COMPONENTS OF PROFESSIONAL COMPETENCE OF FUTURE INFORMATION TECHNOLOGIES SPECIALISTS

COMPONENTES DA COMPETÊNCIA PROFISSIONAL DOS FUTUROS ESPECIALISTAS EM TECNOLOGIAS DE INFORMAÇÃO

COMPONENTES DE LA COMPETENCIA PROFESIONAL DE LOS FUTUROS ESPECIALISTAS EN TECNOLOGÍAS DE LA INFORMACIÓN

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ABSTRACT: The problem of providing conditions for the formation of professional competence of future specialists in information technologies application of innovative technologies in distance education is quite relevant and requires comprehensive analysis. The work aims to study the conditions for the formation of professional competence of specialists in information technologies and justify the possibilities of their provision. Experimental work was organized during 2020–2022 in three stages of scientific and pedagogical research. Nine hundred fifty-three students, 17 university teachers, who teach students of the specialty 122 «Computer Science», 123 «Computer Engineering» of the National University of Poltava Polytechnic named after Yuri Kondratyuk, Poltava National Pedagogical University named after V. Korolenko, Mykhailo Ostrohradsky Kremenchuk National University, took part in the experiment. During the research, the task of creating, supplementing, and modifying an information case on the topic «Information technologies of corporate governance» was performed, as well as a program to calculate errors.

KEYWORDS: Professionalization. Professional development of personality. Communication technologies specialists.

RESUMO: *O problema de proporcionar condições para a formação de competência profissional de futuros especialistas em tecnologias de informação e aplicação de tecnologias inovadoras na educação a distância é bastante relevante e requer uma análise abrangente. O trabalho visa estudar as condições de formação da competência profissional de especialistas em tecnologias de informação e legitimar as possibilidades da sua disponibilização. O trabalho experimental foi organizado durante 2020–2022 em três fases de investigação científica e pedagógica. Novecentos e cinquenta e três alunos, 17 professores universitários, que ensinam alunos da especialidade 122 «Ciência da Computação», 123 «Engenharia da Computação» da Universidade Nacional de Poltava Politécnica em homenagem a Yuri Kondratyuk, Universidade Pedagógica Nacional de Poltava em homenagem a V. Korolenko, Mykhailo Ostrohradsky Kremenchuk Universidade Nacional, participou do experimento. Durante a pesquisa, foi realizada a tarefa de criar, complementar e modificar um caso de informação sobre o tema «Tecnologias de informação de governança corporativa», criado um programa para cálculo de erros.*

PALAVRAS-CHAVE: *Profissionalização. Desenvolvimento profissional da personalidade. Especialistas em tecnologias de comunicação.*

RESUMEN: *El problema de proporcionar condiciones para la formación de la competencia profesional de futuros especialistas en tecnologías de la información y la aplicación de tecnologías innovadoras en la educación a distancia es bastante relevante y requiere un análisis integral. El trabajo tiene como objetivo estudiar las condiciones para la formación de la competencia profesional de los especialistas en tecnologías de la información y legitimar las posibilidades de su disponibilidad. El trabajo experimental se llevó a cabo durante 2020–2022 en tres fases de investigación científica y pedagógica. Novecientos cincuenta y tres estudiantes, 17 profesores universitarios que enseñan a estudiantes de las especialidades 122 "Ciencia de la Computación" y 123 "Ingeniería de la Computación" de la Universidad Nacional de Poltava Politécnica en honor a Yuri Kondratyuk, la Universidad Pedagógica Nacional de Poltava en honor a V. Korolenko y la Universidad Nacional de Kremenchuk Mykhailo Ostrohradsky participaron en el experimento. Durante la investigación, se llevó a cabo la tarea de crear, complementar y modificar un caso de información sobre el tema "Tecnologías de la información de gobernanza corporativa" y se creó un programa para el cálculo de errores.*

PALABRAS CLAVE: *Profesionalización. Desarrollo de la personalidad profesional. Especialistas en tecnologías de la comunicación.*

Introduction

The priority of the development of education in the field of information technologies is the introduction of modern information and communication technologies, which ensure the further improvement of the educational process, and the preparation of the young generation for life in the information society. The complex application of new information technologies in education at the current stage is the main condition for educating young people who can navigate changing circumstances, act adequately in the environment, analyze problematic situations that arise, and find rational means of orientation in them. The focus of the acquisition of knowledge on the use of information technologies as a highly effective method of training not only ensures an increase in the level of professional training of future specialists in information technologies but also significantly affects their motivational sphere, causing the formation of priority professional and educational and cognitive motivations for training, which ensure the successful acquisition of professional knowledge and skills. In this regard, the use of the latest information and communication technologies in education should be considered the most important component of the fundamental training of a qualified specialist in information technologies.

Forming a professional competence system for future specialists in information technologies is impossible to imagine without three interrelated blocks: theoretical, practical, and evaluative, taking into account the general didactic and specific teaching principles. This must be implemented in the integrated system set of information-communication and training resources, allowing the educational process to be implemented remotely.

The problem of innovative technologies in the context of professional training is studied by: Nechausov, Mamusuĉ, and Kuchuk (2017); Soltyk *et al*. (2017); Hafiiak, Borodina, and Diachenko-Bohun (2018); Vitiaz (2019); Zhao, Llorente, and Gómez (2021). Among the foreign scientists who have studied this problem are: MELL and Grance (2009); Sahami *et al.* (2013); Zikov, Kuchuk, and Shmatkov (2018); Vitiaz (2019); Amin *et al.* (2020). Information technologies to support open education and research were considered by: Sviridov (2017); Kuchuk *et al.* (2019); Hafiiak *et al.* (2019a); Kapiton *et al.* (2022); theoretical and methodological principles of formation of information educational space and use of ICT in continuing pedagogical education: Anisimov, Bondarenko, and Kameneva (2019); Hafiiak *et al.* (2019); Denysova *et al.* (2020); Shutova *et al.* (2021); features of the use of ICT tools in subject-oriented activities were studied by: Ashanin *et al.* (2018); Byshevets *et al*. (2019); Mozhaiev, Kuchuk, and Usatenko (2019); Sivaram *et al.* (2019); foreign experience in the use

of ICT and the formation of information and communication competence of the subjects of the educational process: Mell and Grance (2009); Lishchynska (2017); Hafiiak, Borodina, and Diachenko-Bohun (2018); Demianenko and Ichanska (2019); Wang (2021).

Thus, Alyoshin *et al.* (2019) analyze modern information technologies in management decisions, in particular in higher education institutions. Scientists explore the problems of forming the professional competence of future specialists in information technologies. Lishchynska (2017) investigates innovative educational management aimed at improving the quality of training of future professionals based on the developed system of resource-oriented higher education, exploring the place of distance education in modern conditions. Kapiton *et al.* (2022) believe that the main means of ensuring a sufficient level of quality of vocational education is its mobility, non-causal monitoring, analysis, and audit, which are considered as a constant, systematic collection, processing, evaluation, and transfer of information on the education system at all levels for continuous, transparent analysis of its condition, and forecasting development.

The results of these and other leading scientists' research allow us to identify promising areas in the application of information technology in the formation of professional competence of future specialists as a task of modern educational management. The problem of providing conditions for forming these professionals in the process of innovative development of educational space and increasing the application level of innovative technologies in distance education is quite relevant and requires comprehensive analysis.

The study aims to study the conditions for the formation of professional competence of specialists in information technologies and justify the possibilities of their provision. The set goal defined the tasks: to analyze the current problems of professional training of IT specialists; to analyze high-level data structures together with dynamic semantics and dynamic linking; explore the features of development and use of educational software and the possibility of creating a virtual environment; identify further areas of use of IT technologies in the educational process. Modern society is heading towards the acquisition of informative features. As a result, requirements for economic, social, and political spheres of life are changing a person.

The information society requires a new quality of education and a new interpretation. Higher educational institutions in Ukraine borrowed the work experience of foreign scientists from this issue by introducing a new form of distance learning for them. However, there is still the problem of the lack of systematized information regarding uniform requirements, regulatory legal framework, and exchange of experience in implementing an open education system. Its

solution may be creating a virtual information web resource containing systematized and generalized information on this issue, combining existing finishing touches.

Materials and methods

System approaches of social sciences, principles of system approach and functional systems, theoretical provisions of the organization of pedagogical research of domestic and foreign scientists were used to develop the research methodology: Sviridov (2017); Ashanin *et al.* (2018); Hafiiak *et al.* (2019b); Denysova *et al.* (2020); Kapiton *et al.* (2022), which allows considering the professional competence of future IT specialists as an open dynamic system with various interrelated and interdependent components. All components and connections of the educational system depend to some extent on environmental factors and the quality of life of students. The education and training system should take into account the gender, age, morphological and functional capabilities of students, their interests, and preferences.

The experimental work was organized during 2020–2022 in three stages of scientific and pedagogical research (preparatory, ascertaining, and formative). Nine hundred fifty-three students (CG – 471, EG – 482), 17 university teachers, who teach students of the specialty 122 "Computer Science", 123 «Computer Engineering» of the National University of Poltava Polytechnic named after Yuri Kondratyuk, Uman State Pedagogical University named after Pavel Tychyna, National Technical University "Kharkiv Polytechnic Institute", Rivne State University of Humanities, Poltava National Pedagogical University named after V. Korolenko, Oles Honchar Dnipro National University, Sumy State Pedagogical University named after A. Makarenko, Mykhailo Ostrohradsky Kremenchuk National University, took part in the experiment. The experimental and control groups were tested for the presence or absence of statistically significant differences between them using the Pearson test. At the beginning of the experiment, it turned out that the differences between the studied groups were statistically insignificant.

To check the level of professional competence in the field of information technology in universities, namely checking the level of residual knowledge, starting in 2020, it was proposed to monitor students' knowledge using a test that implements them: providing the opportunity for student counseling, organizing remote classes, conducting special events on the most complex issues that are part of the curriculum; conducting automated entrance and intermediate types of control, interactive lectures, practical classes, surveys, interviews, etc. Approbation in

the educational process of the developed product was used during the study of various disciplines during the entire study period.

At different stages, we have used such *set of research methods*:

- *theoretical* – methods of conceptual and comparative analysis, which compared the existing theoretical approaches based on generalization of philosophical, methodological, psychological, pedagogical, educational literature and video materials; method of structural-system analysis and modeling.

- *empirical* – conversation, graphic methods, narrative method, testing, focus group interviews, pedagogical observation, methods of collecting information (questionnaires, surveys, pedagogical testing), analysis of learning outcomes, interviews, methods of expert assessment, self-assessment, generalization of independent characteristics; ascertaining, formative, and control stages of pedagogical experiment, methods of clarity;

- *methods of statistical data processing* – for processing experimental data, their quantitative and qualitative analysis. They were used to identify the reliability of the difference between the studied indicators, the correct processing of the results, reflecting them in graphical and tabular forms, conducting experimental testing; descriptive statistics, and determination of the statistical significance of differences between groups by correlation analysis by Pearson's method.

Results and discussion

The analysis of research on the whole constellation of specialists in vocational education provided an opportunity to define the concept of professional training of future specialists in information technologies as a process of integration of theoretical and practical training in universities; providing extracurricular work with a practice-oriented communicative nature; extensive use of information technologies in the educational process. Thus, the analysis, generalization and systematization of the results of our research made it possible to define the training of future specialists in information technologies as a holistic, dynamic process of organizing the educational space of universities, which aims to form professional competence of students.

The cognitive component is characterized by professional knowledge, which is essential for successful future professional activity, as it contributes to a deep understanding of a number

of basic concepts "information – information culture – educational information – professional approach – professional research – professional communication – professional interaction – professional dialogue – professional training"; knowledge of techniques and methods of professional communication and interaction; knowledge and understanding of information culture and communication (conflict-free existence in the modern information and educational space).

The motivational component is characterized by the desire and need of the future specialist in information technologies to interact with representatives of the IT business to perform tasks of different levels of complexity. Without motivation, the professional competence of the future specialist in information technologies will not be able to take root in the minds of students due to a lack of vision of its scope. The basis for the emergence of motivation is the need, for example, to learn important information from a representative of the industry, a specialist, or a teacher, to establish cooperation with him, to participate in joint projects, and more. This component is characterized by the openness of the future specialist in information technologies to the perception of any new information and is generally based on two main motives: objective and subjective.

The "Objective" motive embodies the main idea, which can be formulated as follows: the quality of education and the level of development and preparedness for the practical activities of a specialist in information technologies becomes the most important factor in business success, quality of IT services and hence the ultimate goal of education activities of the institution of higher education, which provides training in the specialty 122 "Computer science", 123 "Computer engineering" in the field of knowledge 12 "Information Technology". The "Subjective" motive embodies the main idea, which can be formulated as follows: the need of every modern student (conscious or not) – after graduation from a higher education institution – to get a high-paying, interesting, prestigious job in Ukraine or abroad, in a prestigious IT company, make a successful business career in IT business, be realized as a person, etc.

An operational component is a system of professional skills and abilities of professional communication and interaction, which are the practical implementation of the system of professional knowledge in practice. It is characterized by the possession of future information and communication technology specialist experience and skills in building professional communications. Indicator "Skills", which must have a future specialist in information technologies – the ability to carry out professional interaction within the professional activities

in the information environment; the ability to substantiate management decisions in IT business and the ability to ensure their competence based on the results of assessment and forecasting of social, cultural, economic, political and other events in the world; the ability to communicate confidently and effectively with those whose goals, relationships, patterns of behavior and origins are significantly different from our own; ability to recognize and analyze components of organizational problems in IT activities; ability to see and explain the behavior of representatives of IT firms (organizations, enterprises) in terms of industry representatives.

The interpersonal component reflects the interpersonal communication associated with direct contacts of future information and communication technology professionals with representatives of the chosen and other professions. The interpersonal and interdisciplinary components are quite closely related, so they should be considered in conjunction. Thus, the interpersonal component is characterized by affection and sympathy for representatives of other professions (those who have other subjects of study), as well as a positive attitude towards the social information group, which is not their own (allophilia).

The component contains two indicators: "xenophilia + allophilia" – attachment to a representative (group) of another profession, which is manifested by a positive or unbiased attitude towards the bearer of another profession, which is dominant in professional activities. It should be noted that international education involves constant monitoring of effective strategies and tactics to improve the quality of education abroad, which can be adapted to the domestic education system, and the use of distance learning for students.

That is why when implementing distance learning in the system of formation of professional competence of future specialists in information technologies, it is necessary to diversify its types. It is advisable to use: specially created sites that have a powerful feedback system; chat sessions, which are held synchronously when all participants have simultaneous access to the chat; web classes, or distance lectures, conferences, seminars, business games, workshops, and other forms of training conducted using telecommunications; teleconferences, etc. (LISHCHYNSKA; 2017).

One of the global blocks of disciplines studied by applicants for higher education is "Information Technology of Corporate Governance". The study of this topic requires modern educational and methodological developments that should be used in the educational process of higher education institutions to form a system of professional competence for future professionals. An "Information Case" was prepared according to the sections of the selected topic (teaching materials), which includes: an introduction to the section; general knowledge or

information (taking into account the principle of interdisciplinary); problem description; conclusion (formulation of questions, tasks, forecasting awareness of the subject); package of additional information materials (video, audio materials, materials on electronic media links to Internet resources, presentation).

The information case was posted on the Internet resources of distance learning of higher education institutions for the study of the discipline "Information Technology of Corporate Governance". Access to the distance course was opened during the study of this discipline for classroom and independent work during the semester. Using the «Information Case» in the educational process (conducting lectures, laboratory, practical, and consulting classes), an analysis of the effectiveness of its use through testing of learning outcomes, to continuously improve it. A system of tests on the subject of the training course was developed, and many surveys were conducted using the online service "Google Forms".

Before the start of the experiment students who participated in the survey received different information cases and test questions with the same level of complexity. Based on the experiment, the absolute and relative errors of the research results were calculated, based on the postulates of the error theory using numerical methods for solving applied problems. The current state of research on various interacting processes requires substantiation and construction of complex computational algorithms, for this purpose, a wide arsenal of numerical methods is used.

Numerical methods are those sections of mathematics in which the subject of study is the methods of obtaining the result, with a certain degree of accuracy, namely the solution of problems that arise in the process of obtaining approximate data, as a result of research and analysis of its result. Inaccurate, approximate solutions of applied problems replace them with approximate values in practical or theoretical research. When using numerical methods, problem-solving is usually approximate.

This is due, in many cases, to the fact that the exact methods of solving them are impractical or unknown. In addition, even when applying the exact solution method, they are satisfied with the approximate result, in particular, for the following reasons: the same solution is time-consuming, while the approximate solution with a significantly smaller volume of calculations is quite acceptable in nature; the accuracy of the obtained result does not play a significant role, because in any case the result is rounded to an integer (for example, when determining the number of methodological, technical, technological means required to perform this amount of work). Thus, the main problems of numerical solutions of problems can be

considered: the problem of estimating the error of the approximate solution; the problem of correctness and conditionality of the task, and the problem of convergence of the approximate method to the exact.

The results of the study are shown in comparative tables and with the help of infographics. Analysis of the results of the first year of the survey on the topic «Information technologies of corporate governance». Are presented in Table 1 and are represented by a graphical representation of the data. The results of the study are presented taking into account a meaningful analysis of the components of professional competence of future specialists in information technologies (Table 1).

Table 1 – Criteria (components) of professional competence of future specialists
in information technologies

Criteria (components) of professional competence of future specialists in information technologies	Number of surveyed applicants for higher education	Awareness, the result of the survey	Awareness, the result of the survey (%)	Awareness of absolute error of assumption	Awareness, assumptions relative error (%)
	1	2	3	4	5
1. Cognitive	482	421	87%	61	12.7%
2. Motivational	482	452	94%	30	6.2%
3. Operational activity	482	408	85%	74	15.4%
4. Interpersonal	482	450	93%	32	6.6%
5. Interdisciplinary	482	425	88%	57	11.8%
The general level of professional competence of future specialists		431,2	89%	50,8	10.5%
Minimum value		452	94%	74	15.4%
Maximum value		408	85%	30	6.2%

Source: Prepared by the authors

Given the possibility of modifying the structure and content of the information case, as well as meeting the need to achieve a high level of knowledge in the selected section of the topic only in part, there was a need to supplement it and conduct testing. Analysis of the results of the second survey on the topic «Information technologies of corporate governance» is presented in Table 2. The results of the study are shown in comparative tables and with the help of infographics.

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Table 2 – Criteria (components) of professional competence of future specialists in information technologies

Criteria (components) of professional competence of future specialists in information technologies		Number of surveyed applicants for higher education	Awareness, the result of the survey	Awareness, the result of the survey (%)	Awareness of absolute error of assumption	Awareness, assumptions relative error (%)
		1	2	3	4	5
1.	Cognitive	471	426	90%	45	9.55%
2.	Motivational	471	445	94%	26	5.52%
3.	Operational activity	471	403	86%	68	14.43%
4.	Interpersonal	471	447	95%	24	5.09%
5.	Interdisciplinary	471	420	89%	51	10.82%
The general level of professional competence of future specialists			428,2	91%	42,8	9.08%
Minimum value			447	95%	68	14.44%
Maximum value			403	86%	24	5.09%

Source: Prepared by the authors

Along with other educational and methodical materials containing the "Information Case", the system of graphic materials was updated to acquaint the respondents with the main sections of the topic. The possibilities of answering questions for students' independent work have also been expanded, including preparing answers to questions on the topic in the form of interactive presentations.
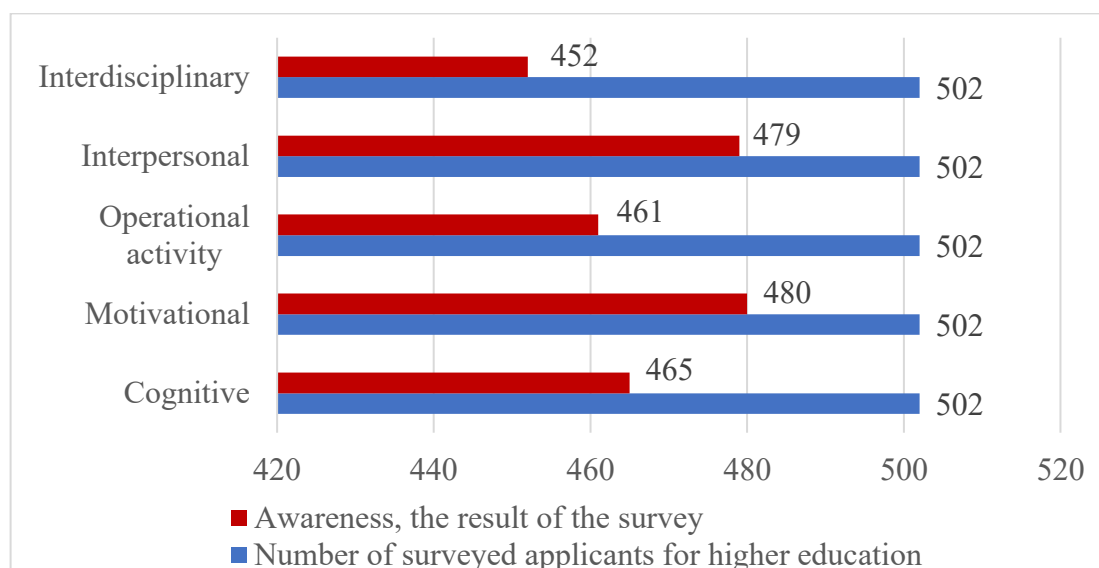
Due to the open structure of the developed information case test, the test needed to be supplemented with questions to achieve a high level of knowledge of students, and the content changed. Analysis of the results of the third survey on the topic "Information technologies of corporate governance" are presented in Table 3 and are depicted using a graphical representation of the data (Fig. 1–3). The results of the study are shown in comparative tables and with the help of infographics.

Table 3 – Criteria (components) of professional competence of future specialists in information technologies

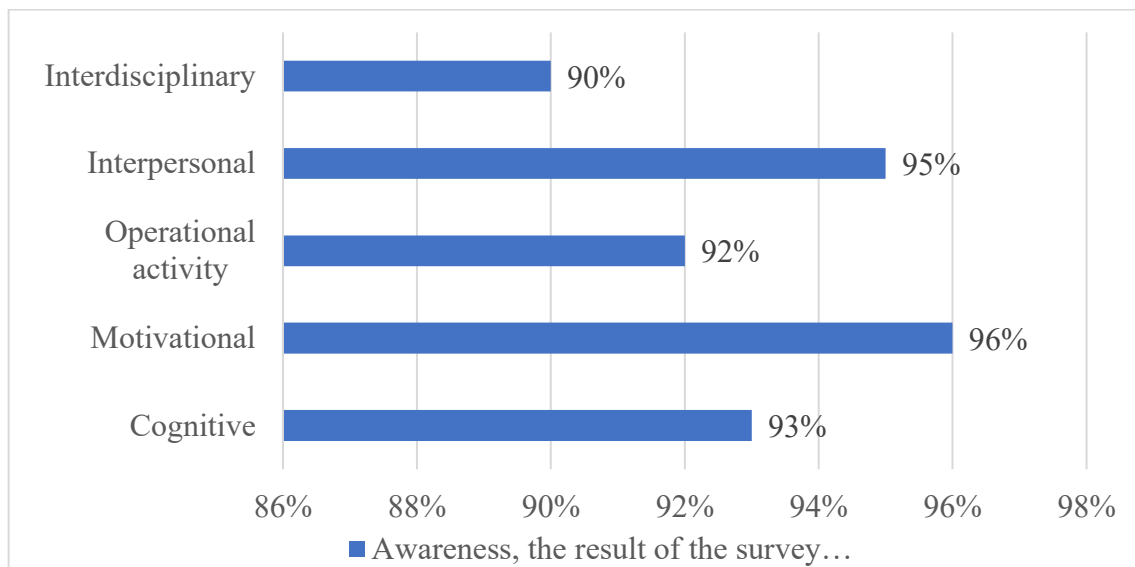|	Criteria (components) of professional competence of future specialists in information technologies	Number of surveyed applicants for higher education	Awareness, the result of the survey	Awareness, the result of the survey (%)	Awareness of absolute error of assumption	Awareness, assumptions relative error (%)
		1	2	3	4	5
1.	Cognitive	502	465	93%	37	7.37%
2.	Motivational	502	480	96%	22	4.38%
3.	Operational activity	502	461	92%	41	8.17%
4.	Interpersonal	502	479	95%	23	4.58%
5.	Interdisciplinary	502	452	90%	50	9.97%
The general level of professional competence of future specialists			467,4	93%	34,6	6.89%
Minimum value			480	96%	50	9.96%
Maximum value			452	90%	22	4.38%

Source: Prepared by the authors

**Figure 1** – The ratio of the forecast and the result of the survey in numerical form

Source: Prepared by the authors

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Figure 2 – The ratio of the forecast and the result of the survey as a percentage

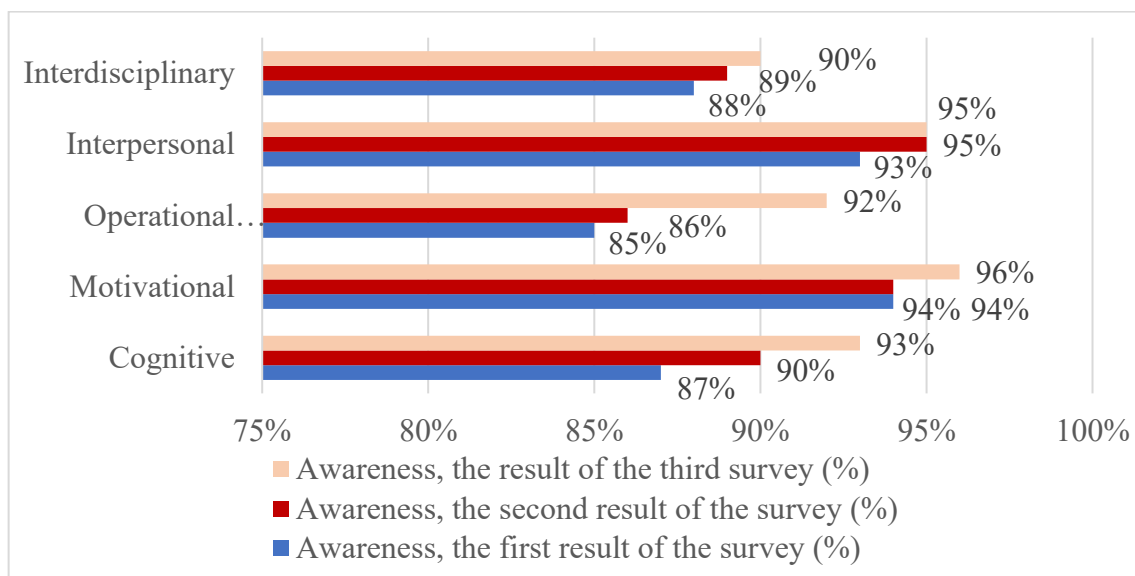Source: Prepared by the authors

Figure 3 – The ratio of the absolute error in numerical form and relative error as a percentage
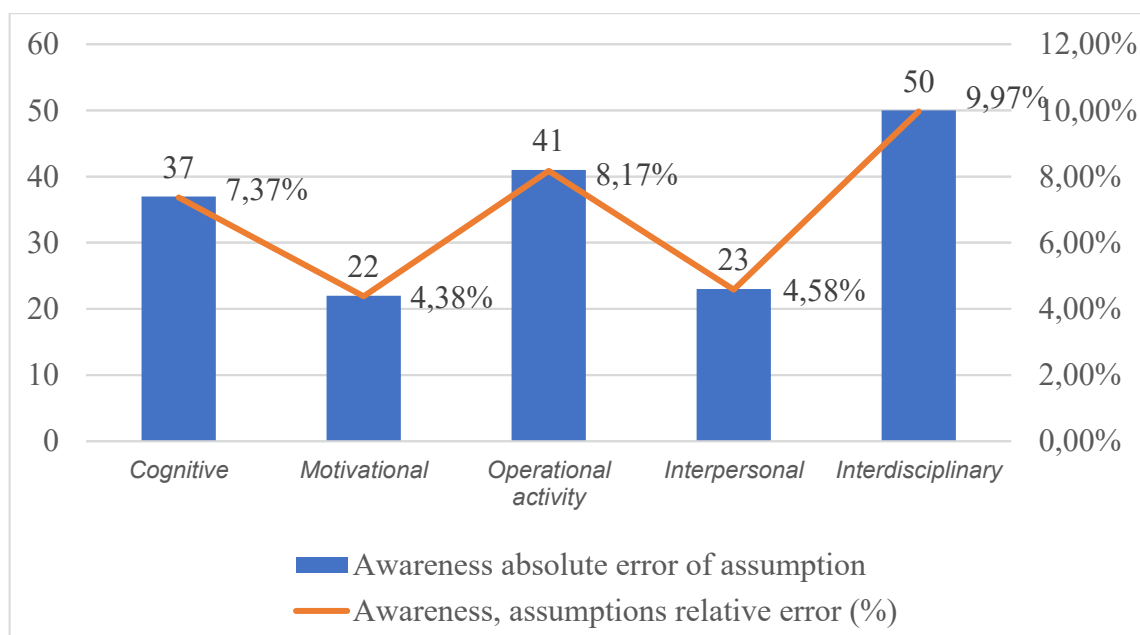
Source: Prepared by the authors

The generalized analysis of dynamics of results of the carried-out tests, owing to updating of the maintenance of "Information case" on a theme "Information technologies of corporate management" are presented by means of graphic representation of data (Fig. 4).

Figure 4 – Dynamics of the results of surveys over three years

Source: Prepared by the authors

Analysis of the positive dynamics of compliance with the criteria of professional competence of future specialists in information technologies proves that the research hypothesis on the use of information cases in the process of distance learning for higher education is to improve the quality of training of future specialists in information technologies.

Final considerations

In the course of the research, a remote approach was used in the formation of a system of professional competence of future specialists in information technologies, which is a set of tools and platforms capable of providing students with open professional training using ICT: interaction of teachers and students at different stages, training and independent work of the latter with the materials of the information network, which in content are focused on the development of professional communication and interaction. During the research, the task of creating, supplementing, and modifying an information case on the topic "Information technologies of corporate governance" was performed, and some surveys were conducted over three years with further analysis of results, creating a program to calculate errors. This indicates that respondents are becoming more aware of this topic, obtained by updating the structure and content of the information case. If we use the ratio of the number of respondents to the number of respondents who answered the questions correctly, they achieved tremendous success in the last survey, compiling detailed answers to the test questions, which was to be expected. The

average value of absolute and relative errors has significantly decreased, which provides a sufficient level of professional competence for future specialists in information technologies.

The formation of information competence of future specialists in information technologies is an essential component in the process of their professional training. A systematic, holistic view of information competence, highlighting its structure, allows you to purposefully and effectively organize the educational process within the framework of educational activities, increase the level of visual-specialized knowledge, make effective decisions in educational work, deliberately and systematically develop knowledge, abilities, and skills in the system of continuous education, which, as a typical result, is the main component of improving the quality of professional education.

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