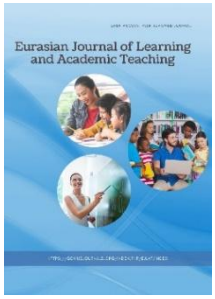

Methodology for Developing Students' Geographical Knowledge through Digital Technologies

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ABSTRACT

This article scientifically and practically examines the methodology of teaching geography in general secondary schools using digital technologies and evaluates its effectiveness. During the research process, the role of modern digital platforms such as Google Earth, artificial intelligence, and Canva, as well as interactive educational games such as Kahoot, Wordwall, and Jeopardy, in developing the geographical thinking of students in grades 7–9 was analyzed. The impact of digital tools on students' learning achievement indicators was statistically substantiated through experimental research. The obtained results demonstrate that the integration of competency-based approaches and innovative pedagogical technologies into the teaching process contributes to improving the quality of education to the level of international standards (PISA, TIMSS).

Keywords: Digital technologies, geography education, interactive methods, Google Earth, artificial intelligence, 5E model, education quality, innovative approach, PISA

Introduction

In the context of globalization and digital transformation, the need to improve the education system in accordance with international standards is steadily increasing. Today, the quality of education is recognized as one of the key indicators of a country's socio-economic development and its capacity to train competitive professionals. In particular, in teaching geography, developing students' spatial imagination and their competencies in understanding natural processes and cause–effect relationships is considered an important task. Traditional explanatory teaching approaches often lead to superficial comprehension of complex concepts by students; therefore, the need to integrate digital technologies into the educational process has emerged.

The digital technology method is an approach to organizing the learning process through the use of modern digital tools, software, web platforms, artificial intelligence systems, and virtual environments. This method enhances students' analytical thinking, information processing skills, map creation abilities, geographical modeling, and visual analysis in geography education. The use of advanced pedagogical technologies in accordance with the standards of international organizations such as UNESCO, OECD, PISA, and TIMSS significantly increases the effectiveness of teaching.

The main objective of this study is to develop methodological foundations for the use of digital tools (Google Earth, Canva, interactive games) in geography lessons for grades 7–9 and to experimentally verify their impact on students' academic achievement.

Research Methods

In order to achieve the objectives set during the research process, a number of scientific and pedagogical methods were employed, including the analysis of scientific literature, pedagogical observation, experimental research, testing and diagnostic assessment, as well as statistical analysis methods. The experimental research was conducted during the 2023–2025 academic years with the participation of 7th-grade students from general secondary schools. Students were divided into control and experimental groups: lessons in the control groups were conducted using traditional teaching methods, whereas in the experimental groups, instruction was organized based on the 5E instructional model and digital technologies. During the study, the following digital educational tools were widely used:

Google Earth and digital maps: Enabled students to visually analyze the relief of continents, mountains, and rivers in a virtual environment.

Weather portals (Ventusky.com, Windy.com): Served to conduct real-time climate and meteorological analyses.

Artificial intelligence: Used as a tool for analyzing statistical data and drawing logical conclusions on topics such as demography and urbanization.

Graphic design tool (Canva): Used by students to present acquired knowledge in the form of interactive infographics.

Gamification tools (Kahoot, Wordwall, Jeopardy): Provided opportunities to reinforce lessons, create a competitive learning environment, and rapidly assess acquired knowledge.

The educational assessment methodology was adapted to the approaches of international programs such as PISA (Programme for International Student Assessment), which evaluates students' global competencies, and TIMSS, with a particular emphasis on students' ability to solve real-life problems.

Research Results

The experimental work demonstrated that digital technologies not only enrich the learning process with information but also increase students' interest in the subject. Within the framework of the research, special digital lesson plans were implemented for each grade level:

1.Virtual Spatial Analysis in 7th-Grade Geography Lessons (Continents and Oceans Course)

Google Earth was used as the primary digital tool in the lesson. While studying the topic "Structure of Continents and Oceans," students were assigned the task of identifying the highest mountain and the largest river on the African continent.

Introduction (5 minutes): Motivational question-and-answer activities about the world map were conducted.

New Topic (15 minutes): Rivers, mountains, and landscapes were observed using Google Earth.

Reinforcement and Presentation (20 minutes): Each group presented an infographic (created using Canva) based on the analyzed region.

2.Climate Modeling in 8th-Grade Lessons (Climate-Forming Factors)

Digital weather maps from Ventusky.com or Windy.com were used in the lesson. Students were divided into groups and analyzed real-time data on air temperature, precipitation, and wind direction for regions such as the Amazon Basin or Siberia. Based on this information, students developed conclusions regarding the impact of climate on flora and fauna.

3.Integration of Artificial Intelligence in 9th-Grade Lessons (Demography and Urbanization)

Students were taught how to search for accurate information using ChatGPT. Through problem-based questions such as "Which cities in the world are experiencing the fastest growth?", students compared AI-generated responses with official statistical sources and produced critically analytical reports.

Impact of Interactive Assessment Tools

The following platforms were actively used during reinforcement activities:

Kahoot: Real-time quizzes were conducted, increasing students' attention and strengthening competitiveness.

Wordwall: Created convenience for visual and kinesthetic learners in mastering terminology and completing map component matching tasks.

Jeopardy: Thematic game stations were organized to develop teamwork and enhance rapid thinking competencies.

Statistical Results

In order to determine the effectiveness of lessons organized based on the 5E instructional model and digital technologies, diagnostic tests were conducted in both experimental and control groups during the research process. The obtained results are presented in Table 1 and Figure 1.

Group	Learning Achievement Level (%)
Experimental group (before the experiment)	54%
Experimental group (after the experiment)	79%
Control group (before the experiment)	56%
Control group (after the experiment)	62%

According to the data presented in Table 1, the average level of learning achievement in the experimental groups was 54% prior to the experiment, whereas this indicator increased to 79% after the experiment. As a result, an average increase of 25% in learning achievement was recorded. In some experimental groups, this indicator was observed to increase by up to 30–35%.

In the control groups, the learning achievement level was 56% before the experiment and reached 62% after the experiment. This indicates that the knowledge level in the control group increased by only 10–12%.

Figure 1 illustrates the comparative dynamics of learning achievement levels in the experimental and control groups, clearly demonstrating that the rate of increase in the experimental groups was significantly higher. This confirms the positive impact of integrating the 5E model and digital technologies on educational effectiveness.

Furthermore, the level of competencies developed in students through the use of digital tools was also determined during the research (Table 2 and Figure 2).

Type of Competency	Level of Development (%)
Geographical competency	82%
Map-reading skills	78%
Analytical thinking	75%
Problem-solving skills	73%

According to the results presented in Table 2, students demonstrated the development of geographical competency at 82%, map-reading competency at 78%, analytical thinking competency at 75%, and problem-solving competency at 73%.

Figure 2 graphically presents the results by competency type, indicating that the highest level was observed in geographical competency, whereas a relatively lower level was recorded in problem-solving competency.

Overall, the obtained statistical results indicate that lessons organized on the basis of the 5E instructional model and digital technologies not only improve students' level of knowledge acquisition but also effectively contribute to the development of their practical, analytical, and problem-solving competencies.

Discussion

The obtained results are fully consistent with the views of a number of international and local scholars. The integration of the 5E instructional model (Engage, Explore, Explain, Elaborate, Evaluate) with digital technologies transforms students from passive recipients of knowledge into active researchers. Scholars such as Bybee, Atkin, and Karplus have emphasized in their studies that such models contribute to the independent construction of knowledge.

J.Hattie (2012), in his Visible Learning theory, highlights that active student participation plays a decisive role in improving educational

effectiveness. The Kahoot and Wordwall platforms used in our lessons not only increased motivation through gamification but also provided opportunities for learning through mistakes and receiving immediate feedback. This serves as a direct practical confirmation of Hattie's theory.

Furthermore, J. Biggs, in his concept of Constructive Alignment, substantiates the need for alignment between assessment, learning outcomes, and teaching methods. The assessment criteria used in our research (for example, evaluating infographics created in Canva on a three-point scale) were developed accordingly and enabled the accurate evaluation of students' ability to use maps and visually present information.

According to OECD (2021) and international PISA studies, students should possess "global competence," that is, the ability to apply acquired knowledge to real-life situations. The analysis of population density and migration issues through artificial intelligence, as well as the modeling of climate in natural zones using weather applications, enhanced the life competencies required by the PISA assessment system. As noted in the local studies of R. Qodirov and M. Jo'rayev, the use of digital technologies in education serves as a key tool for aligning system monitoring with international standards.

Conclusion

In conclusion, it should be emphasized that the use of digital technologies and pedagogical models based on international standards (such as STEAM, 5E, and Blended Learning) in geography lessons yields highly effective results. The research findings confirmed the following:

Digital technologies (Google Earth, interactive maps) enable a deeper visual and interactive understanding of geographical objects and complex natural processes.

Artificial intelligence systems and design platforms (Canva) contribute to the development of students' independent inquiry, data selection, critical analysis, and creativity competencies.

Interactive assessment tools (Kahoot, Wordwall, Jeopardy) ensure the reinforcement of knowledge in an engaging and competitive environment and encourage continuous learner engagement.

The integration of principles of global educational organizations (UNESCO, OECD) and international assessment systems (PISA, TIMSS) into national educational programs fosters not only memorization skills but also the ability to find solutions to real global problems.

Overall, the development of students' geographical knowledge through digital technologies creates the foundation for essential life competencies required for modern professions and digital literacy. The widespread implementation of these innovative methods in school education will serve as a strategic step toward ensuring the global competitiveness of Uzbekistan's education syst

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