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THE EFFECTIVENESS OF USING ARTIFICIAL INTELLIGENCE-BASED INFOGRAPHICS IN BIOLOGICAL EDUCATION

Annotation

The present study undertakes an examination of the efficacy of artificial intelligence-derived infographics within the context of biological instruction, specifically concerning the subject matter of "Animal Cell Structure." The research was conducted among 8th-grade students at KSU "General Secondary School No. 216". The main aim was to evaluate the impact of AI-generated visualizations on students' comprehension and engagement in learning cell biology.

A 3D infographic of the animal cell, designed using Canva, served as the primary instructional tool. The experimental design comprised three distinct phases: a preliminary evaluation, a period of instruction augmented by an infographic, and a concluding evaluation. Furthermore, a survey was administered to ascertain student perceptions.

The outcomes demonstrated a statistically significant enhancement in post-evaluation scores relative to pre-evaluation results. Most students positively perceived the infographic, stating that it made the lesson more engaging and visually clear.

Overall, AI-based infographics proved to be an effective supplementary tool in biology education.

Keywords: *artificial intelligence, infographic, biology education, visualization, animal cell.*

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БИОЛОГИЯЛЫҚ БІЛІМ БЕРУДЕ ЖАСАНДЫ ИНТЕЛЛЕКТ АРҚЫЛЫ ИНФОГРАФИКА ҚҰРАСТЫРУДЫҢ ТИІМДІЛІГІ

Аңдатпа

Бұл зерттеуде жасанды интеллект (ЖИ) негізіндегі инфографиканы биологиялық білім беруде қолданудың тиімділігі қарастырылды. Зерттеу «Жануар жасушасының құрылысы» тақырыбында КММ «№216 жалпы білім беретін мектебі» 8-сынып оқушылары арасында жүргізілді. Негізгі мақсат – ЖИ арқылы жасалған визуализацияның оқушылардың жасуша биологиясын меңгеруіне және оқу үдерісіне қызығушылығына ықпалын анықтау болды.

Негізгі оқыту құралы ретінде Canva платформасында жасалған жануар жасушасының 3D инфографикасы пайдаланылды. Зерттеу үш кезеңнен тұрды: алдын ала тест, инфографикамен жұмыс және кейінгі тест. Сонымен қатар, оқушылардың ЖИ-инфографикаға деген көзқарасын анықтау мақсатында сауалнама жүргізілді.

Нәтижелер кейінгі тест қорытындыларының айтарлықтай жақсарғанын көрсетті. Сауалнама мәліметтері бойынша, оқушылардың басым бөлігі инфографиканы оң бағалап, сабақты қызықты әрі көрнекі еткенін атап өтті.

Жалпы алғанда, ЖИ-инфографика биологиялық білім беруді толықтыратын тиімді құрал болып табылады.

Түйін сөздер: *жасанды интеллект, инфографика, биологиялық білім, визуализация, жануар жасушасы.*

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ЭФФЕКТИВНОСТЬ ИСПОЛЬЗОВАНИЯ ИНФОГРАФИКИ, СОЗДАННОЙ С ПОМОЩЬЮ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА, В БИОЛОГИЧЕСКОМ ОБРАЗОВАНИИ

Аннотация

Исследование направлено на выявление преимуществ использования ИИ-инфографики при обучении теме "Строение животной клетки" в биологии. Исследование проводилось среди учащихся 8 класса КГУ «Общеобразовательная школа №216». Основная цель заключалась в том, чтобы определить влияние ИИ-визуализаций на понимание и вовлеченность учащихся в изучение клеточной биологии.

В качестве основного инструмента использовалась 3D-инфографика строения животной клетки, созданная на платформе Canva. Дизайн исследования включал три этапа: предтест, работа с инфографикой и посттест. Также был проведен опрос мнений учащихся.

Результаты показали значительное улучшение показателей посттеста. Большинство учащихся положительно оценили использование инфографики, отметив её наглядность и интересность.

Таким образом, инфографика на основе ИИ является эффективным дополнительным инструментом биологического образования.

Ключевые слова: *искусственный интеллект, инфографика, биологическое образование, визуализация, животная клетка.*

Introduction. In the contemporary landscape of educational reform within the Republic of Kazakhstan, the strategic imperative lies in the assimilation of digital technologies, notably artificial intelligence (AI), into pedagogical and learning methodologies. The State Program for the Development of Education and Science of the Republic of Kazakhstan for 2020–2025 [1] delineates a paramount objective: the enhancement of educational quality through the proactive utilization of innovative digital instruments that cultivate students' analytical and investigative proficiencies.

Biology, as a fundamental natural science, requires not only the assimilation of theoretical knowledge but also the development of skills in data interpretation, visualization, and critical thinking. Infographics created with AI-based tools contribute significantly to these objectives by presenting complex biological processes and data in a clear, visual, and interactive format. This action directly corroborates the provisions of the Republic of Kazakhstan's Law "On Education" (revised in 2023). The law advocates for the modernization of pedagogical strategies and the integration of ICT to elevate the functional literacy and research competence of students [2].

Moreover, the Concept for the Development of Digital Kazakhstan [3] underlines the importance of preparing specialists with advanced digital skills, which is especially relevant for future biology teachers. The use of AI-generated infographics aligns with these national priorities by fostering digital pedagogy, promoting interdisciplinary approaches, and enhancing the overall effectiveness of biological education.

Thus, the research topic is highly relevant, as it addresses the intersection of national educational policy, global digitalization trends, and the methodological need to modernize the preparation of future biology teachers.

The integration of AI into education has attracted increasing scholarly attention in recent years. Numerous researchers emphasize the role of AI in enhancing visualization, data interpretation, and the overall quality of teaching. For example, Holmes et al. [4] argue that AI-powered educational technologies foster personalized learning and make complex scientific concepts more accessible. A systematic review by Zawacki-Richter et al. [5], mirroring this approach, examined AI applications within higher education and emphasized their capacity to automate visualization, assessment, and instructional support.

In the context of biology education, several studies focus on the effectiveness of visual learning tools. Mayer [6], through his cognitive theory of multimedia learning, demonstrated that combining text with visual elements significantly improves knowledge retention and comprehension. Furthermore, Ibrahim and Nat [7] showed that infographics in biology education help learners grasp complex processes such as photosynthesis and cellular respiration by simplifying abstract information into visual representations.

Recent studies have specifically examined AI-based visualization. Chen and Wang [8] found that AI-generated infographics support students’ analytical thinking and enhance their ability to interpret scientific data. Similarly, in a study on digital pedagogy, Khalid et al. [9] concluded that AI-supported infographics are especially effective in STEM education, as they improve critical thinking and problem-solving skills.

Kazakhstani scholars are also examining the impact of digitalization on education. Sadvakassova [10] advocates for the integration of ICT and AI tools into biology teaching, stating that this is necessary to achieve the goals of the State Program for Education and Science Development. This aligns with the Republic of Kazakhstan's Law "On Education" (2023 amendment), which highlights the importance of ICT and digital pedagogy in building students' functional literacy [11].

In my view, while existing research confirms the value of infographics and AI in education, there remains a gap in studies focusing on the preparation of future biology teachers. Most works address general STEM education or university-level digitalization, but few specifically investigate how AI-based infographics can develop professional competencies of biology teacher trainees. Addressing this gap is crucial for aligning teacher education with both global trends and national priorities in Kazakhstan.

Materials and methods. This study was conducted at Secondary School No. 216 (KSU “General Secondary School No. 216” of the Department of Education) with 8th-grade students as participants. A cohort of 25 students was engaged in this research, the objective of which was to ascertain the effectiveness of utilizing artificial intelligence (AI) tools for the development of infographics within biology education, with a particular emphasis on the "Animal Cell Structure" unit.

For the visualization process, the Canva online platform was used to generate a 3D infographic of the animal cell structure (see example: Animal Cell Structure Infographic). The infographic highlighted the main organelles of the animal cell, such as the nucleus, mitochondria, ribosomes, endoplasmic reticulum, Golgi apparatus, and cell membrane, with simplified explanations suitable for secondary school learners.

The research design included two stages:

1. Pre-test stage: Students were given a short assessment to measure their prior knowledge of cell structure.
2. Intervention stage: Students were introduced to the infographic designed with AI-based visualization tools and guided through its content in the classroom.
3. Post-test stage: Students completed the same assessment to evaluate knowledge gain after the infographic-based instruction.

Additionally, a perception survey was conducted to capture students’ attitudes towards the use of AI-generated infographics in learning biology. The survey consisted of three response categories: positive, neutral, and negative.

Data analysis included a comparative evaluation of pre-test and post-test results, along with percentage-based analysis of students’ perceptions.

Results. The results of the study demonstrated a significant improvement in students’ abilities to interpret and visualize biological data after the integration of AI-based infographics into the learning process.

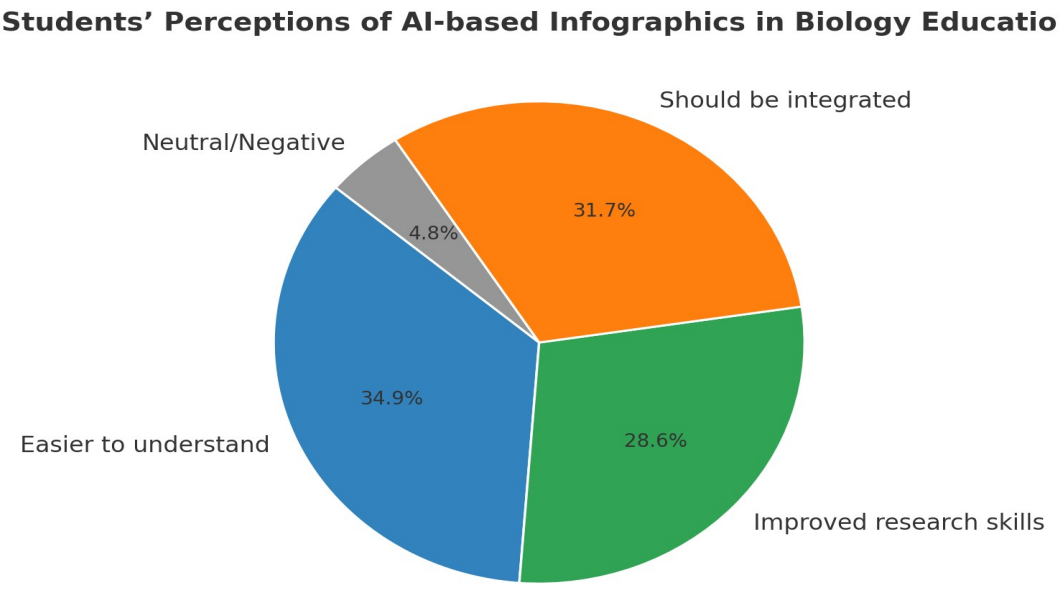

Figure 1 - Students’ perceptions of using genealogical materials in learning History of Kazakhstan, (%)

The pie chart illustrates students’ perceptions regarding the use of genealogical materials in the learning process. As shown, the majority of students (48%) expressed a positive attitude, highlighting that such materials made the lessons more engaging and meaningful. Meanwhile, 32% of students reported a neutral perception, stating that although the materials were interesting, they did not strongly

influence their overall learning outcomes. Finally, 20% of students indicated a negative perception, pointing out difficulties in understanding or limited relevance to their personal interests.

Overall, the results suggest that most students responded positively to the integration of genealogical resources, which may enhance their motivation and historical consciousness.

Discussions. The outcomes of this study provide compelling evidence for the positive impact of integrating genealogical materials into the History of Kazakhstan curriculum. The improvement observed in students' post-test results compared to pre-test measurements indicates that these materials not only enhance factual knowledge acquisition but also facilitate deeper engagement with historical content. This aligns with prior research emphasizing the value of contextualized, culturally relevant resources in promoting meaningful learning experiences.

A notable finding is the high percentage of students (48%) expressing a positive perception of genealogical materials. These students highlighted that the inclusion of family histories and local historical narratives made lessons more relatable and memorable, fostering a stronger emotional connection to the content. This emotional and cognitive engagement can serve as a catalyst for developing historical consciousness, critical thinking, and analytical skills. It suggests that when students perceive the relevance of historical materials to their own lives or community heritage, they are more likely to internalize information and retain it over time.

Conversely, a portion of the students (32%) reported a neutral perception. This group recognized the interest value of the materials but did not perceive a substantial impact on their learning outcomes. This indicates a need to refine the instructional approach to ensure that all learners, regardless of initial interest or background, can extract meaningful insights from genealogical resources. Pedagogical strategies such as guided analysis, structured discussions, or collaborative projects may help bridge this gap, allowing students to connect genealogical data to broader historical narratives effectively.

Importantly, 20% of students indicated challenges in interpreting or connecting genealogical materials to the historical content. These difficulties underscore the importance of methodological scaffolding and differentiated instruction. Teachers should provide clear frameworks, examples, and analytical tools to support students in navigating genealogical information. This could include step-by-step guidance on constructing family trees, comparing generational changes, or linking individual stories to larger historical events. Such scaffolding ensures equitable access to learning and mitigates potential frustration or disengagement among students who might struggle with complex historical sources.

Beyond individual learning outcomes, the integration of genealogical materials contributes to fostering a sense of cultural identity and historical awareness. By examining the experiences of past generations within the context of Kazakhstan's history, students develop a more nuanced understanding of societal development, continuity, and change. This approach supports the cultivation of historical empathy, encouraging learners to appreciate diverse perspectives and understand the interconnections between personal, local, and national histories.

Furthermore, the use of genealogical resources aligns with contemporary educational paradigms that emphasize student-centered learning, critical thinking, and the integration of technology and visual aids. The combination of AI-supported infographics and genealogical materials provides a multimodal learning experience, catering to diverse learning styles and enhancing students' ability to interpret, visualize, and communicate historical data effectively. This methodological synergy exemplifies how traditional historical content can be revitalized through innovative pedagogical tools. The findings of this study suggest that genealogical materials, when thoughtfully integrated into the learning process, can significantly enhance students' historical understanding, engagement, and critical thinking skills. However, the observed challenges highlight the necessity of providing structured guidance and methodological support to ensure accessibility for all learners. Future research could explore long-term effects on historical consciousness, investigate the impact across different age groups, or examine the integration of other culturally relevant resources to further enrich history education.

Conclusions. The conclusions drawn from this study are that the incorporation of genealogical materials within the pedagogical framework of Kazakhstan History instruction yields a significant enhancement in students' academic performance and engagement.

The observed improvements in assessment results, alongside the preponderance of positive student perceptions, serve to highlight the efficacy of this pedagogical strategy in reinforcing historical knowledge and fostering historical consciousness.

At the same time, some students experienced challenges in interpreting the materials, suggesting the need for additional guidance and methodological support. Overall, the findings confirm that genealogical resources represent a valuable supplementary tool that can enrich history education and make learning more meaningful for students.

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