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A SOCIAL SCIENCES

AA	PHILOSOPHY AND RELIGION
AB	HISTORY
AC	ARCHAEOLOGY, ANTHROPOLOGY, ETHNOLOGY
AD	POLITICAL SCIENCES
AE	MANAGEMENT, ADMINISTRATION AND CLERICAL WORK
AF	DOCUMENTATION, LIBRARIANSHIP, WORK WITH INFORMATION
AG	LEGAL SCIENCES
AH	ECONOMICS
AI	LINGUISTICS
AJ	LITERATURE, MASS MEDIA, AUDIO-VISUAL ACTIVITIES
AK	SPORT AND LEISURE TIME ACTIVITIES
AL	ART, ARCHITECTURE, CULTURAL HERITAGE
AM	PEDAGOGY AND EDUCATION
AN	PSYCHOLOGY
AO	SOCIOLOGY, DEMOGRAPHY
AP	MUNICIPAL, REGIONAL AND TRANSPORTATION PLANNING
AQ	SAFETY AND HEALTH PROTECTION, SAFETY IN OPERATING MACHINERY

NEUROTECHNOLOGIES AND ARTIFICIAL INTELLIGENCE IN FORMING THE PROFESSIONAL CULTURE OF PEDAGOGICAL FIELD SPECIALISTS

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Abstract: The purpose of the article is to justify and implement the methodology of formation of the readiness of specialists in the pedagogical field to form a professional culture based on the use of neurotechnology and artificial intelligence in higher educational institutions of Ukraine as a guarantee of their readiness to carry out professional activities. The basis of the methodological approach of the research is the substantiation and verification of the effectiveness of the methodology for the development of the professional culture of specialists in the pedagogical field while working in a higher educational institution. The methodology also employed empirical methods (analysis, comparison, systematization, survey, questionnaire, testing, modeling and design), experiment (ascertaining and formative), methods of mathematical statistics: processing of the final indicators of the formation of the level of readiness of specialists in the pedagogical field for the formation of professional culture based on the use of neurotechnologies and artificial intelligence. The content of the concept of "artificial intelligence" is defined; its features and peculiarities are revealed, the methodology for the development of the professional culture of specialists in the pedagogical field is developed and implemented. During an experimental study on the basis of the Oleksandr Dovzhenko Hlukhiv National Pedagogical University, a methodological toolkit was developed to increase the readiness of pedagogical specialists to form a professional culture based on the use of neurotechnology and artificial intelligence, namely the implementation of components of readiness with selected methods for their formation and pedagogical conditions: ensuring the formation of the professional culture of specialists in the pedagogical field during advanced training through the introduction of neurotechnologies and artificial intelligence in professional activities; integrativeness in the content of educational programs for improving the qualifications of educators; integrity, continuity and systematic formation of professional culture; active mastering of the experience of implementing neurotechnologies and artificial intelligence in the subject-subject dimension; ensuring reflexive activity in the direction of self-improvement. After conducting an experimental study, promising directions for improving the methodology of training specialists in the pedagogical field for the formation of professional culture based on the use of neurotechnology and artificial intelligence were outlined. The practical value of the work lies in the development of a methodical system for improving the formation of the professional culture of specialists in the pedagogical field.

Keywords: professional culture; readiness components; pedagogical conditions; neurotechnologies; artificial intelligence.

1 Introduction

In recent years, general trends in the development of technologies and equipment have been formed in Ukraine and the world - the fourth industrial revolution - an era of rapid development of innovations. The active development and implementation of digital technologies definitely affect the nature of production, scientific research, education, culture, everyday life, social relations and structures [5].

Solving the issue of involving artificial intelligence in the educational process of a higher school is the key to changing the educational landscape. Together with the active implementation of distance and mixed education, the problem of diversification and better visualization of educational material arises as a prerequisite to the formation of the professional culture of specialists in the pedagogical field. Methodically balanced use of artificial intelligence tools and cloud services of open science can be a possible solution to this problem [12; 26].

Today, there is an increase in global demand for wireless communication networks due to the constantly growing number of wireless network users and the emergence of new wireless

services. Active development of fifth-generation (5G) and newer 5G (B5G) wireless networks is expected, with higher data transfer speeds, improved coverage, better economy, resource utilization, security, adaptability and scalability. Artificial intelligence (AI) technologies have the potential to effectively solve problems related to large volumes of data that must be solved during the design and optimization of 5G and B5G wireless networks [4; 21].

The Ministry of Digital Transformation of Ukraine submitted the project "Concept of the Development of Artificial Intelligence in Ukraine" to public discussion. The concept was developed based on the example of already adopted documents in the countries belonging to the European Union and a number of other developed countries. The Concept project covers various aspects of artificial intelligence, namely: science, economy, defense, public administration, etc [22].

According to leading scientists M. Khan and M. Lulwani, the implementation of artificial intelligence should be seen as a tool for preserving global leadership, developing society, and preventing numerous political, economic, environmental, military, and other risks and threats. Artificial intelligence systems have been actively implemented in various areas of life for many years, including "smart home" and "smart city", automatic translation and image recognition, unmanned aircraft and cars, systems for processing large data sets, automatic factories, the latest medical diagnostic systems, etc. [16].

The development and introduction of neurotechnologies and artificial intelligence definitely affects the development of the professional culture of specialists in the pedagogical field.

However, at this stage, one should note the low level of pedagogical professional culture of a significant part of pedagogical personnel, which combines the level of general and professional development. The study of the experience of teachers training shows that the level of professional culture is a clear indicator of their readiness for professional activity in the conditions of digitalization.

Professional culture is interconnected with the components of personal culture, namely: moral, legal, gender, mental, aesthetic, etc. Their development is influenced by the entire complex of social, economic, and pedagogical factors. Professional culture is inextricably linked with the general level of personality culture [11]. In particular, the professional culture of a teacher is a combination of competence and professionalism in a certain field of knowledge with the actual pedagogical culture of the individual, which contributes not only to the transmission of knowledge, but also to the creation of a humane developmental environment in the educational process. In the light of the ideas of humanism, the leading characteristics of the professional culture of specialists in the pedagogical field include the humanistic pedagogical position of the teacher, psychological and pedagogical competence and developed pedagogical thinking, culture of professional behavior (values, ability to reflect, self-regulation of own activity), culture of pedagogical communication, information culture, the ability to use digital technologies [2; 15].

The purpose of the article is to investigate the significance of the introduction of neurotechnologies and artificial intelligence into the system of pedagogical education.

With the development of the era of automation and informatization, the issue of the introduction of artificial intelligence by experts in the pedagogical field, in particular, into the education system, is becoming increasingly important. In connection with the extraordinary pace of artificial intelligence development, the outlined issue is gaining increasingly more relevance and feasibility of conducting research in this direction.

2 Materials and Methods

To achieve the goal, the following complex of theoretical research methods was used: comparative and systematic analysis, synthesis and evaluation of scientific sources regarding the use of neurotechnology and artificial intelligence in education in order to analyze and determine the state of the investigated problem of the use of neurotechnology and artificial intelligence at different levels of education, and study their relationships; verification and generalization to build the main theses and research provisions; analysis of existing approaches to the use of artificial intelligence in education; assessment of the level of their effectiveness and efficiency [14].

The main methods in the process of experimental research were aimed at studying the problems of shaping the readiness of pedagogical specialists to form a professional culture based on the use of neurotechnologies and artificial intelligence, searching for perspectives and priorities for the use of digital technologies during the formation of the professional culture of pedagogical specialists, which involved the development of components of readiness and criteria (namely: emotional component (emotional-volitional criterion), motivational component (motivational-value criterion), cognitive-activity component (knowledge-operational criterion), reflective component (relaxation criterion)) and psychological and pedagogical conditions, namely: provision of formation of the professional culture of specialists in the pedagogical field during advanced training through the introduction of neurotechnologies and artificial intelligence in professional activities; integrativeness in the content of educational programs for improving the qualifications of educators; integrity, continuity and systematic formation of professional culture; active mastering of the experience of implementing neurotechnologies and artificial intelligence in the subject-subject dimension; ensuring reflexive activity in the direction of self-improvement.

These methods included: analysis, comparison, systematization, surveys, questionnaires, classification and generalization of theoretical data, modeling of the diagnostic process of the formation of the professional culture of pedagogical specialists with the help of developed components of readiness and pedagogical conditions, generalization of the method of shaping the professional culture of pedagogical specialists in the process of professional training.

The experimental study was conducted at the Oleksandr Dovzhenko Hlukhiv National Pedagogical University. The sample size was 68 teachers.

36 respondents were involved in the control group, and 32 respondents - in the experimental group, including 30 women and 38 men.

In order to ensure the representativeness and reliability of the sample, the peculiarities of the formation of experimental groups, age and gender were determined. The formation of the control-research array was carried out by pairwise selection. The condition was taken into account that at the end of the selection, the number of the experimental group met the requirements of representativeness. The sample consisted of 68 master's students. 36 respondents were involved in the control group, and 32 participants in the experimental group. From the selected respondents, 30 women and 38 men were selected for the experimental study.

To obtain initial indicators, at the beginning of the experiment, an analysis of the level of development of the professional culture of specialists was carried out, problems that can be effectively and qualitatively solved with the help of the practical use of the author's methodology were identified; after determining the contingent of participants, a diagnosis of the individual levels of the formation of the components of the professional culture of specialists in the pedagogical field in institutions of higher education was carried out, their surveying was conducted, the necessary conclusions were drawn.

An analytical study of the effectiveness of the formation of the specified components of the readiness of pedagogical specialists for the formation of professional culture based on the use of neurotechnologies and artificial intelligence was conducted. Integrated trainings have been developed, which are implemented in training programs for specialists in the pedagogical field along with the use of doping methods aimed at forming the ability to maintain confidence during professional activities (lecture, open class, etc.), development of pedagogical portfolios, presentations, creative and cultural events, implementation of project activities, etc. The obtained data were processed using the methods of mathematical statistics: processing of the final characteristics of the formation of levels of readiness of specialists in the pedagogical field for shaping of professional culture based on the use of neurotechnology and artificial intelligence.

Based on the results of the implementation of the outlined methods, the obtained results were analyzed, their generalization was made, conclusions were drawn, and prospects for further research were formulated.

3 Results and Discussion

The study of the strategic development of the economy for 2020-2030 gives reasons to claim that a completely new type of industrial production will emerge in Ukraine, which will be based on Big Data and its analysis, full automation of production, augmented reality technologies and the Internet of Things.

That is why the rapid development of artificial intelligence in all areas of human life determines the use of digital technologies in the educational process of higher education institutions in the formation of the professional culture of specialists in the pedagogical field [6; 25].

The continuous development of specialists in the pedagogical field, their formation as a person of culture, an agent of change, an innovative personality involves the creation of effective conditions for professional growth, personal self-development through the use of potential opportunities of the modern information society [12]. Among the important means of forming the professional culture of specialists in the pedagogical field, there is readiness to use neurotechnologies and artificial intelligence in professional activities [1].

In determining the content of the basics of artificial intelligence, one should proceed from provisions that reflect the logical and psychological aspect of the selection of educational material. Their essence lies in the assimilation of knowledge based on the conditions of their origin, due to which they acquire their significance, and, along with this, the educational material should provide the opportunity to identify the subject sources of knowledge and to single out the genetically original, essential, universal relationship that determines the content and structure of object of given knowledge.

In the draft Concept, the notion of "artificial intelligence" is defined as "the property of systems to correctly interpret external data in accordance with the set goal, learn from such data and use the results of learning to achieve the set goals, including the collection and use of new data through interaction with the environment".

On the basis of the British Industrial Strategy (*Industrial Strategy: Building a Britain fit for the future*), other emphasis is placed on understanding the concept of artificial intelligence - these are technologies capable of performing tasks that would otherwise require human intelligence, for example, visual perception, speech recognition and translation of languages. But, regardless of which definition to choose, the development of artificial intelligence implies approximately the same requirements for education and changes in the education system itself [3; 24].

All countries that create strategic documents on the development of artificial intelligence see approximately the same main goal of education in this process - to guarantee that society will be able to take full advantage of the opportunities provided by artificial intelligence.

To date, "DigCompEdu" has been created - a science-based basic foundation whose purpose is to help guide policy in the field of digital educational technologies; it can be adapted to the implementation of regional and national tools and educational programs. "DigCompEdu" provides a common language and approach that creates a dialogue and exchange of best practices between countries in the field of pedagogy. The "DigCompEdu" framework is intended for specialists in the pedagogical field, including inclusive and non-formal education [17].

The framework of the digital competence of the teacher "DigCompEdu" defines 6 main areas reflected in 22 components (Figure 1), in which the competence of the teacher is expressed.

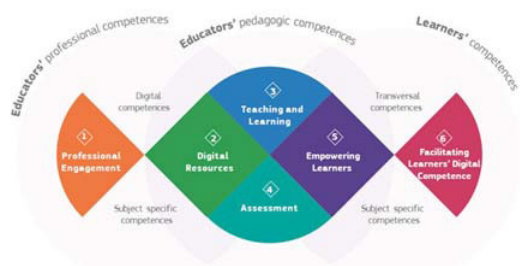


Figure 1. Areas of digital competence

Area 1 "Professional Engagement" involves the use of digital technologies for communication, collaboration, and professional development.

Area 2 "Digital resources" includes the search, creation, and distribution of digital resources.

Area 3 "Teaching and learning" brings together the management and organization of the use of digital technologies in teaching and learning.

Area 4 "Assessment" is the use of digital technologies and strategies to improve assessment.

Area 5 "Empowering students" involves the use of digital technologies to improve inclusion, personalization, and active engagement of students.

Area 6 "Facilitating learners' digital competence" includes providing opportunities for creative and responsible use of digital technologies for working with information, communication, content creation, well-being and problem solving [18].

Artificial intelligence (AI) is the ability of digital devices to perform the tasks inherent in intelligent beings.

The basis of any intelligence is a neuron. When it comes to humans, it is a biological neuron, and when it comes to computers, it is an artificial neuron.

Research in the field of artificial intelligence began in 1954. In 1956, an expert in the field of informatics J. McCarthy proposed a definition of artificial intelligence, according to which training should be carried out with great accuracy [29].

The studies highlight the following aspects of the use of artificial intelligence in education:

Adaptive learning. It consists in providing an opportunity to monitor the individual process of students and alerting the teacher about difficulties in understanding the educational material.

Personalized learning. Artificial intelligence allows choosing own learning speed.

Automatic assessment. With the help of the use of artificial intelligence, automatic evaluation of answers, provision of individual feedback, creation of an individual training plan is carried out.

Interval training. Consolidation of educational material using artificial intelligence systems can be carried out in stages.

Evaluation of the teacher by students. On the basis of student questionnaires, their relationship to teachers is revealed, which is the basis for obtaining relevant information and adjusting actions [30].

For this purpose, the following are used:

– Chat bots, which are used to collect information using a dialog interface that simulates this process. Conversations can be adapted to the character of the student and modified depending on his answers. Chatbots can filter out rude comments and personal insults that are sometimes found in feedback forms.

– Smart campuses. The smart campus answers any questions students may have related to their studies and life: how to find a lecture hall, register for a chosen course, receive an assignment, contact a teacher, etc. [27].

One of the main features of the Fourth Industrial Revolution, which is taking place today, is that the latest technologies and universal innovations are spreading much faster and on a larger scale compared to previous revolutions. The prospects of total automation and robotization of all spheres of production, the emergence of artificial intelligence open up wide opportunities for growth to the world economy, contribute to raising the level and quality of life of individuals and society in general. At the same time, the active implementation of advanced technologies and innovations entails new challenges, primarily in the social sphere.

The ability to communicate and control computers with the help of thinking and perspectives began to be used in education (teaching and learning), and now it is considered as the fourth technological revolution, which radically changes the structure of higher education around the world. The use of machine learning and neural networks has great potential for open science, namely: pattern recognition, natural language processing, robotic agents, strategic thinking, etc. [20].

Two types of artificial intelligence are distinguished: rule-based and machine learning. Rule-based AI uses decision-making rules to generate or suggest a recommendation or solution to a given query, such as an intelligent tutoring system. Artificial intelligence based on machine learning is much more powerful. In education, artificial intelligence tools based on machine learning can be used to monitor student activity and create models to predict student behavior outcomes. Today, the use of machine artificial intelligence is actively implemented in the educational process of higher education institutions. For example, Pearson uses natural language processing for assessment [30].

The study highlights the advantages of using artificial intelligence in the education system:

1. Artificial intelligence systems are able to adapt to the educational needs of students.
2. Artificial intelligence systems are capable of analyzing and monitoring the student's current learning style and available abilities.
3. Artificial intelligence systems evaluate not only closed answers in the test format, but also descriptive ones.
4. Adaptive training of students is used at the initial level, and then gradually moves to the next stage, completing the previous one.
5. Artificial intelligence can give students access to education according to need.

6. Using artificial intelligence to create educational content: AI programs that convert voice to text are widely used.

Artificial intelligence manifests itself in the implementation of adaptive learning, personalized learning, interval learning, automatic evaluation of educational achievements with the possibility of analyzing answers and providing personalized assistance, evaluation of teachers by students, etc. A rather promising and effective technology in the conditions of online education is adaptive learning, which involves adjusting the content of education within individual educational components based on the analysis of the educational achievements of the students. In the educational field, there is the use of intelligent information systems, expert learning systems, multi-agent and adaptive learning systems, ontological knowledge bases grounded on the use of the Semantic Web. For example, in the formation of the professional culture of specialists in the field of pedagogy, it is possible to use an intellectual system of information and cognitive support for the functioning of the National Qualifications Framework (NQF), which allows to automatically compare the level of qualifications with specific personal data of specialists in the pedagogical field, compare the list of competencies of the NQF with the list of competencies of another countries, providing assistance in choosing a specialty based on acquired competencies, etc. [28].

Approaches to the use of artificial intelligence in online education are highlighted on the basis of the studied literary sources are distinguished, namely:

1. Hyper-personalized educational process. It consists in the development by educational institutions of individual study profiles according to the abilities of each student. Based on such a profile, educators from all over the world are able to assess students' abilities and help improve success rates.
2. Voice assistants to improve the perception of information. The applications Amazon Alexa and Microsoft Cortana are offered for use, designed to carry out the planned course materials and satisfy one's information needs. The use of voice assistants is that they replace the traditional handouts given to students by the teacher. Thanks to this approach, the need for internal constant support from the teacher is reduced and the quality of students' education is increased. The practice of using voice assistants allows reducing the active load on both the teacher and the student.
3. Teacher assistants. In a higher education institution, there is a need to manage the teaching staff and students' performance, as well as to perform administrative tasks that ensure the continuous operation of the academic environment. Such assistants include services that improve work with personnel and management of the educational environment, output of the main document flow, duties not related to teaching: performance evaluation, student cooperation, etc. Artificial intelligence is used in the design of Google services, where since 2016 the Google Neural Machine Translation (GNMT) technology has been integrated into the translation system. GNMT significantly improves the quality of translation, in which the system learns from information found in millions of sources on the Internet. Due to the significant end-to-end structure, the system learns to produce better translations over time [23].

Attention should be paid to mobile applications that help the teacher to select educational material in relation to the audience of students, the educational program, the curriculum. Such applications are employed during the study and consolidation of educational material, analytical selection of educational material in the process of performing educational tasks. Based on the received information, artificial intelligence can provide a report to the teacher, and he, in turn, can adjust his course.

In recent decades, the use of chatbots has gained importance.

A chatbot, mentioned above, is an artificial intelligence system with which users interact through text. They are most often used in almost all spheres of activity: from e-commerce to industry and the provision of public services.

The role of chatbots in education is quite significant. They are a promising tool because they are individualized for a certain listener according to his level of knowledge acquisition and pace of learning. They do not require resource costs in addition to computer equipment and act as an analogue of "feedback" services, processing user questions and finding an answer to them, or directing a request to a service center. The lack of feedback should be attributed to the disadvantages of using chatbots.

In theory, a chatbot is a very flexible and adaptive tool that can adapt to user requests, simulating a "live dialogue". Reaching the level of dialogic communication is an important element in language learning. However, the question arises whether a chatbot is capable of generating dialogues for educational purposes [19].

Voice assistants and chatbots have become widespread. The advantage of chatbots is the ability to simplify online learning, give it personalization and productivity. Such chatbots include Duolingo, Thinkster, Querium, Aita by Knewton. Today, ChatGPT chatbot, which entered the market at the end of 2022, is gaining the most popularity in terms of power. The main advantage of the ChatGPT chatbot is the ability to generate text in several areas of knowledge, which is similar to the text produced by a person. Due to intelligent methods (Generative Pretrained Transformer language model), ChatGPT can learn and generate text using the patterns and features of the text it was trained on. The use of ChatGPT during adapted personalized training is recommended [9].

The Duolingo app was one of the first to use bots in learning a foreign language. At the end of 2016, Duolingo developed several characters for conversations in a foreign language. However, users of the program noted in discussions and thematic forums that the chatbot often could not imitate a "natural" conversation, and sometimes prevented the correct study of a foreign language. At the same time, chatbots are effective assistants during the work of a teacher or methodologist and are used as an assistant or translator of lecture and practical material for a wide audience [13].

The work of chatbot is directed according to the principle of "daily challenge" (a daily task with a limited time period for its execution), making a newsletter to users who have started a dialogue with the bot on the network. The reason for choosing this format of work is directly related to the results of acquiring knowledge. The main advantage of chatbot technology is that it does not require special IT training or financial investments.

The introduction of a dialogue with a chatbot can be carried out in two ways: passively and interactively. Passive means reliance on theoretical material (lectures, tables, etc.) prepared in advance by the teacher. After the end of the time for assimilation of the theoretical material (block-pause), the interactive phase begins. The chatbot can send a message containing a multiple-choice question (blockchain) related to the educational topic. Chatbots can make the online learning process more productive by offering personalized programs. This option saves time not only for the user, but also for the teacher, giving the former the opportunity to get the necessary information instantly and at any time of the day, and the latter to more effectively use time for developing educational materials and deepening work with students [7].

Chatbots used in education include:

1. Duolingo, designed to personalize courses by adapting them to the strengths, weaknesses, and preferences of each student. Artificial intelligence pays attention to what vocabulary pupils and students have, which examples of grammar are difficult for them and what content they like. Duolingo also uses natural language processing to create interactions with chatbots, giving students the opportunity to practice speaking in real time.
2. Thinkster. It uses artificial intelligence for personalized math tutoring. Users start with an assessment text, and then

AI can customize questions based on their level of knowledge and how well they master the learning material. Thinkster combines artificial intelligence with training from live math teachers.

3. Querium. This virtual learning program analyzes the steps students take to solve a STEM problem and provides negative feedback on what students are doing right or wrong. This prevents students from learning the wrong answer to learning and relieves teachers of a huge amount of work that needs to be corrected. A feature of the use of artificial intelligence is that in order to provide correct feedback, it must understand the student's input data, which can take different forms each time.
4. Aita by Newton. This product uses adaptive learning to identify gaps in student knowledge and then fill them with high-quality learning materials that are selected from its own database. In this example, artificial intelligence represents a learning tool that identifies and closes knowledge gaps [8].

Based on the analysis of scientific works, the need to develop the professional culture of specialists in the pedagogical field was determined, which is due to constantly growing requirements for the level of their training on the basis of the introduction of neurotechnologies and artificial intelligence, the preparation of future specialists for a professional, competent entry into the labor market with firmly established needs for permanent professional self-development, self-improvement, and self-realization.

Thus, we highlight areas of practical application of neurotechnologies and artificial intelligence in the process of forming the professional culture of specialists in the pedagogical field (see Table 1).

Table 1: Areas of practical application of artificial intelligence in modern conditions

Field of application	Characteristics
Machine learning	It is designed to automate the construction of an analytical model, provides analysis and use of statistical data. Aimed at forming ideas about certain situations and ways to solve them
Neural network	Refers to types of machine learning. It acts to correct the performance of assigned tasks or to make the right decisions in advance in relevant situations
Deep learning	It is capable of forming multi-layer neural networks, which allows taking advantage of computing power and advanced learning methods to process more complex models with larger datasets
Cognitive computing	Cognitive computing is used to simulate processes. On the example of a person who first interprets images and language, and then can speak and perform certain actions on his own
Computer vision	Machines are capable of recognizing patterns and learning what is happening in an image or video. This option allows machines to independently process and analyze video or images and offer their own solutions for processing and using the material
Proof of theorems	In the process of development of artificial intelligence, the study of methods of proving theorems played an important role. Many different problems use the same methodological approaches used in proving theorems. At the same time, proving a theorem includes not only making deductions based on hypotheses, but also making intuitive assumptions about what needs to be proved to confirm the theorem
Image recognition	The system developer creates a list of features on which the quality of recognition depends a lot. The essence of recognition consists in a priori obtaining a vector of features for a selected individual object, and then, based on a list of features, determining

	which of the figures corresponds to this vector of features
Machine translation and understanding of human language	Based on the semantic model of text representation, a language was created for the internal representation of knowledge. Therefore, today systems analyze phrases and texts in the following stages: morphological, syntactic, semantic, and pragmatic analysis
Game programs	One example is learning a chess game system. At the same time, there are several levels of complexity in chess, which reflect the quality of the system's game and identify clear criteria for evaluating the intellectual growth of the system
Machine creativity	Software systems capable of independently creating music, poems, stories, articles, diplomas and even dissertations. In addition, many musical applications have been created: sound processing systems, sound synthesis, interactive composition systems, algorithmic composition programs
Expert systems	They are used in science, business, technology, production, and other areas where there is a well-defined subject area. A condition for the effective operation of such a system is the existence of an algorithm in a defined subject area

Source: compiled according to [18; 27]

An experiment was conducted in order to check the level of formation of the professional culture of specialists in the pedagogical field.

During the ascertaining stage of the experiment, a set of methodological tools aimed at studying the levels of formation of the professional culture of pedagogical specialists at different stages of the experiment was designed. The author's methods were implemented in the experimental group by creating artificial conditions for conducting the experiment.

A comparative analysis of the scientific base on research problems, systematization, classification, and generalization of theoretical data was carried out; modeling and generalization of methods of training specialists in the pedagogical field was carried out: emotional, motivational, cognitive-active, reflective.

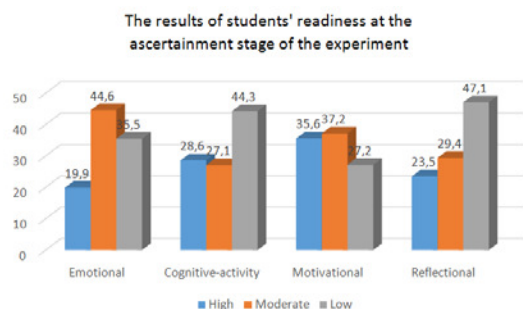
The sample consisted of 68 teachers of the Oleksandr Dovzhenko Hlukhiv National Pedagogical University.

36 respondents were involved in the control group, and 32 respondents in the experimental group, including 30 women and 38 men.

In the course of the ascertaining experiment, a contingent of respondents who are in the same conditions (training course, educational program, etc.) was determined, a survey was conducted on the basis of which a diagnosis of the levels of formation of the components of readiness for the formation of the professional culture of specialists in the pedagogical field was performed.

To determine the initial level of development of the professional culture of specialists in the pedagogical field at the ascertaining stage of the experiment in the control group, a survey of specialists in the pedagogical field was used regarding the readiness to use neurotechnologies and artificial intelligence in the educational program for training specialists in the pedagogical field. In the course of the experiment, a set of adapted methods for studying the levels of professional culture of pedagogical specialists during the experiment was selected.

The results of the data obtained in the process of surveying students allowed us to conclude that the respondents are mostly at a medium and low level of readiness for the introduction of neurotechnologies and artificial intelligence. The results obtained at the experimental stage are presented in Figure 2.



Source: compiled by the author

Figure 2. Results of diagnostics of the readiness of pedagogical specialists to form a professional culture based on the use of neurotechnology and artificial intelligence at the ascertaining stage of the experiment in the control group

At the formative stage of the experiment, a number of specialized methods were implemented in the experimental group for the formation of components of professional culture at all stages.

The following psychological and pedagogical conditions must be met for the quality formation of professional culture: ensuring the formation of the professional culture of specialists in the pedagogical field during professional development through the introduction of neurotechnologies and artificial intelligence in professional activities; integrativeness in the content of educational programs for improving the qualifications of educators; integrity, continuity and systematic formation of professional culture; active mastering of the experience of implementing neurotechnologies and artificial intelligence in the subject-subject dimension; ensuring reflexive activity in the direction of self-improvement.

The implementation of the first condition aims to ensure the formation of the professional culture of specialists in the pedagogical field during advanced training by introducing neurotechnologies and artificial intelligence in professional activities through the emotional-volitional and motivational criterion and is coordinated through the culturally oriented principle: the implementation of the formation of professional culture during retraining with the help of personal and social requests.

To implement the first pedagogical condition, methods aimed at activating the potential of using digital technologies by specialists in the pedagogical field have been defined, namely the introduction of: integration trainings (reflective, with elements of innovation); the use of doping methods aimed at forming the ability to maintain confidence when using something new in the educational process (lecture, open class, etc.); the use of methods and techniques for the development of pedagogical self-presentation skills (development of pedagogical portfolios, improvement of own pedagogical skill based on the use of neurotechnology and artificial intelligence, etc.).

Ensuring the implementation of the second pedagogical condition - integrativeness in the content of educational programs for improving the qualifications of educators - consists in ensuring the formation of professional culture among specialists in the pedagogical field based on the principle of motivation of culturally integrated learning.

Implementation of the outlined psychological and pedagogical conditions should be carried out by establishing intra-subject, inter-subject, transdisciplinary connections aimed at shaping readiness for the formation of professional culture and actualization of the motivational and value sphere of the individual.

It is proposed to implement the specified condition by introducing the following tasks into the educational process: formation of the motivational sphere for the chosen profession;

creation of situations of success during the implementation of professional activities; creation of appropriate conditions for systematic and integrated acquiring of knowledge and skills regarding the use of neurotechnologies and artificial intelligence in the educational process in synthesis with professional ones.

To implement this condition, the following methods should be used: integrative and interactive.

Implementation of the third psychological-pedagogical condition - the integrity, continuity and systematic formation of professional culture - was carried out by performing the following tasks: acquiring knowledge about humanistic-valued professional and professional-cultural orientations and basic technologies of using forms, methods, techniques and means of their implementation in the process of using neurotechnologies and artificial intelligence; creation of conditions for the activation of specialists in the pedagogical field to conscious knowledge, perception, analysis and generalization of the use of artificial intelligence through the borrowing of world, European, and domestic experience.

The indicated methodological complex is recommended for use during foreign internships and professional development by specialists in the pedagogical field.

The implementation of the fourth psychological and pedagogical condition - active mastery of the experience of implementing neurotechnologies and artificial intelligence in the subject-subject dimension, ensuring reflexive activity in the direction of self-improvement - was carried out with the help of involving specialists in the pedagogical field to work in the digital environment both individually and collectively.

Implementation of the third and fourth conditions is proposed by ensuring the formation of the cognitive-activity component of readiness.

It is proposed to use a methodological toolkit for the implementation of a certain pedagogical condition, namely: the implementation of creative methods (portfolio, implementation of interactive educational games, public presentations, holding an interactive discourse).

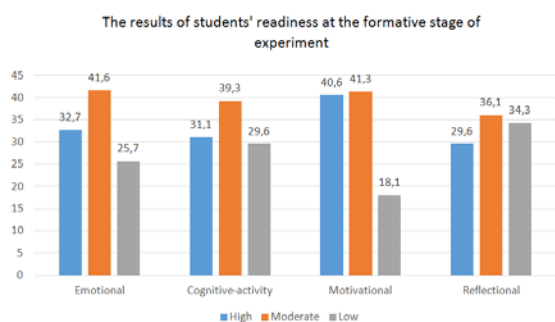
The fifth condition is the provision of reflexive activity in the direction of self-improvement, which ensures the achievement of the intended goal through the creation of appropriate circumstances for the formation of professional culture of specialists in the pedagogical field based on the principle of reflective orientation of professional culture.

The implementation of the specified condition is envisaged through the process of active development of students' ability to self-analyze, control, and evaluate the levels of their own professional culture, which ensures self-regulation of educational activities of pedagogical specialists.

It is proposed to use the method of writing self-reviews, training activity of lateral (non-standard) thinking; use of strategic self-improvement techniques; method of problem-reflective dialogue and polylogue, reflexive-business games, as well as the method of positional discussion.

In the conditions of both face-to-face and distance education, for the successful implementation of certain conditions and components of readiness, the use of neurotechnologies and artificial intelligence defined in the study is proposed.

Thus, after the implementation of a methodological toolkit aimed at the formation of the components of readiness for the formation of the professional culture of specialists in the pedagogical field and the psychological and pedagogical conditions through which they are implemented, testing of teachers was conducted and the level of formation of the professional culture was determined. The obtained data results at the formative stage of the experiment are presented in Figure 3.



Source: compiled by the author

Figure 3. Results of diagnostics of the readiness of specialists in the pedagogical field to form a professional culture based on the use of neurotechnology and artificial intelligence at the formative stage of the experiment in the experimental group

Based on the results of the analysis of experimental data, it was concluded that at the formative stage of the experiment, the level of formation of the components of the readiness of the pedagogical specialists to form a professional culture based on the use of neurotechnologies and artificial intelligence increased, which allows speaking about the effectiveness of the outlined methodology.

4 Conclusions

In the course of the study, it was concluded that the high-quality formation of the professional culture of specialists in the pedagogical field should be based on the principles of using neurotechnologies and artificial intelligence.

The concept of "artificial intelligence" was defined. Prospective directions for improving the process of increasing the readiness of pedagogical specialists for the formation of professional culture based on the use of neurotechnology and artificial intelligence have been formed.

In the process of conducting the experiment, it was established that the level of readiness of specialists in the pedagogical field to use neurotechnology and artificial intelligence in the educational process of a higher school is mainly at a low and medium position.

Such a trend requires the creation of the necessary methodological toolkit, which will serve to increase the level of training of specialists in the pedagogical field, as a result of the formation of their professional culture.

The components of the readiness of specialists in the pedagogical field to form a professional culture based on the use of neurotechnologies and artificial intelligence and the criteria for them are highlighted, namely: the emotional component (emotional-volitional criterion); motivational component (motivational and value criterion); cognitive-activity component (symbolic-operational criterion); reflexive component (relaxation criterion).

In the process of determining the stages of formation of the professional culture of specialists in the pedagogical field, the following levels of formation of readiness components were selected: high, moderate, and low. The process of formation of professional culture is built on the basis of algorithmicity, gradualism, systematicity, interdependence of the outlined components.

In the course of the research, questionnaires and surveys were applied; the content of professional development programs for specialists in the pedagogical field was updated.

Psychological and pedagogical conditions are highlighted, namely: ensuring the formation of the professional culture of pedagogical specialists during professional development through the introduction of neurotechnologies and artificial intelligence

in professional activities; integrativeness in the content of educational programs for improving the qualifications of educators; integrity, continuity and systematic formation of professional culture; active mastering of the experience of implementing neurotechnologies and artificial intelligence in the subject-subject dimension; ensuring reflexive activity in the direction of self-improvement.

The generalized data of the results of the experiment after the application of the proposed methodology allow drawing conclusions about the effectiveness of the implemented methodological tools. In this regard, the policy of educational institutions of Ukraine should be aimed at updating the methodology of retraining specialists in the pedagogical field.

Thus, the direction of further research should be aimed at considering modern programs of the international level for specialists in the pedagogical field with the possibility of professional development abroad and the results of own research. Scientific research, as well as the conclusions formulated on its basis, can be used in the future as an effective basis for improving the training of pedagogical specialists in higher educational institutions, finding ways to increase the level of professional culture, using the experience of foreign countries, introducing digital resources for the organization of scientific research processes in the context of higher education, conducting professional activities at a high level, taking into account the requirements of the labor market, deepening the study of the structure of the professional culture of educators in professional training.

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