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ARTIFICIAL INTELLIGENCE COMPETENCIES: THE FORMATION WITHIN PROFESSIONAL TRAINING

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КОМПЕТЕНЦИИ В ОБЛАСТИ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА: ФОРМИРОВАНИЕ ПРИ ПРОФЕССИОНАЛЬНОЙ ПОДГОТОВКЕ СТУДЕНТОВ

Abstract. Artificial intelligence (AI) has become one of the most dynamically developing scientific and technological areas in recent years. Nowadays artificial intelligence technologies are actively used in various spheres – medicine, finance, manufacturing, and marketing. Employers are increasingly looking for employees able to use AI technologies effectively in their professional activities. Thus, the ever-growing emphasis on training specialists with knowledge and skills in the field of artificial intelligence has become a trend in professional education. The paper presents the approach of Yugra State University to the formation of theoretical knowledge and practical skills in the field of artificial intelligence in students of all areas of training. Methods and approaches aimed at developing strong skills in this area are considered. The work was prepared using materials accumulated in the period 2022–2024, as well as the results of surveys conducted among second-year students at Yugra State University. The authors' comprehensive approach to developing AI competencies, combining quantitative and qualitative methods of analysis, has improved the quality of the educational process, resulting in an overall student satisfaction level rate of 92%. The study showed that early exposure to artificial intelligence technologies helps students quickly master modern digital tools and apply them in different fields. This generally contributes to the more effective training of future specialists who are prepared to solve real production problems using artificial intelligence technologies.

Key words: artificial intelligence; artificial intelligence systems; professional education methods.

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Аннотация. Искусственный интеллект (ИИ) за последние годы стал одной из самых динамично развивающихся научных и технологических сфер. На сегодняшний день технологии искусственного интеллекта активно применяются практически во всех сферах деятельности – от медицины до финансов, от производства до маркетинга. Работодатели всё чаще ищут сотрудников, способных эффективно использовать технологии ИИ в своей профессиональной деятельности. Как следствие, одной из тенденций современного профессионального образования стало всё нарастающее внимание к подготовке специалистов, обладающих знаниями и навыками в области искусственного интеллекта, стало. В работе представлен подход Югорского государственного университета к формированию у студентов всех направлений подготовки теоретических знаний и практических навыков в области искусственного интеллекта. Рассматриваются методы и подходы, направленные на формирование у студентов прочных компетенций в данной области. При подготовке работы были использованы материалы, накопленные в период 2022–2024 годов, а также результаты опросов студентов второго курса Югорского государственного университета. Представленный авторами комплексный подход к формированию компетенций в области ИИ, сочетающий количественные и качественные методы анализа, позволил улучшить качество образовательного процесса до общего уровня удовлетворенности студентов курсом в 92%. Проведенное авторами работы исследование показало, что раннее знакомство обучающихся с технологиями искусственного интеллекта позволяет им быстрее осваивать современные цифровые инструменты и применять их в различных сферах деятельности. Это в целом способствует более эффективной подготовке будущих специалистов, готовых решать реальные производственные задачи с помощью технологий искусственного интеллекта.

Ключевые слова: искусственный интеллект; системы искусственного интеллекта; методика профессионального образования.

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Currently, Russian authorities are paying a lot of attention to the formation of deep theoretical knowledge and practical skills in the field of artificial intelligence (AL). In accordance with the Ministry of Education and Science of the Russian Federation’s letter, "Artificial Intelligence Systems" module has been included in educational programs. The decision comes from the widespread use of AL technologies and their integration in all sectors of the economy, including industry, medicine, education, finance. The modern labor market demands that graduates possess theoretical knowledge, practical skills and hands-on experience in AL. Students' exposure to AI technologies, their integration and active use throughout the educational process facilitate their adaptation to modern professional demands. This enables them to utilize effectively the latest advancements in AI, neural networks, and machine learning for solving practical problems in their future careers.

A number of contemporary scholars have given particular attention to developing AI competencies among students. L.R. Panteleeva [5] outlines the structure of the “Artificial Intelligence Systems” course introduced in the IT bachelor’s curriculum at TISBI University of Management. S.V. Danilenko, Y.M. Martynyuk, and V.S. Vankova [2] discuss the theoretical and practical learning process for computer science bachelors specializing in the field of AI pedagogy. I.V. Kasparov provides a detailed analysis of the challenges and difficulties encountered by students and educators when learning AI techniques, as well as offers recommendations for overcoming these issues [3].

Special emphasis is placed on the implementation of AI technologies in educational process. M.S. Yakubov, B.A. Akhmedov, N.E. Duisenov, and Zh.G. Abduraimov analyzed the trends in the use of neural networks and artificial intelligence in the modern higher education system, and identified the role of intelligent technologies in addressing the challenge of improving the learning experience quality [15]. K.D. Struchkova proposed the idea that information technologies and neural networks represent powerful tools that have the potential to enhance learning significantly [10]. A.N. Starovoit and N.A. Cherpakova described the utilizing neural networks process in

Russian Language and Literature classes to enhance the learning process, tailor education to individual needs, and develop innovative methods for assessing knowledge [9]. O.N. Filatova, M.N. Bulaeva, and A. V. Gushchin presented a concept for advanced learning through the using of neural network-assisted artificial intelligence that provides the potential to improve the quality of vocational education [13].

In 2022, Ugra State University integrated artificial intelligence (AI) technologies into its educational process. The course on "Artificial Intelligence Systems" was introduced into the curriculum for all training areas, with a total of 108 academic hours and three credits. Initially, the training was conducted in a full-time format, with classroom sessions that included lectures and laboratory work in a computer lab. For the 2024–2025 academic year, the training in artificial intelligence (AI) technologies was transformed to an online course, with a tutor providing guidance. This training format tends to maintain the benefits of the traditional full-time program through the interaction between students and a tutor, while also introducing features that enhance the learning experience, such as:

– suppleness and mobility are online learning key features, allowing learners to access educational content at a time and location that suit them best, and from a variety of devices (computer, tablet, smartphone). This accessibility makes learning available almost anywhere.

– individual learning pace: students are able to progress through the material at a pace that suits their learning needs, revising difficult concepts as often as required;

– Independent learning: students are free to decide when and how long they study, which helps develop self-discipline and time-management skills;

– Interactive materials: the incorporation of interactive elements into an online course enhances the learning experience and makes it more engaging and effective.

To optimize the information processing experience, enhance the quality, and expedite the development of theoretical understanding and practical skills, all course content has been organized and divided into nine sections:

1. Introduction to Artificial Intelligence Systems: the concepts of intelligence and artificial intelligence are discussed; the various types of AI are described, and special attention is given to the history and stages of AI evolution.

2. Areas of Application of Artificial Intelligence: an overview is provided of the potential use of AI within the fields of medicine and healthcare, environmental sustainability, financial services, defense and aerospace, sports, transportation, industry, and education; specific examples are provided to illustrate how AI can be applied in various sectors of the economy.

3. Classification of Artificial Intelligence Systems: the AI functional structure and principles of classification for AI systems are presented.

4. Ethics of Artificial Intelligence: ethical considerations related to the use of AI systems and the AI Code of Ethics are discussed.

5. Knowledge Representation Models: definitions of data, knowledge, and knowledge representation are provided; knowledge representation models (logical, frame, semantic, and productive ones) are discussed.

6. Fuzzy Logic: the concepts of fuzzy logic, fuzzy systems, and fuzzy sets are introduced; fuzzy sets operations, the fuzziness index, and binary fuzzy relations are discussed.

7. Expert Systems Technologies: the definition of an expert system, the structure of expert systems, and classifications of expert systems are provided; the stages of expert system development and methods for finding solutions in expert systems are discussed; the main difficulties in expert system development and the tools for their construction are also described.

8. Loginom. Machine Learning: the machine learning concepts, deep learning, big data, data science, and data mining are discussed; the components of machine learning systems are described, as well as the main tasks they perform, including classification, regression, clustering, the search for associative patterns, dimensionality reduction, and anomaly detection; Loginom is discussed as an analytical low-code platform for machine learning.

9. Neural Networks: Common tasks solved by neural networks are discussed; the difference between neural networks and traditional machine learning techniques is explained; the architecture of a neural network, types of neural networks, and training methods for neural networks (unsupervised learning, supervised learning with teacher assistance, and reinforcement learning) are considered.

Each section is a self-contained, logically structured unit that consists of video lectures as a theoretical component, and assessments and applied exercises as a practical one. The selection of sections is guided by the principle of necessity and sufficiency, ensuring an optimal balance between the theoretical content depth and the number of applied tasks. This method ensures that students acquire exactly the requisite amount of knowledge and abilities to give them a competitive edge in the job market, as well as providing a platform for ongoing self-improvement and professional development.

When incorporating video lectures into the educational process, it is essential to consider the organizational, technical, and psychological aspects of the student-teacher interaction [1]. Course authors present theoretical material in short (15–30 minute) lectures accompanied by infographics as visual aids. The quality of the videos is crucial, for student engagement and learning outcomes are directly related to the video quality and well-designed infographics [12]. Communicative techniques employed by the lecturers, such as incorporating relevant examples, alternating between presentations and demonstrations, and engaging in question-and-answer sessions, enhance the learning experience and make it more interactive [16]. The understanding that the labor market would demand the acquired knowledge and skills motivates students to study material in depth. Students recognize the links between studying AI technologies and their future career paths.

A series of practical assignments (tests, essays, calculations, and creative projects) makes a significant component of the educational program. A test set, including both multiple-choice

questions and open-ended questions, are designed to assess the understanding of lecture materials. Each lecture is accompanied by a set of ten questions related to the material covered for the students to answer. A range of diverse creative assignments has been developed to enhance practical AI skills:

– creating a presentation using AI techniques;

– generating and creating text-using AI;

– processing and manipulating images and animations using AI.

Here are some examples of creative tasks that involve working with text and images.

Task 1. Utilizing the neural networks GigaChat or Yandex PT (14, 18, 20), complete the following tasks:

– Generate a verse greeting for a friend in the style of a favorite poet.

– Generate headline options for social media posts on a topic of your interest.

Task 2. Utilizing the Kandinsky neural network (17, 19), generate various images based on the following requirements:

– Design a fantasy or science fiction book cover, or that of a favorite book of yours.

– Create a creative agency's or business' homepage background design.

Assignments allow students express their creative potential experimenting with approaches and methods of solving tasks. The format encourages independent thinking and the searching for unique ideas, contributing to the development of critical thinking and creativity, which are key qualities of a professional. The ability to analyze problems independently, find non-standard solutions and adapt to new conditions is especially appreciated in the rapidly changing world of professionals.

Creative thinking and the readiness for experiment help young professionals stand out from their colleagues by offering innovative ideas and improving work processes.

Another possible option for a practical assignment that promotes creativity is a peer-reviewed essay on the AI technologies application in professional activities. Employing the "mutual learning" approach in this assignment contributes to creating an active learning environment, with each participant contributing to the overall learning experience [6; 11].

Computational tasks, such as the development of semantic and frame-based models for knowledge representation and the application of fuzzy sets operations, necessitate an understanding of fundamental principles in AI theory and methods for data processing and information organization. It also requires a clear comprehension of the relationships among concepts and objects and aims to foster the development of abstract thinking and system analysis skills.

These days many AI systems employ similar models for the storage and knowledge processing. The experience gained through the creation of such models will facilitate students' adaptation to working with actual AI projects.

A valuable learning experience for students is the practical task of solving machine learning problems using the Loginom data mining platform [8]. This platform, used in a variety of industries

such as finance, marketing, healthcare, and manufacturing, automates the knowledge extracting process, and enables the creation of predictive models, business processes analysis, and data-driven decision-making.

The assignment “Training a Neural Network using the Teachable Machine Service” completes the practical component of the course, providing a unique opportunity for students to apply their acquired knowledge and consolidate their skills in working with machine learning technologies [4; 7].

Nevertheless, the learning process for students is not entirely remote. The course involves at least three in-person meetings with a tutor. At the first meeting, before launching the online course, the teacher introduces the students to the course, shares interesting facts about AI, engages the students in a discussion on the use of AI in real life, and lays the groundwork for further interaction and a productive learning experience. At this point, rules and expectations are established, an atmosphere of trust and respect is fostered, and the goals and objectives of the course are defined.

The second face-to-face session is scheduled for the midpoint of the course. This session involves a group discussion on practical tasks and an exchange of experiences. Throughout the course, face-to-face consultations with a tutor are organized for students weekly and the tutor provides timely feedback on students’ work, helps to comprehend the material better and prevent errors. The course outcomes assessment is also conducted in an in-person format.

In order to investigate students' interest in AI technologies, assess their self-perceived competence development, and determine their motivation level as well as identify any areas of concern, provide feedback, and maintain an ongoing dialogue between students and educators, an anonymous survey was administered to 326 second-year students at Ugra State University in 2024. The authors have conducted an analysis of the survey results, which are presented in the following table.

Table

The findings of a survey on students' satisfaction with the course

Criteria	Satisfaction score
Lectures’ quality in the chosen discipline	92,4%
Practical training quality in the chosen discipline	91,3%
E-learning course quality in the chosen discipline	88,5%
The quality and diversity of assignments used by the educator	94,2%

At the same time, the following responses were received to the question "Should the next course be made more challenging, less challenging, or left as it is", as shown below (Fig.).

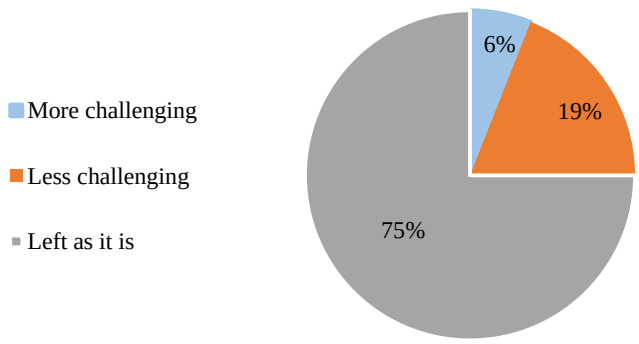

Fig. The results of the responses to the question regarding whether the next course should be made more challenging, less challenging, or maintained at the current level.

The findings indicate that the overwhelming majority of students perceive the AI Systems Course as optimal in terms of its complexity and the quality of the materials presented.

The emphasis on up-to-date knowledge in the field of digital technologies, coupled with a wealth of examples and a variety of practical tasks, enables us to provide high-quality education to students in the area of AI technologies. Through the combination of these teaching methods, we create a balanced educational environment in which students actively engage in the learning process, gaining in-depth theoretical knowledge and developing practical skills.

Understanding the fundamentals of artificial intelligence (AI) and the ability to utilize its tools is becoming a valuable asset in today's job market. Consequently, teaching students about these technologies is an essential component of their education.

After completing the course on AI systems presented in this paper, students will have the skills necessary to apply actively these tools in both personal and professional settings. They will be able to create and generate text, produce interactive presentations, use avatars to read text, generate and manipulate images and animations, solve classification, regression, and clustering problems, and train neural networks for various applications.

The research findings can be applied in the development of educational programs, tailoring them to meet the demands of the modern job market. The methods and guidelines developed by the researchers will enhance the quality of professional training and foster the acquisition of essential skills in the area of artificial intelligence among students.

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