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PEDAGOGICAL CONDITIONS OF INTEGRATION OF ARTIFICIAL INTELLIGENCE AND GEOINFORMATION SYSTEMS IN GEOGRAPHY EDUCATION

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Abstract

The article analyzes the pedagogical conditions for using the integration of artificial intelligence (AI) and geographic information systems (GIS) in geography education from a theoretical and methodological perspective. The didactic possibilities of digital technologies in the processes of searching, sorting, spatial analysis, mapping and interpretation of geographical data are highlighted. The main pedagogical conditions are based on the combination of AI and GIS tools with educational goals, the development of students' geographical and digital competencies, the improvement of teacher methodological training and the improvement of educational resources. A methodological approach is also proposed to organize integrated education.

Key words

geography education, artificial intelligence, geoinformation systems, GAT, digital education, pedagogical conditions.

INTRODUCTION

In modern geography education, an important role is played by explaining territorial processes, identifying connections between natural and socio-economic phenomena, and drawing informed conclusions based on geographic data. Enriching traditional methods of working with maps and texts with digital analysis tools brings the content of education closer to practical activities. In this process, the targeted use of artificial intelligence and geographic information systems is of particular importance.

Geographic information systems allow you to collect, store, combine by layers, spatially analyze and present data on the territory. Artificial intelligence tools can help in the initial analysis of data, clarify concepts, formulate educational tasks and compare different sources of information. However, the effectiveness of using these technologies

does not depend on their availability, but on their selection in accordance with pedagogical goals and their correct implementation in the educational process.

Bernhäuserová et al.'s systematic review of the limitations of implementing ICT in education shows that teacher-related factors and barriers arising from technological resources are of great importance.

UNESCO's recommendations on the use of generative artificial intelligence in education and research emphasize the need to protect human interests, data privacy, and assess the pedagogical suitability of technologies.

In this regard, the purpose of the article is to identify the pedagogical conditions that serve to effectively organize the integration of SI and GAT in geography education, to reveal their interdependence, and to propose a methodical approach.

RESEARCH METHODOLOGY

The research has a theoretical-methodological nature and relies on the methods of analysis of scientific literature, comparative analysis, generalization and pedagogical design. Scientific works on the use of GAT in geography education and international recommendations on the responsible introduction of generative SI into education were taken as an analytical basis.

In the course of research, the tasks of SI and GAT, the possibilities of adapting them to the content of education, and the features of organizing integrated educational tasks were compared. Based on this, pedagogical conditions were systematized in the following directions:

1. Targeted-didactic condition: linking the goals of using technologies with learning outcomes.

2. Methodological prerequisite: use of problem-based learning, research-based teaching and practical assignments.

3. Training of personnel: development of competences of teachers and students in using SI and GAT tools.

4. Technical-resource conditions: providing software, digital maps, open geodata and internet access.

5. Information security and academic integrity: verifying sources, protecting personal information, and disclosing the use of SI.

Based on these methods, an organizational-methodical model of integrated education was formed. This model is the result of theoretical analysis; its effectiveness should be checked through a separate pedagogical experiment.

RESULTS AND DISCUSSION

The results of the analysis indicate that a set of interrelated pedagogical conditions is necessary to organize the integration of SI and GAT in geography education.

First, it is necessary to clearly define the learning objectives. Using SI or GAT in itself is not an independent learning outcome. For example, if a student is required to calculate population density, determine the expansion of an urban area on a map, or compare changes in land cover, the technologies should serve to perform these tasks.

Secondly, practical and research-oriented assignments are important. The student must not limit himself to observing the finished map, but must select data, check its reliability, identify spatial relationships, and justify his results. In this case, the GAT helps organize the data into map layers and perform spatial analysis, and the SI helps develop an analysis plan or provide a preliminary interpretation of the results.

Third, the teacher's professional and methodological training is one of the decisive factors. In addition to knowing the technical capabilities of technologies, the teacher must also clearly determine for which subject, what tasks, and according to which assessment criteria they should be used.

Fourth, educational resources and a culture of working with information should be provided. The source of geographic information, its update time, territorial coverage, and level of accuracy should be taken into account. Information or recommendations provided by the SI should be verified through independent sources.

Fifth, the assessment system should not only cover the process of using technology, but also the results of the student's practical and intellectual activities. This will take into account indicators such as the application of geographical knowledge, the purposeful use of digital tools, spatial analysis, evaluation of sources, and drawing informed conclusions.

Integrated methodological model

The proposed model consists of three interrelated parts:

- Content: geographic concepts, spatial data, digital maps, and rules for using SI.
- Process part: problem definition, data collection, analysis in GAT, interpretation of results using SI, verification and presentation.
- Outcome: practical application of geographic knowledge, purposeful use of digital tools, and evidence-based reasoning.

For example, students might be given an assignment to study the urbanization process in a specific area. They would first collect geographic information about the topic, then compare map layers from different periods in the GAT program. The SI tool could be used to clarify the analysis questions or provide a preliminary interpretation of the results. Finally, students would base their conclusions on maps, tables, and reliable sources.

In this process, SI does not completely replace geographic analysis. It serves as a means of supplementing the student's independent thinking and practical work done in the GAT.

DISCUSSION

The theoretical and methodological results obtained show that it is not enough to interpret the integration of SI and GAT only as a technical innovation. The pedagogical value of integration is determined by the student's ability to independently formulate a geographical problem, analyze data, and explain the results based on evidence.

Systematic reviews of GAT have noted, along with the educational opportunities of technology, barriers related to teacher training and resources in its implementation.

This situation also indicates the need to align technology with the curriculum, teacher competence, and assessment system when implementing SI.

Also, the answers of generative AI may not always be precise or verified. Therefore, students should be taught not to accept ready-made answers, but to check them, compare them with other sources, and assess the possibility of error. The human-centered and responsible approach emphasized in the UNESCO recommendations is consistent with these objectives.

The model proposed in this article is theoretically based, and in order to draw firm conclusions about its practical effectiveness, it is necessary to compare the initial and final results of students, study the opinions of teachers, and evaluate practical assignments based on unified criteria.

CONCLUSION

The integration of artificial intelligence and geographic information systems in geography education creates opportunities for linking educational content with practical activities, spatial analysis of geographic data, and the development of students' digital competencies. However, the use of these opportunities depends on the clarity of pedagogical goals, methodological preparation, technical resources, reliable data, and adherence to academic integrity.

Based on the analysis, a methodical model covering content, process and result parts of integrated education was proposed. At the next stage, it is desirable to test this model on the basis of certain subjects of geography, to evaluate the changes in the geographical and digital competences of students based on the criteria.

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