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FORMING TEACHERS' AWARENESS OF KNOWLEDGE IN THE FIELD OF ARTIFICIAL INTELLIGENCE

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Abstract

The article discusses the problem of forming the knowledge awareness in the course of teaching the basics of artificial intelligence to the future and working teachers. Based on the analysis of scientific sources and generalization of pedagogical experience, the authors state that the low level of knowledge awareness in the field of AI among future teachers usually shows up during the design of expert systems and in the process of developing intelligent programs. The description of the developed methodology that ensures the formation of teachers' knowledge awareness in the AI is presented in the article. The authors emphasize that special attention should be paid to the informal assimilation of theoretical material in the process of forming the knowledge awareness. The article presents the examples of lectures on the following topics: "Introduction to AI", "The models of knowledge representation in AI systems", "Expert systems" where interactive surveys of various types and content are implemented and collective work on the virtual whiteboard is carried out. Pedagogical experiment confirmed the effectiveness of the developed methodology which has a number of advantages over traditional training. Among them we can state visualization of theoretical material which helps a lot to solve the problem of formal learning. Also, the ability for the teacher to take into consideration the student's point of view shown via interactive surveys and react on them simultaneously. Finally, students get an opportunity to act as participants of the educational process and meanwhile to conduct their self-control and self-assessment during learning the theory.

Keywords: Artificial intelligence, awareness, teacher, computer science, interactive surveys, virtual whiteboards

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1. Introduction

The current stage of the development of the information society is characterized by the increasing role of such a promising section of computer science as "Artificial Intelligence" (AI). This is one of the most discussed areas that touch upon the questions of the integration of digital technologies in various areas of human activity. In the near future, AI-related competencies will be in demand for specialists of all professions. The breakthrough nature of AI technologies is defined as the basis of the Fourth Industrial Revolution ("The Industry 4.0") which will lead to the spread of cyber-physical systems and the "Internet of Things" (Maslov & Lukyanov, 2017).

The educational system of Russian Federation is focused on the development and implementation of educational programs in the field of artificial intelligence both for schools and for higher pedagogical education. Training modules, courses, and extracurricular activities dedicated to intelligent technologies are developed actively nowadays (Baker et al., 2021; Bosova & Samylkina, 2018; Levchenko, 2020; Sperling & Lickerman, 2012). Despite the fact that the problem of training teachers who are competent to educate the basics of artificial intelligence has been brought up in the scientific and methodological literature for quite a long time (Henner & Shirokikh, 2007), there is a huge demand for the pedagogical staff capable of teaching the design, modeling and developing intelligent systems and being able to use them to solve various problems of information activity. Teachers whose professional activity is related to teaching computer science should understand the essence of such concepts as "neural network", "expert systems", "machine learning", "big data", know the models of knowledge representation, understand the distinctive features of the intelligent programs, build and apply the simplest expert systems, know the principles of operation and training of neutron networks.

2. Problem Statement

The analysis of the results of the State Examination over the past few years has shown that the section devoted to AI causes the biggest difficulties for the most future teachers. The assessment of the knowledge quality in this area shows a low level of their awareness. In psychological and pedagogical research the awareness is defined as an ability to understand the connections between knowledge and the ways to obtain it, the capacity to prove and apply this knowledge in various situations (Bespalko, 1971; Skatkin & Kraevsky, 1978). The key characteristic of the knowledge awareness is to see the main meaning of the studied object, phenomenon or concept and to include the knowledge to practical activities. The holistic view of the studied theoretical material can possibly appear only if both formal-logical structural and functional connections as well as emerging associations, heuristic descriptions are revealed. All the things stated above help to overcome the superficial and formal learning of the educational material and serve as an important condition for the development of the semantic sphere of the individual (Bretigam, 2015). The knowledge awareness assumes the ability to memorize not only some theoretical material, but also a higher-level problem-solving skill (Ichsan et al., 2021) – this is called "the understanding learning" (Lyashchenko & Sotnikova, 2011).

The low level of the future teachers' awareness of knowledge in the AI can be seen when students in the process of designing an expert system do not understand and do not distinguish logical models of

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knowledge representation from the production ones. That makes impossible for them to understand the principles of the knowledge-based systems. When students start developing intelligent programs, they don't always understand how they work. There is no step-by-step algorithm in the AI program, but the intelligent system makes a choice between many options from the knowledge base in conditions of uncertainty and functions as a "black box". The difficulties in the programming process using this approach appear due to the formal assimilation of the theory which often leads to the loss of interest in studying artificial intelligence.

3. Research Questions

The generalization of the results of the analysis of psychological, pedagogical, scientific, methodological literature and the pedagogical experience allow us to reveal the contradiction between the need to form the awareness of teachers' knowledge in AI and the lack of conscious learning methods development. This contradiction determined the problem of the study: how should we organize the theoretical training of future and working teachers in the field of artificial intelligence to ensure the formation of their knowledge awareness in this area?

4. Purpose of the Study

Research objectives are:

1. to develop a methodology of teaching the basics of AI that will ensure the formation of the awareness of teachers' knowledge in this area;

2. to organize and accomplish experimental work on testing the developed methodology and evaluating its effectiveness.

5. Research Methods

The research was based on the following methods: theoretical analysis and systematization of psychological, pedagogical and methodological literature; analysis of normative documents, curricula of the school computer science course; generalization of pedagogical experience and reflection of the content of the formed knowledge; testing of participants of the educational process, quantitative and qualitative analysis of the results.

During the creation of our pedagogical tests, we formed the tasks which can identify the skills that characterize the knowledge awareness (the awareness of knowledge signs or AK signs) (Lerner, 1978; Rubinstein, 2002; Skatkin, 1971):

1) the ability to reformulate definitions (1st AK sign);

2) the ability to change the logic of the presentation while maintaining the links between its individual fragments (2nd AK sign);

3) the ability to rearrange the logic of the presentation depending on the goal set (3rd AK sign);

4) the ability to apply knowledge in variable situations according to the model (4th AK sign);

5) the ability to apply knowledge in non-standard situations (5th AK sign).

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In order to prove the effectiveness of our teaching methodology, we chose an approach according to which the success of learning can be characterized by the material assimilation coefficient Kα determined by the following ratio (Bespalko, 1989): (See in Figure 1).

$$K_\alpha = \frac{a}{p},$$

where a – a number of operations performed correctly; p – total number of operations required to complete the task

Figure 1. The material assimilation coefficient Kα

The success criteria were set in accordance with the "principle of training completeness". The Kα coefficient shows the proportion of the elements that were actually learned in relation to the possible ones. In our study the approach of Bespalko (1971, 1989) was generalized to the results of the skills measurements which represent the signs of the knowledge awareness and were identified through testing and questionnaires. In other words, the results of their implementation were related to one of the three gradations allocated in accordance with the model of complete assimilation of Bespalko (1971, 1989):

1st: $K\alpha < 0.5$ – low level of learning the sign;

2nd: $0.5 \leq K\alpha < 0.7$ – acceptable level;

3rd: $K\alpha \geq 0.7$ – sufficient level.

6. Findings

In the developed methodology of training teachers AI which aim is to form their knowledge awareness in this area, we pay special attention to resist the formal leaning of the theoretical material. Theory training is often carried out on lectures and the biggest difficulty is to provide and control a deep understanding of the presented issues precisely on that type of classes (Mohammadreza & Safabakhsh, 2021; Shestak, 2018). This is caused by to a number of objective reasons: the wide availability of high-quality educational material in the Internet resources, the free access to mobile tools given to students so that they can find any information and organize discussion of any questions right in the classroom etc. That's why it is obvious that the inclusion of interactive IT on lecture classes gives us an opportunity to make any student an active participant of the educational process and thereby involve him to it (Artyukhina & Artyukhin, 2013).

Interactive survey systems have been actively used in educational practice recently (Kulakova et al., 2015). These tools allow you to organize a survey or test the students with a fast automatic analyses of given responses and instant visual presentation of the results to all participants of the educational process. When we teach theoretical material on AI classes we often use interactive surveys in the on-line service "Mentimeter.com". Students go to the survey page using their mobile phone, answer the questions meanwhile the teacher simultaneously shows the results in his multimedia presentation.

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Here are some examples of such surveys. It seems to us that in the course of studying the topic "Introduction to AI" one of the most important points where we should ensure the knowledge awareness are the principles of artificial intelligence systems operation and the differences between traditional and intellectual computer programs. We focus on these points with the help of an interactive survey which can include a multiple-choice question (students choose the correct version of the definition of "artificial intelligence"), a cloud of tags based on the characteristics of an intelligent system (students enter their understanding of what makes a system intelligent), an open type of question (students formulate their own opinion about the key difference between a program written in a structural programming language and an the intelligent one). Then the teacher organizes a discussion based on the results of the survey.

In order to organize the reflexion and interception on the lecture lesson "The models of knowledge representation in AI systems" we can recommend the Mentimeter Quiz which allows you to organize an on-line intellectual competition between students. This technique integrates the game element to the self-control of learning new knowledge, activates cognitive activity, mobilizes intelligence and memory. The material of this topic is extremely important in understanding the deep principles of knowledge organization in AI systems and according to our experience often remains "passed" formally. Sample questions for the participants of the competition may be: "In which model of knowledge representation are new inferred aggregates obtained by applying inference rules to the original sets: logical, production, network or frame?", "There is a rigid structure of information units in the _____ model of knowledge representation unlike the others" (here students fill the gap). At the end of the quiz the students' leader tables are displayed on the screen and the results are summed up.

The next component of the developed methodology is the usage of Web 2.0 collective social services during lectures. For example, we use virtual whiteboards which allow us to combine various multimedia content in the process of collaboration and present it in an interactive form. These Internet services have a great potential in visualizing educational material and organizing collective discussions (brainstorming, conducting various types of discussions, etc.). For example, in order to consolidate the lecture material on the topic "Expert Systems", we divide students into groups and ask them to design the work of a simplest expert system based on the production model of knowledge representation. The result of this activity is shown on the "Padlet" virtual whiteboard. Students choose roles like real participants of the expert systems development process have (an expert, a knowledge engineer, a tester) and publish posts on the virtual whiteboard according to their role and the development stage (problem selection, knowledge extraction, knowledge structuring, knowledge formalization and rule building, implementation and testing).

A pedagogical experiment of testing the developed methodology took place at Omsk State Pedagogical University (2017-2021 years). The experiment involved BA students of the direction 44.03.05 Pedagogical Education ("Mathematics and Computer Science" profile) in the course of studying the discipline "Fundamentals of Artificial Intelligence" as well as MA students of direction “44.04.01 Pedagogical education” ("Information Technologies in physical and mathematical education" profile) studying the discipline "Designing intelligent systems". The control and experimental groups were formed from their content.

The results of the formative stage of the experiment are shown in Figure 02.

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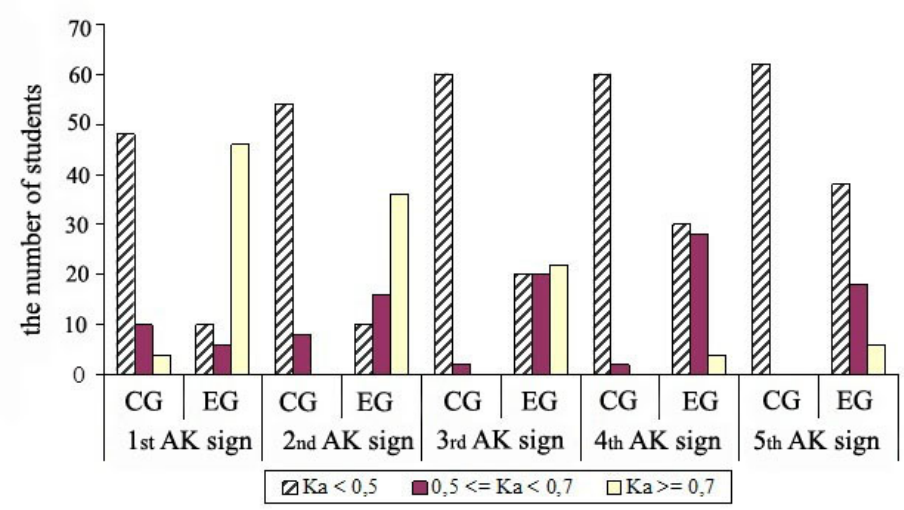

Figure 2. The level of students' knowledge awareness in the control (CG) and experimental (EG) groups

The diagram shows that according to signs 1, 2, 3 of knowledge awareness in artificial intelligence, the number of respondents who are at a low level has significantly decreased. On the contrary, the quantity of students who show a sufficient level of knowledge awareness in AI has significantly increased. As for signs 4 and 5 they also show a reduction in the number of students who are at a low level. At the same time we see that students with a sufficient level of these signs appeared.

7. Conclusion

The arguments stated above prove that the training teachers' artificial intelligence with the help of the proposed methodology aimed to form the awareness of their knowledge is effective.

The analysis of the methodology approbation results let us reveal the following didactic advantages:

- forcing the visibility and visualization of the theoretical material presented through various types of questions;

- the ability for the teacher to take into consideration the student's point of view shown via interactive surveys and react on them simultaneously;

- the opportunity for a student to act as a participant of the educational process and meanwhile to conduct his self-control and self-assessment during learning the theory;

- effective assistance to the students in memorizing key information and mastering fundamental concepts.

Finally we'd like to mention that in the traditional situation of the activity lack, during theoretical classes when the attention of students is mostly occupied with gadgets and non-educational process, the developed methodology provides an increase in the effectiveness of the lectures and contributes to the formation of the knowledge awareness in AI. It happens due to the fact that students feel themselves highly involved in the learning process and that in its turn contributes a lot to understanding and better assimilation of theoretical material.

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