

Artificial intelligence - The space for the new possibilities to train teachers

Inteligencia artificial. Un espacio de nuevas posibilidades para el entrenamiento de docentes

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ABSTRACT:

The relevance of the study is due to the need for practical and dynamic training of teachers of the Russian Federation to work in the electronic information and educational environment (EIEE), which is continuously and intensively enriched with artificial intelligence (AI) technologies. The article shows that solving this problem requires: development of new science-based programs of educational disciplines, focused on targeted training of teachers to use technologies and methods of AI in their professional activities; justify the effectiveness of programs by testing them in pedagogical universities of Russia. The purpose of the article is to propose mechanisms for the adequate and adaptive preparation of future teachers for solving the tasks of professional activity using technologies and methods of AI. The study of the problem was carried out using observation of the dynamics of the development of the process of training future teachers, pedagogical experiment, and mathematical statistics methods. The experiment involved bachelor and master students of various faculties of the Herzen State Pedagogical University of Russia and master students of the Ammosov North-Eastern Federal University (majoring in "Pedagogical Education"). Authors' results: developed a system for adaptive training of future teachers using the elements of AI and the new

RESUMEN:

El estudio se refiere a la necesidad de capacitación práctica y dinámica de los maestros de la Federación de Rusia para trabajar en el entorno educativo y de información electrónica (EIEE), que se enriquece de forma continua e intensiva con las tecnologías de inteligencia artificial (AI). El artículo muestra que resolver este problema requiere: desarrollo de nuevos programas de disciplinas educativas basados en la ciencia, enfocados en la capacitación específica de los maestros para utilizar tecnologías y métodos de inteligencia artificial en sus actividades profesionales y en justificar la efectividad de los programas en universidades pedagógicas de Rusia. El propósito del artículo es proponer mecanismos para la preparación adecuada y adaptativa de los futuros maestros para resolver las tareas de la actividad profesional utilizando tecnologías y métodos de IA. El estudio se llevó a cabo mediante la observación de las dinámicas del desarrollo del proceso de capacitación de futuros maestros, experimentos pedagógicos y métodos de estadística matemática. Involucró a estudiantes de licenciatura y maestría de varias facultades de la Universidad Pedagógica Estatal de Herzen de Rusia y estudiantes de maestría de la Universidad Federal del Noreste de Ammosov (con especialización en "Educación Pedagógica"). Los autores: desarrollaron un sistema para la capacitación adaptativa de futuros

content of the discipline "Information Technologies", focused on studying the trends of AI in education; the high motivation of students confirms the effectiveness of the system to the content and methods of studying the discipline. It is shown that the use of new types of educational activities in the conditions of EIEE enriched with AI elements contributes to the innovative professional training of a modern teacher

Practical and theoretical significance: the study proved the effectiveness of the proposed methodology for preparing bachelors and master students for their future professional activities; as a result of its introduction, the level of students' readiness for work in EIEE, developing towards the use of AI, has increased.

Keywords: adaptive training; artificial intelligence; electronic information and educational environment; interdisciplinarity; teacher

maestros utilizando los elementos de la inteligencia artificial y el nuevo contenido de la disciplina "Tecnologías de la información", centrado en el estudio de las tendencias de la inteligencia artificial en la educación. La alta motivación de los estudiantes confirma la efectividad del sistema para el contenido y los métodos de estudio de la disciplina. Se muestra que el uso de nuevos tipos de actividades educativas en las condiciones de EIEE enriquecidas con elementos de AI contribuye a la capacitación profesional innovadora de un maestro moderno.

Importancia práctica y teórica. El estudio demostró la efectividad de la metodología propuesta para preparar maestros y estudiantes para sus futuras actividades profesionales.

Palabras clave: entrenamiento adaptativo; inteligencia artificial; información electrónica y entorno educativo; interdisciplinaria; profesor

1. Introduction

The "Concept of the federal target program for the development of education for 2016–2020 in the Russian Federation" points to the need to implement "promising breakthrough developments in the creation and implementation of advanced models, programs, technologies, and educational solutions" (Government of the RF, 2014). These technologies include AI technologies that are increasingly aggressively manifesting themselves in the educational segment (Barrat, 2015; Bostrom, 2016; Keith, 2017; Popenici and Kerr, 2017). They increase the educational and developmental potential of the electronic information and educational environment; saturate it with intellectual tools of interaction, communications, increase the efficiency and effectiveness of the management of educational material and the educational process. The peculiarity of the current educational situation lies in the fact that students are often more mobile in learning new technologies and are more adapted to life and training in an updated continuously EIEE compared with teachers (Nikolaeva et al., 2014). Teachers of the department of computer technology and e-learning of the Herzen State Pedagogical University of Russia (St. Petersburg) conducted a study to solve this problem. The purpose and tasks of the study are to develop and implement a continuous training system for future teachers in a specially created adaptive EIEE with integrated AI elements in the form of programs for independent communication with students (chatbots); and methods oriented to solving professional tasks by future teachers using AI methods and technologies that are relevant for the formation and development of their abilities to carry out professionally significant activities. The study was carried out within the framework of an adaptive, interdisciplinary and synergistic approach to the professional training of teachers to work in the conditions of electronic information and educational environment, which is developing in the direction of integrating elements of artificial intelligence into it. The training process was carried out at an interdisciplinary level, taking into account the synergistic effects that allow the student to reach a new level of their professional development through the joint use of traditional educational technologies, e-learning technologies, as well as technologies and artificial intelligence methods introduced into the electronic educational environment. The study involved teachers and students of the Ammosov North-Eastern Federal University (Republic of Sakha (Yakutia)). This allowed cooperative use of innovative, human and resource potential of universities to solve the problem of high-quality and practical training of education specialists (1Ren et al., 2017); identify possible risks and specific psycho-physiological, moral and ethical features of working with them in the conditions of digitalization of the Russian education system.

2. Literature review

Russian and foreign researchers are interested in the problems of using AI in learning (Gaebel et al., 2014; 17, 2018) in general (Osipov, 2014; Bialik et al., 2018) and its various aspects, including psychological (Luxton, 2014) and cognitive (Osipov et al., 2018). Australian researchers emphasize that AI will change the nature of higher education in the

world and has now become an integral part of modern universities (Stefan, 2017). Examples of the use of AI for the development of e-learning are didactically significant (Camilleri, 2017; dos Santos et.al., 2017; Jiang et.al., 2016). This, in turn, contributes to innovative changes in electronic information-educational environments (Schulz et.al., 2014; Pathak, 2016), the motivation for new educational activities (Clark and Mayer, 2016; Rani et.al., 2016) in them, the evolution of interactions between teachers and students (Mohammad, 2013) using new tools. Confirmation of this is found in other sources (Gunter and Reeves, 2017). Its authors study the attitudes of teachers, their involvement and support for online professional development. It is expressed in different embodiments of e-learning and mobile learning, to which the authors' studies are devoted (Gunter and Reeves, 2017; Yang et.al., 2017). They consider not only the positive but also the negative aspects of this training. Realizing the existence of this problem, many researchers propose to use the ideas of adaptation and AI methods in e-learning and the development of EIEE. These include works by (Redko, 2018) on the value of adaptive behavior for the educational process. Of practical interest are the works by (Weinstein et.al., 2018). Its authors propose algorithms for adapting mathematical educational content and options for integrating them into the e-learning system. Their ideas are complemented by the suggestions of the author of the article (Sérgio et.al., 2018) about adaptive tests relevant for machine learning (Brink et.al., 2017).

Nevertheless, it should be noted that the analyzed works do not sufficiently reflect the problem of studying effective ways of adaptive preparation of students of pedagogical higher educational establishments for the use of AI elements in education in general and in e-learning, in particular, as well as in professional activities.

The theoretical foundations of the study were the works of Russian authors in the use of adaptive (Vlasova et.al., 2018; Barakhsanova et.al., 2016), e-learning (Prokopiev, 2015) and training using AI (29, 2018; 30, 2018; 35, 2018).

3. Materials and methods

This study was conducted from 1992 to 2018 by a team of authors who worked and are working in educational institutions in various regions of Russia (St. Petersburg, Sakha Yakutia, Murmansk, Ussuriysk). It allows for the following: 1) better understand and comprehend the problems, tasks, and dynamics of adequate training of education specialists, as well as ways of their professional adaptation to work in a situation when the electronic information and educational environment is developing in the direction of introducing adaptive technologies using artificial intelligence; 2) design and put into practice the necessary for this relevant educational technologies adapted to modern educational needs, regional characteristics, possible risks and recommendations for their minimization.

The study was conducted over a fairly long period (over 25 years). The work is still ongoing. The results of the study reflect the dynamics of changes in ideas about how to organize and implement the educational process, the degree, and options for using electronic tools, information technologies, e-learning technologies, elements of artificial intelligence in the educational process of a pedagogical higher educational establishment. During the entire period of the study, a priori information is collected, analyzed and systematized on the problem of using technologies and artificial intelligence methods in preparing teachers to carry out their professional activities in a dynamically developing information society, actively introducing computers and information technologies into the educational process. The extent to which this training is adapted to real professional situations and activities is being studied.

As a result of analyzing the content of curricula, monitoring the educational process in many pedagogical higher educational establishments in Russia, conversations with fellow teachers of pedagogical higher educational establishments, a general conclusion was made that studying theoretical and applied questions about artificial intelligence is fragmentary, retrospective far from education. Besides, teachers of the higher pedagogical school practically do not use the technologies and methods of AI in their professional activities. The results of the initial period of the study (1992-1993) are reflected in the dissertation

research by E.Z. Vlasova, devoted to the development of knowledge bases of expert systems in the methodical preparation of physics students. It was proved in work on the scientific and methodological and practical level that the use of artificial intelligence tools makes it possible to significantly expand the methodological base for training future teachers through the multivariate methods, forms, means of working with students, enhancing their cognitive capabilities, using interdisciplinary tools, activating self-organizing activities. The study was developed in work by the teacher S.V. Goncharova together with the students of the Murmansk Pedagogical University in teaching the "Programming Languages for Artificial Intelligence" discipline (1994-1999). Considering the specific nature of students' professional training, they were asked to develop programs or program fragments for solving problems from the educational field. The author of the study notes that the success of the tasks assigned depends on the strategic interaction of various student competencies and the characteristics of the task. For the successful implementation of tasks, all students selected, analyzed, activated, and coordinated the components of their competencies necessary to perform the required activities. Such as modeling of an educational situation, its adaptation, adjustment of the task, conditions, and limitations of its implementation, planning, control, analysis, execution, correction to achieve the educational goal. This undoubtedly contributed to their professional and pedagogical growth. During the next period of the study (1999-2005), special attention was paid to the issues of an adaptive approach to training, the development of various adaptive technologies for the training of educational specialists. One of the developed technologies is based on the life cycle of intelligent learning systems. Its analysis in the aspect of professional orientation and the results of practical implementation showed that students considered the design of knowledge bases as an active method of their professional self-development; student's joint work with a subject matter expert or methodologist contributed to the increased operationalization of their professional knowledge.

The initial methodological prerequisites for research are currently: 1) development of new content for preparing students of a pedagogical higher educational establishment in AI with a focus on the practical application of technologies and methods of this scientific direction for solving professional educational problems in general and in the context of the implementation of the educational process in EIEE at the new stage of its development with the inclusion of AI elements; 2) changing the nature of the educational process due to the inclusion of students in active interdisciplinary, synergistic activities in the process of performing specially designed integrated professionally oriented tasks involving the use of AI methods and technologies; 3) training of students in an electronic information and educational environment with AI components, which is considered as a system integrator of the entire educational process and adapted to their future professional activity; 4) design and development by students of their electronic educational environment using technologies and methods of AI. The research participants set a goal not only to qualitatively learn to master the proposed methods and technologies of AI, but also to motivate students to actively use them as tools for learning, self-study, and for implementing new adaptive educational activities in developing electronic information and educational environment. First-year students (bachelor students of natural-mathematical and humanitarian faculties) of the Herzen State Pedagogical University of Russia, students in the direction of training "Pedagogical Education", as well as master students of the Ammosov North-Eastern Federal University, majoring in "Pedagogical Education" (master's program "Technology and management of e-learning" and "Corporate e-learning"). More than 5,500 bachelor students and 58 master students took part in the experiment.

After completing the study of the "Information Technology" discipline, bachelor students were asked to answer the question: "Do you find it useful to study the elements of knowledge about AI, its methods and technologies within the discipline?" For all the years of the experiment, no student gave a negative answer. It should be noted that all respondents emphasized the effectiveness of training in an adaptive electronic information-educational environment, including the AI elements (<https://inftech.spb.ru>). The environment was developed by teachers of the department of computer technology and e-learning of the Herzen State Pedagogical University is focused not only on the interdisciplinary adaptive

training of future teachers to use the didactic and developmental potential of electronic educational environments but also on designing their professional activities, professional interaction with various remote agents (students, colleagues from the professional community).

Every year, students who completed the study of the discipline were divided into two groups (the first group - students of natural and mathematical faculties, the second group - students of humanitarian faculties). Each group was asked to answer the question: "Do you consider it expedient from your professional development to study the methods and technologies of artificial intelligence in order to use them to solving problems of professional activity"? At the significance level of $\alpha = 0.02$ ($g = 0.98$), the hypothesis of equality of the characteristic shares was tested, namely, the hypothesis was tested that both students of natural and mathematical faculties and humanitarian students consider it expedient to study methods and technologies of artificial intelligence in order to use them in relation to the tasks of professional activity.

The study was attended by the master students of two universities who purposefully studied the methods and technologies of artificial intelligence in teaching various disciplines of their educational program. At the same time, they were trained with the active use of these technologies and methods, which significantly changed the educational activities of both students and teachers. Master students from the Herzen State Pedagogical University of Russia and the Ammosov North-Eastern Federal University were asked to answer the question: "Which of the listed characteristics of a new educational activity influence the efficiency of professional training of a modern teacher? Arrange them in order of importance". The hypothesis was tested that the correlation between two ordered groups of characteristics in the sample of the Herzen State Pedagogical University of Russia and the sample of the Ammosov North-Eastern Federal University is statistically significantly different from zero (that is, the opinions of students from two universities on the issue being studied are similar). The Spearman's rank correlation method was used to process the results.

4. Results

Based on the theoretical analysis and study of the trends in the development of modern Russian education, the expediency of applying technologies and artificial intelligence methods in the process of forming and developing the readiness of future teachers to work in an adaptive EIEE that integrates the innovative achievements of the digital society, including the development and tools of AI, has been proved. A special adapted for solving professional pedagogical tasks of EIEE with AI elements has been developed to solve this problem. Its practical use in the educational process is confirmed by specific results obtained after processing the experimental data. The results of surveys by year are presented in Table 1.

Table 1

The results of a survey of students of natural-mathematical and humanities departments in 2012-2018

Year	Students of natural and mathematical departments		Students of humanities departments		Statistics, t
	Total number n1	Replied "Yes" m1	Total number n2	Replied "Yes" m2	
2012	120	63	108	57	0.463
2013	124	69	102	74	2.63
2014	115	57	111	58	0.374

2015	123	59	118	65	1.138
2016	117	62	109	71	1.729
2017	120	71	115	58	1.390
2018	121	82	117	73	0.869

It contains two samples of volumes of and of two sets. The data were processed using the algorithm for testing the hypothesis of equality of the shares of the feature. The sample fractions of w_1 and w_2 were calculated respectively by the formulas:

$$w_1 = \frac{m_1}{n_1}, \quad w_2 = \frac{m_2}{n_2}, \quad (1)$$

where m_1 and m_2 mean the number of elements of the first and second samples with the studied indicator. The formula calculated statistics t (for each year) □

$$t = \frac{w_1 - w_2}{\sqrt{p(1-p)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}, \quad (2)$$

where p is calculated by the formula

$$p = \frac{m_1 + m_2}{n_1 + n_2}, \quad (3)$$

The significance level $\alpha = 0.02$ received the values of $t_{cr.} = 2.33$, which were found using the tables. Since

$$|t| < t_{kp}, \quad (4)$$

then the hypothesis that both students of natural and mathematical departments and students of humanities departments consider it equally expedient to study technologies and methods of AI to solving problems of professional activity is accepted in all cases except the results in 2013. Besides, the creative content of the master's programs "Technologies and management of e-learning" and "Corporate e-learning," the effective organization of the educational process with the active use of technologies and methods of AI allowed to obtain highly positive results of students' training based on modern technologies. This is confirmed by the results of an experiment conducted with master students from two universities. The data obtained were averaged over 24 subjects, and the averages were ranked. Table 2 presents the ranking indicators of the characteristics of the new educational activities. There are 12 of them. They were used to find the Spearman's rank correlation coefficient $r_s = 5.505$. It is calculated by the formula

$$r_s = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)}, \quad (5)$$

There is a positive correlation between the views of students of two universities on the issue under study at the significance level $\alpha = 0.05$, since $t_{\text{calc.}} > t_{\text{cr.}}$ ($5.505 > 2.23$). t - student statistics, which is used to make a decision, is calculated by the formula

$$t = |r_s| \sqrt{\frac{n-2}{1-r_s^2}}, \quad (6)$$

The relationship between the views of master students at two universities is statistically significant at the 5% level of significance.

Table 2
Rank indicators of the characteristics of new educational activities

Characteristics	Rank in the sample The Herzen State Pedagogical University of Russia	Rank in the sample The Ammosov North-Eastern Federal University	d	d²
Individual direction	12	12	0	0
Flexibility	2	3	-1	1
Mobility	1	4	-3	9
Interdisciplinarity	3	2	1	1
Vigorous activity of the students	7	5	2	4
Operational control	4	6	-2	4
Independent cognitive activity of students	5	1	4	16
Availability	10	9	1	1
Distribution	9	10	-1	1
Cooperation	6	7	-1	1
Adaptivity	8	8	0	0
Active communications	11	11	0	0

The most significant results include the development of fundamentally new content of the "Information Technologies" discipline for bachelor degree students majoring in "Pedagogical Education." It is adapted to the professional activity of the teacher, filled with theoretical and

practical issues of using technologies, methods, and tools of AI, relevant to education. Teaching the discipline is carried out under conditions of active use of adaptive EIEE with the integrated AI elements and programs based on artificial intelligence for independent communication with students using adaptive e-learning technologies. Bachelor degree students who have completed training in this discipline are motivated to continue exploring options for using technologies and methods of AI in their training and in the process of solving educational and methodological problems. It should be noted that students demonstrate a steady interest in the development of new technologies and forms of e-learning based on their knowledge and studied practices in the field of AI. They confirm that the use of new types of educational activities contributes to their effective professional training.

5. Discussion

The introduction of AI in education is one of the leading social consequences of the development of the means of this science. The lacking exploration of this field from pedagogy makes this problem of paramount importance for representatives of various trends in pedagogical thought. The relevance of research in this area is enhanced by the fact that intellectualization, as a social process, is of exceptional strategic importance. It has two main objectives: the formation of intelligence corresponding to the modern development of the society, its needs and the full, rational use of this intelligence. This article is devoted to effective adaptive training of future teachers based on interdisciplinary integration with the use of technologies and methods of AI, which are used for effective mental and professional development of students. This is impossible without deep penetration into the systemic functioning of the brain, into human mental processes, into thinking processes, which according to L.M. Vekker, is an integrator of intelligence. The process of research showed that with the aim of developing future teachers' natural intelligence, their professional intellectual maturity, one should apply teaching technologies that are focused on developing such abilities as: cognitive activity, the ability to create a holistic picture of the subject area, the allocation of essential knowledge, the ability to reason, the synthesis of cognitive procedures, the ability to reflect, setting goals and choosing means to achieve it (the ability to goal-setting and planning behavior), adapting to the pedagogical situation, the formation generalizations and learning by example, the ability to select knowledge, the ability to learn, and the ability to reasoned decision-making. Besides, learning technologies should be aimed at reducing the period of dynamic adaptation of the student to future professional activity. The development of professionally essential qualities and the ability to perform special teaching activities should take place by a coordinated interdisciplinary synthesis of knowledge and learning activities in the process of holistic professional training of students. The synergetic approach allows finding common features in various subject areas, the use of which in the learning process will allow forming future professional and pedagogical knowledge, abilities and main types of teaching activity among future teachers. Synergy is related to education on the development questions. It is the need to develop EIEE from raising the level of its intellectuality that makes teachers - the developers of this environment continually improve it from a meaningful and technological point of view. Currently, the implementation of adaptive learning technologies is carried out in an updated version of the environment. Students and teachers can quickly use the services based on the semantic web, carry out a semantic search for information on semantic educational portals, get acquainted at a theoretical and practical level with intelligent interfaces, questions of recognition and speech synthesis, text analysis, cognitive graphics, knowledge extraction, development of ontological models. Students study the "Concept Map" methodology and apply it to solve their actual problems. Student assignments in the system are monitored using a chatbot.

More profoundly, technologies and methods of AI are studied by master students who have been and are studying under the educational programs of "Technologies and management of e-learning" and "Corporate e-learning." Students study issues of knowledge engineering, semantic modeling in the design of educational information AI systems, etc. They are guided by the leading ideas in the creation of various types of intelligent systems for educational

purposes, which is the transition from knowledge-centrist to knowledge-generation views. This is especially important because the study of the mechanisms of generation should be a red thread through the entire educational process in pedagogical universities. The essential importance of these issues is also given to the content of the new master degree program "Information Technologies and E-learning in Teaching School Objects" developed in the course of the study. Experts recommend the last two educational programs for inclusion in the register of educational programs of the Russian Federation.

6. Conclusion

As a result of the conducted study, it was shown that targeted training of school teachers in AI and its application in education is necessary to let them successfully carry out the educational process in the modern electronic information-educational environment with elements of artificial intelligence integrated into it. For that purpose, a continuous and effective system of training for future teachers (Bachelor and Master degrees students enrolled in "Pedagogical Education") has been developed under the conditions of a specially created adaptive electronic information and educational environment that integrates elements of artificial intelligence, including programs for independent communication with students (chatbots). A methodology has been developed, under which students are gradually learning from theory to practice to study the theory and practice of using technologies and methods of AI in education. The content of the "Information Technologies" discipline has been significantly updated and is focused on the practical application of AI elements for solving professional problems of education. The tasks involving active learning activities of students were created. Master's programs were enriched with the disciplines developed for a more in-depth study of the methods and technologies of AI, relevant to education. This not only allowed students to be trained in a contemporary way and to improve the quality of training but also to motivate them to use their knowledge and skills for learning and self-study. The results of the study showed the relevance and interest of future subject teachers in specialized training in the field of AI in education with work in EIEE with AI elements.

Further development of the work may be associated with the creation of programs for raising the qualifications of teachers on the use of technologies and methods of AI in education.

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