{i=1}^{n}(m_i - \text{np}i)^2}{\sum_{i=1}^{n}\text{np}i} \quad (6)$$

where m_i – frequency.

VIII. Using the CHIINV (), we calculate the critical value of the χ^2 criterion for a given significance level α = 0.05 and the number of degrees of freedom df, where

IX. df = number of private intervals-1 number of parameters.

X. Compare the critical and calculated values of χ^2. If the calculated value is more than the critical value, then the hypothesis that the general population submitted to the normal distribution law is rejected.

Objective: To establish empirical data based on the sum of scanned characters of 106 students that obey the normal distribution law.

Decision. We will enter the data into the MS Excel table and with the help of the AVERAGE () and STDEV () functions.

To automate the process of dividing data into intervals, run the Histogram of the Data Analysis add-in. To do this, in the window, make links to the column "Sum of considered characters", and also use the Output interval switch, set the place for the results of the performed operations, and also set the histogram output. After entering the initial data, we obtain the interval series and its visual representation. The table in the "Pocket" column (the studied value *x*) contains the boundaries of the intervals, and in the "Frequency" column the frequency of the random value falling into the corresponding interval.

We construct a series containing theoretical frequencies. To do this, we find p_i, as well as the theoretical (expected) frequency.

Make column «p_i» and write down formula NORMDIST (x_i) - NORMDIST (x_{i-1}) into first cell. Set value *x* for function argument (in our case it is sum of reviewed characters, average and standard deviation *s*.

For first cell formula is

$$p_1 = \text{P}(-\infty < X < 538) = NORMDIST(538; 827{,}48; 138{,}8; 1)$$

For next ones –

$$p_2 = \text{P}(538 < X < 592{,}6) = NORMDIST(592{,}6; 827{,}48; 138{,}8; 1) - NORMDIST(538; 827{,}48; 138{,}8; 1)$$ and so on.

After entering the formula in another cell, we will autocomplete it. Accordingly, the last cell will have the form

$$p_5 = \text{P}(1029.4 < X < +\infty) = 1 - P(-\infty < X < 1029.4) = 1 - NORMDIST(1029.4; 827{,}48; 138{,}8; 1)$$

Since in this case the frequency of the first "pocket" is small (equal to 2), we combine the first and second intervals and the corresponding theoretical frequencies.

We form a column for calculating the Pearson criterion and enter the appropriate formula and perform auto-completion (Fig. 3).

Using the SUMM () function, we find that the Pearson matching criterion χ^2 is 22.14, and using the CHIINV () function, we calculate that its critical value that is 14.07.

Comparing the calculated critical value of the χ^2 criterion, we state that the calculated value is more than critical. Thus, the hypothesis that the general population obeys the normal distribution law is rejected.

An independent study is carried out to check the statistical hypothesis of the normality of the distribution by the Kolmogorov-Smirnov or Shapiro-Wilkie criteria of depending on the sample size and comparing the results according to the Pearson criterion. At the end of the class, students get marks according to the results of practical work.

№	Sum of considered characters	Pocket	Frequency	p_i	np_i	Frequency	np_i	$(np_i-m)^2/np_i$
1	838	538	2	0,01851	1,962044			
2	643	592,6	4	0,026796	2,840325	6	4,802369	=(I3-J3)^2/J3
3	583	647,2	10	0,051697	5,47988	10	5,47988	3,728453716
4	709	701,8	4	0,085608	9,074475	4	9,074475	2,837662126
103	980	756,4	13	0,12168	12,8981	13	12,8981	0,000804987
104	890	811	11	0,148451	15,7358	11	15,7358	1,425273327
105	953	865,6	21	0,155456	16,47833	21	16,47833	1,240751679
106	1064	920,2	16	0,139731	14,81151	16	14,81151	0,09536567
average	827,48113	974,8	4	0,107805	11,42736	4	11,42736	4,827509531
standard deviation	138,803474	1029,4	15	0,071391	7,567451	15	7,567451	7,300052214
		Еще	6	0,072875	7,72472	6	7,72472	0,385083029

Figure 3. An example of solving Pearson criterion χ^2 in program MS Excel

The practical class contains a brief theoretical part, and the main part is aimed at mastering the practical skills of processing and analysis of sports-pedagogical and medical-biological data using specific and universal criteria using various computer programs.

As result of implementation this approach to the process of management mathematics and statistical students training of masters in physical education and sports, we got that 18% masters of experimental group (EG) have high and 53% - good level. At the same time 3% of students of the control group (CG) showed high level of knowledge, 19% of students from control group have good level knowledge. It should be noted that at the end of the experiment, particle of students from experimental group with sufficient level is more statistically significant than it is in control group ($p<0,05$).

Particle of students from experimental group with high and good level of motivation to learning mathematics and statistics knowledge among masters of the experimental group became more statistically significant than it is in control group ($p<0,05$).

Besides, research showed, among masters of experimental group the level of readiness to apply mathematics and statistics methods in the process of preparing master project are more statistically significant ($p<0,05$).

Received results prove the effectiveness of the proposed approaches to management of the process mathematics and statistical students training of masters in physical education and sports.

4. Discussion

During the pedagogical and scientific activities of various kinds of specialists, questions arise related to the statistical processing of data. Experts agree that only a sufficient level of mathematical and statistical literacy can solve research problems [21-22].

At the same time, masters of physical education and sports often experience difficulties in mastering statistical methods of data processing. This indicates the need to apply innovative teaching methods aimed at simplifying the process of perception of educational material from statistical data analysis.

The normal distribution law has a wide range of applications in the field of sports-pedagogical and biomedical research and among other laws it occupies a special position, we believe that in the process of mathematical and statistical training of masters in physical education and sports, we should dwell on the problem of expanding theoretical knowledge and the formation of practical skills and abilities to assess the degree of deviation of the data obtained during the experiment from the normal distribution law.

V.V. Pavlova [21] points to the low quality of training of future humanitarian researchers for the use of mathematical statistics, states that the effectiveness of the learning process increases provided that the priority of pedagogical support and student support on the path to the introduction of mathematical and statistical literacy, the phased introduction of educational material on probability theory and mathematical statistics in the content of education, as well as the integration of a competency-based approach into the organization system the educational process of the magistracy and graduate school.

In the process of searching for teaching methods that contribute to the generalization and systematization of students' knowledge in the study of mathematical statistics, after introducing the basic concepts of the theme A.O. Rozumenko [23] offers students a general guideline rule (algorithmic prescription), revealing the contents of a statistical test of statistical hypotheses, after processing of which emphasis is placed on differences in the choice of criterion. In addition, the author also points out the effectiveness of creating and using a table in which the methods of statistical verification of the considered parametric hypotheses are systematized.

Outlining ways to overcome the teaching problems of students understanding of mathematical and statistical processing of the results of psychological experiments, V.V. Gorbunova [24] drew attention to the desirability of using descriptive statistics and methods of statistical inference for quantitative analysis and verification of the significance of the results of their own experiments. According to the author, it is a combination of theoretical knowledge with the practice of planning and conducting their own experimental research that is an effective factor that motivates students to master mathematical and statistical knowledge.

Analyzing the experience of training future economists in Germany, N.V. Shulga [1] focuses on the effectiveness of teaching methods aimed at strengthening the practical component of the stochastic training of future economists and the visualization and computerization of the learning process.

Taking into account the advanced pedagogical experience, as well as on the basis of systematizing the results of our own pedagogical activity, we have proposed methodological methods for the formation of skills in analyzing sports-pedagogical and biomedical data of masters in physical education and sports. They are concentrating students' attention on the practical component of testing the hypothesis of subject observance given the normal distribution law without detailing of theoretical information. At the same time, the use of computer programs creates the conditions for overcoming the problems that may arise during complex calculations. This approach contributes to the creation of “success situations”, which positively affects the motivation of masters to use statistical analysis in the course of their own experimental studies.

Approbation of these methodical techniques in the process of management mathematics and statistics students training of other specialties for courses "Informational systems in management" for bachelors and "Informational systems and technologies in management of organizations" for masters gave positive results. It proves the versatility of proposed methods.

Approbation of these methodical techniques in the process of management mathematics and statistics students training of other specialties for courses "Informational systems in management" for bachelors and "Informational systems and technologies in management of organizations" for masters gave positive results also. It proves the versatility of proposed methods.

5. Conclusions and Perspectives of Further Research

1. Mathematical statistics is a powerful tool for studying patterns, and the use of statistical methods in sports-pedagogical and biomedical research ensures the development of sports sciences. Thus, the urgent task of higher education is the formation of skills of processing sports-pedagogical and biomedical data in masters of physical education and sports.
2. Recently, sufficient attention to the question of verifying the subordination of empirical data to the normal distribution law in biomedical and sports pedagogical studies was not paid. However, neglecting the data indicated by the data processing stage inevitably leads not only to a decrease in the quality of data analysis, but also to a distortion of all the results and declared conclusions and forecasts. Evaluation of the distribution form is the first stage of high-quality data processing. Its neglecting negates all further stages of statistical analysis. So, the problem of increasing the level of mathematical and statistical training for masters of physical education and sport, including of the formation of their skills to establish normal distribution in the masters of physical education and sports remains unresolved.
3. In order to improve the quality of mathematical and statistical training of masters in physical education and sports during the formation of their theoretical knowledge and practical skills of processing and analysis of sports-pedagogical and medical-biological data, it is advisable to use specific methods. Among the most effective methods we can point the use of professionally-oriented tasks, introducing a step-by-step algorithm for solving them, as well as the automation of computational procedures.
4. A practical class has been developed as an example of the formation of skills for estimating the normality of the empirical distribution, which includes the goal, tasks, means, methods and forms, as well as its content. It should be noted that the practical class contains a brief theoretical part, and the main part is aimed at mastering the practical skills of processing and analysis of sports-pedagogical and medical-biological data using specific and universal criteria using various computer programs. The proposed method is based on a step-by-step algorithm for the implementation of calculations by IT.
5. Implementation of these methodical techniques in the process of management mathematics and statistics students training of masters in physical education and sports proved their effectiveness.
6. Implementation of these methodical techniques in the process of management mathematics and statistics students training of other specialties for courses "Informational systems in management" for bachelors and "Informational systems and technologies in management of organizations" for masters proved their effectiveness. It shows the versatility of proposed methods.

Further research is to design the universal technology of forming mathematical and statistical competence of masters.

Compliance with Ethical Standards

Conflict of Interest

The authors declare that they have no conflict of interest.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent

Informed Consent Informed consent was obtained from all individual participants included in the study. All subjects of the institutional survey gave consent for anonymised data to be used for publication purposes.

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