Information and Communication Technologies in the Study of Mathematical Methods in Psychology

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Abstract. The article discusses the methodological aspects of ICT in teaching students mathematical methods psychologists. This study examines the problem of the formation of future psychologists in the process of studying the discipline "Mathematical methods in psychology" of professional competence as the ability to independently plan, organize and carry out psychological research in combination with the general competence - the use of information and communication technology. For successful professional activity, future psychologists need to know the principles of finding and selecting methods of mathematical processing of statistical data during psychological research, so a special-purpose software was developed to apply it to solve the applied professional problems of a practical psychologist within the discipline "Mathematical Methods in psychology". The use of information and communication technologies: packages of statistical processing of psychological data MS Excel, SPSS, Statistica, etc. or special-purpose software in practical classes on mathematical methods in psychology –is quite a regular phenomenon in the era of informatization of education, and the effectiveness of their use depends on the quality of teaching methods. The paper presents examples of the application of two methods of psychological research, which are often used by practical psychologists in their professional activity: a technique for the diagnosis of self-esteem of mental states and a technique for the diagnosis of temperament as the basis of psychodynamic features.

Keywords: information and communication technologies; mathematical methods; future psychologists; psychological research, professional competence of the psychologist.

1   Introduction

1.1   Formulation of the problem.

In the context of sharp political and economic changes in our country, there is an urgent need of society for qualified psychologists who can perform a variety of professional duties at a high level. In practice, the psychologist is necessary to conduct experimental studies that take into account the dynamics and trends of the society and the individual. Such psychological research requires the compilation of statistical material and its analysis using modern mathematical methods and information technologies. This situation makes the formulation of educational goals as the use of new information and communication technologies in teaching students of psychology, and as a result, improves their training.

Today one of the most important characteristics of a qualified professional psychologist is the ability to correctly solve professional problems. Exploring the problem of formation of professional competence of future psychologists - the ability to independently plan, organize and carry out psychological research [1], it should be noted that the introduction of information and communication technologies (ICT) in the educational process makes it possible to significantly strengthen the connection of the content of training with the work of a psychologist-practitioner: to provide practical training with significant learning outcomes, significantly reduce human resources utilization, and broaden knowledge of practical needs.

Analysis of curricula and educational programs for a bachelor's degree in specialty 053 - Psychology of Higher Education Institutions (HEI) of Ukraine (V. N. Karazin Kharkiv National University, Ternopil Ivan Puluj National Technical University, Kherson State University, Karpathian University Augustine Voloshin, Borys Grinchenko Kyiv University, Pavlo Tychyna Uman State Pedagogical University) indicates that curriculum developers in These HEIs consider it necessary to introduce a subject such as "Mathematical Methods in Psychology", although in some HEI this subject is identified with mathematical and statistical methods in psychology.

120 to 240 hours are allocated for studying this discipline in different HEI of Ukraine.

According to the educational-professional program "Psychology" of the first level of higher education [2], during the study of the discipline "Mathematical methods in psychology" at Kremenchuk Mykhailo Ostrohradskyi National University, psychology students have:

- formulate the purpose, objectives of the study; have the skills to collect primary material, follow the study procedure;

- Reflect and critically evaluate the reliability of the results of psychological research, formulate reasoned conclusions;

- present the results of your research orally / in writing to professionals and non-professionals.

In doing so, students acquire the application of the following skills of mathematical methods for solving psychological problems:

- the ability to find, process and analyze data from different sources to solve professional problems, including and using ICT;

- the ability to use appropriate software to conduct psycho-diagnostics and experimental psychological studies;

- the ability to analyze and implement in the professional activity of innovation, to make informed decisions;

- the ability to improve and develop their intellectual and cultural level, to acquire new knowledge using modern ICTs and innovations.

The knowledge and skills that are formed in the process of studying the given discipline are used by future psychologists during the conduct of psychological research, namely:

- a first-order ascertaining study aimed at ascertaining the causal connection between the phenomena;

- formative research, which aims not only to study but also to form one phenomenon as a result of the influence of another;

- a second-order ascertainment study, the purpose of which is to compare the effect of one phenomenon on another in groups with different characteristics.

Research these types provides an opportunity for students at all stages of learning to be active and independent in the formation and development of knowledge and skills, which in turn contributes to future psychologists the ability to plan, organize and carry out the psychological study, using modern ICT; to analyze and systematize the obtained results; make informed decisions; formulate reasoned conclusions and recommendations.

1.2 Analysis of recent research and publications.

The problem of the use of ICT in the study of mathematical subjects by students of humanities studied such scientists as O. Adamenko, V. Kirichenko, E. Vakarev, N. Dergunova, R. Ostapenko, and others. For example, E. Vakarev believes that the mathematical competence of the psychologist-practitioner acts not only as a subject but is included in the structure of professional competence. This applies to both the initial diagnostic evaluation of the specialist's data and materials, as well as the reflection, ie the ability to evaluate the effectiveness of psychological measures using mathematical methods of statistical data analysis using modern ICT [3].

The article [4] emphasizes the special importance of the introduction of ICT in the educational process and the interest of scientists in this field of education; on the importance of the acquired skills and abilities, which were acquired as a result of informatization of education and introduction of ICT into the educational process. The types of training directly related to ICT are considered, to which the authors include: distance, e-mail, mobile, blended learning, etc. Such training expands the opportunities and choices for everyone who wants to study or improve their skills or receive additional education.

Also, today published many works on forming professional competence in the preparation of future psychologists while studying at HEI [5] - [12].

Yu. Vintyuk in his papers [6, 7] considered the essence of the problem of training of future professional psychologists in HEI in modern conditions and found that the process of professional training of future psychologists is a means of forming their professional competence.

In the article [9] R. Ostapenko considered a practical lesson he conducted with students-psychologists from the course "Mathematical Methods in Psychology" using reflection. The author determines that the inclusion of students in educational and research activities through reflection - one of the conditions for the formation of the mathematical competence of the future psychologist. R. Ostapenko also concludes the importance of conducting these classes in the context of future professional activity for the wide practical application of modern information technologies and software. In the textbook [10] he considers specific algorithms for processing psychological data both manually and in statistical programs MS Excel and SPSS. This manual selects a large number of examples of the use of mathematical methods in psychology based on real results of psychological research, which are related to the activities of a practical psychologist: correctional, developmental, diagnostic, counseling, prevention, and research.

I. Levinska in [11] analyzed the structure of the professional competence of the future psychologist in foreign psychological and pedagogical studies. Based on leading European and American sources the content of the structure of the professional competence of the future psychologist is revealed.

In her research [12] T. Lavrukhina analyzed the information competence of future psychologists and included to her components the following competencies: information-communication, communicative, productive, automation, moral, psychological, subject, social, mathematical and personal qualities of the student. The researcher also determined that the generated information competence ensures that the following psychologists have the following abilities:

- apply ICT not only in the educational process but also in everyday life;
- apply ICT in solving various professional tasks;
- use ICT to explore different information models and more.

The purpose of the article is to substantiate the feasibility of using ICT in the study of the discipline "Mathematical Methods in Psychology" in the formation of the professional competence of a student psychologist.

2   Results

Usually, experimental research in psychology is conducted to test the hypothesis, which is a consequence of theoretical ideas. There are several approaches to organizing an experiment in psychology [13] - [15], but mainly the authors identify four stages of psychological research:

1. Theoretical stage (definition of research topic, formulation of goals and objectives).

2. Preparatory stage (formulation of experimental hypothesis, development of research methodology).

3. Experimental stage (gathering of actual data, testing of experimental hypothesis).

4. Interpretation stage (quantitative processing of research data, graphing, etc., formulation of conclusions).

Most often, the study of mathematical methods in psychology focuses on the last two stages, as the most time consuming and needing knowledge of mathematical statistics. We propose to use such an algorithm of psychological research in practical classes on mathematical methods in psychology.

1. Formulation of the experimental hypothesis.

2. Collection of actual data.

3. Primary data analysis (quantitative processing of research data, graphing, etc.).

4. Choosing a mathematical method of analysis.

5. Testing the experimental hypothesis.

6. Formulation of conclusions.

The processing of statistics data by mathematical methods requires, on the one hand, careful and routine operations, if performed manually, on the other - knowledge, skills, and application of software for statistical analysis of data; in turn, it causes some difficulties because the computer converts some of the numbers that are the original data into the other - the results of processing.

During the practical training in the course "Mathematical Methods in Psychology" without the use of ICT to cover all stages of psychological research - a rather difficult task that takes a long time, and sometimes - it is impossible due to limited time (statistical criteria that include quite complex formulas).

To speed up this process using available software products, such as MS Excel, SPSS, Statistica, and others. But using them again does not make it possible to solve the problem at all stages of psychological research. For example, in MS Excel convenient to just build a histogram, in SPSS - calculate the empirical value criteria.

So, to improve the process of study of the discipline "Mathematical Methods in Psychology", a software tool has been developed [16], which can be used to solve the following problems:

- conducting psychological research to test the effectiveness of the psychocorrection program of negative mental states of the individual;

- conducting psychological research to identify the relationship between temperament and self-esteem of mental states of the individual.

For the first time, the authors combined the work of both a psychologist and a respondent in one software application, which makes it possible to automatically process the statistical data of the experiment and draw conclusions about the mental state of the individual. Performed program calculations allow: to classify the individual by levels of mental states; build visual graphs of temperament distribution in the group; test statistical hypotheses about the effectiveness of psycho-correctional programs.

This software uses tests for the diagnosis of self-esteem of mental states and temperament according to G. Eysenck, which is quite often used by practical psychologists in their professional activity [17].

Let's consider in more detail all the stages of psychological research that can be carried out with the help of the developed program.

The first stage of the algorithm "Formulation of the experimental hypothesis" is positioned as a statement of the problem. For example, the student must develop a program of psychocorrection of the mental states of the individual and check its effectiveness.

To collect data on the mental states of the individual can be used G. Eysenck's test "Self-assessment of mental states", designed to determine the four mental states of personality: anxiety, frustration, aggression, and rigidity. Cystine is an important element in determining the overall adaptive capacity of humans. The test consists of 40 questions, each rated from 0 to 2 points.

So, the second step is "Actual Data Acquisition", which can be done both on paper and with the help of developed software. Fig. 1 gives an example of one of the questions of the first test of Eysenck.

Fig. 1. Example questions during user testing

Next, all the data obtained from the questionnaires should be processed. With the help of the developed tool, you can view the original data after bringing it to a convention for further analysis of the look, which is automatically recorded in the xlsx file (Fig. 2).

The next step is the primary data analysis. The software provides the ability to build conjunction tables and histograms of frequency distributions that are needed to visually compare test results before and after exposure (Fig. 3).

The stage "Choosing a mathematical method of analysis" is not made explicit, but I discuss with students why the Wilcoxon statistical criterion was chosen; what samples we have; on what scale the actual data is measured, and so on.

Fig. 2. Output in the table xlsx

.At the penultimate stage of "Testing the experimental hypothesis", after obtaining the test results, the hypothesis about the effectiveness of the impact is tested using the Wilcoxon test. When applying this criterion in the process of manually processing data, for students it is difficult to understand how to rank variables correctly or how to identify typical and atypical shifts in the values of the trait under study. In Fig. 4. in the central table you can see the table of calculations according to Wilcoxon criteria.
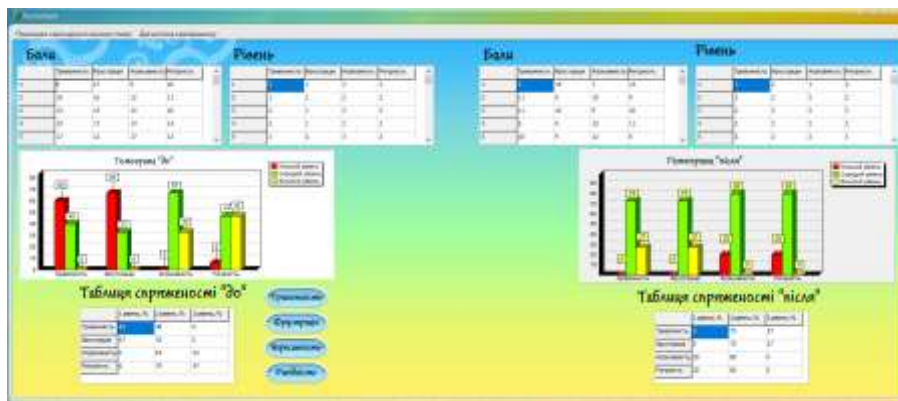

Fig. 3. Program window with primary data analysis after passing the first G. Eysenck test

By applying the above software, future specialists can simultaneously perform real psychological testing, consider the above method, and make the right statistical conclusion at the last stage of "Formulation of conclusions".

The course "Mathematical Methods in Psychology" examines other methods of computation that can be used in solving psychological problems. Therefore, it was decided to add one more test to demonstrate the practical application of the Fisher angle conversion method.

Fig. 4. Program window at the stage of "Testing the experimental hypothesis"

Therefore, the second test is used to diagnose temperament as the basis of psycho-dynamic features. The two-factor model of personality, proposed by G. Eysenck, allows using the main indicators (extraversion-introversion and neuroticism) to assess the orientation of the individual to the inner or outer world, as well as to reveal the level of emotional anxiety (tension).

Respondents are asked to answer 57 questions. The questions are aimed at identifying the type of temperament of the subject. It is necessary to present typical situations and give the first "natural" answer. Each question must be answered either "yes" or "no".

After obtaining the results of the second test, we hypothesize that there is a relationship between temperament and indicators of self-esteem of mental states using the φ* -Fisher test. This criterion is intended to compare the two samples by the frequency of occurrence of the effect being studied. The criterion evaluates the significance of the differences between the percentages of the two samples that have an interesting effect on the study.

The essence of Fisher's angular transformation is to translate the percentage of particles into the magnitude of the central angle, which is measured in radians. A larger percentage will correspond to a larger angle φ* and a smaller percentage to a smaller angle, but the ratios are nonlinear here. Therefore, mathematical concepts such as inverted trigonometric functions, central angle, radians, and the application of these quantities are quite difficult for non-mathematical students.

Upon completion of the survey, the program provides an opportunity to obtain calculations and conclusions about the relationship between temperament and indicators of the mental state of the individual. Fig. 5 - Fig. 7 shows the windows of the program after passing the first five stages of the second psychological study.

This software tool can also be used by psychology students while writing course work in the course "Mathematical Methods in Psychology" and graduate work of the bachelor.

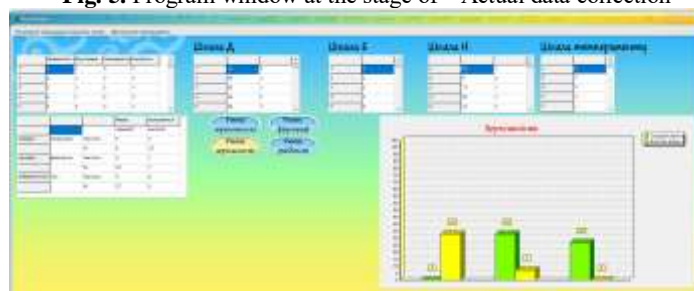**Fig. 5.** Program window at the stage of "Actual data collection"

Fig. 6. Program window at the stage of "Primary data analysis"
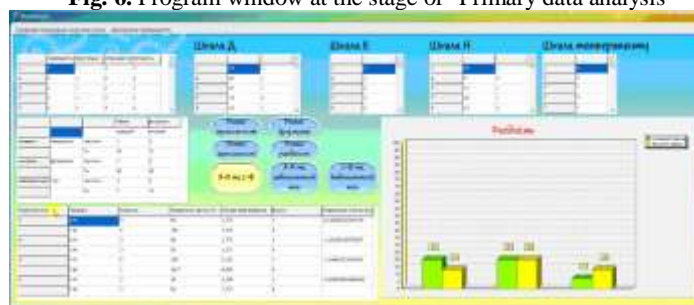

Fig. 7. Program window at the stage of "Testing the experimental hypothesis"

Let us note the main advantages of using a software tool in solving psychological problems. The training of future psychologists takes place in the course of training in the HEI and should focus on the formation of the professional competence of the psychologist. The software offered allows you to create a system of professional skills that allow you to achieve professional success and self-actualization in practice.

The formation of the professional competence of the psychologist occurs during the implementation of practical classes in the initial discipline of "Mathematical Methods in Psychology", bachelor's course and final works, during practice, and the result of its formation is the development of professional training of the future psychologist, which determines the effectiveness of his practical activity.

3   Conclusions

Therefore, a fundamental role in the formation of future psychologists is fundamental education, in particular, the teaching of mathematics and computer science as a basis for the study of general and specialized disciplines. It is impossible, but important to develop the correct conception of formation and development of thinking, to help to form students' correct ideas about the interrelation of mathematics and professional disciplines, to acquaint future psychologists with some principles of using the methods of activity of practical psychologist and application of ICT.

It should be noted that the use of the developed software in the study of the discipline "Mathematical Methods in Psychology" allows future psychologists to focus on the organization of experimental research in psychology, which contributes to the formation of professional competence - the ability to independently plan, organize and carry out psychological research. When studying mathematical methods in psychology using ICT, future psychologists acquire the following skills: mastering the principles of finding and selecting mathematical methods for analyzing statistics of psychological research; use of basic methods of mathematical processing of results of psychological researches; mastering standard packages of statistical processing of psychological data and special-purpose programs.

The prospects for further research include the experimental verification of the effectiveness of using the developed software during the study of the discipline "Mathematical Methods in Psychology" undergraduate students of specialty 053 - "Psychology" at the Kremenchuk Mykhailo Ostrohradskyi National University.

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