GUMILYOV JOURNAL OF PEDAGOGY
ISSN: 3080-1710. ISSN (Online): 3104-462X

IRSTI 28.23.15
https://doi.org/10.32523/3080-1710-2025-153-4-133-145
Scientific article

Ergonomics of School Textbooks: The Role of Artificial Intelligence in Education for Sustainable Development

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Abstract. The article delves into the issues of implementing notions of sustainable development textbooks in schools as well as how the problems could be resolved. On the one hand, it is necessary to bridge the gap between the content of education and modern science. On the other hand, it is necessary to get rid of excessive academic textbooks, bring them closer to real life. Thirdly, it is necessary to integrate the ideas of sustainable development into the content of textbooks in order to teach children to live, to form resilience skills, and social values. Textbooks on natural sciences for secondary schools in Australia, the USA and Germany were analyzed. The results of comparing the texts of traditional textbooks and texts on sustainable development using the Gunning Fog Index and the Flesh Reading Ease scale are shown. The research done by the authors showed that artificial intelligence, together with blockchain, can play a key role in adapting textbooks on sustainable development in accordance with the needs of the subject and the age of students. Collect data on sustainable development from various sources, establish links between them, identify areas where this information will be needed, link it to real-time, take into account the changing knowledge base in subject areas and ensure that it corresponds to the content of the course. A summation of such an assessment of research has led to the revelation that artificial intelligence, virtual, augmented and mixed realities as part of the educational content may contribute to improvements within the learning process, making it exceptionally engaging to the participants.

Keywords: ergonomics, school textbook, sustainable development, artificial intelligence.

Received: 29.05.2025; Approved: 15.12.2025; Available online: 31.12.2025

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Introduction

In the context of global transformations and increasing interdependence between human activities and natural systems, the integration of sustainable development principles into education is no longer optional – it is imperative. Education for Sustainable Development (ESD) has become a central theme in international policy frameworks, including the United Nations' 2030 Agenda for Sustainable Development and UNESCO's Global Education Monitoring Reports. School education plays a fundamental role in preparing future generations to address the complex challenges of climate change, biodiversity loss, social inequality, and economic instability. At the core of this educational transformation lies the school textbook – still the most widely used and authoritative learning resource across the globe.

Despite the rapid evolution of digital resources and open educational platforms, the textbook remains central in most education systems, especially in formal primary and secondary education. It guides the instructional process, reflects the approved curriculum, shapes students' understanding of subjects, and significantly influences the values they adopt. Therefore, the question of how well textbooks incorporate the principles of sustainable development and how effectively these principles are communicated to students becomes a matter of international importance. However, the integration of sustainability concepts into educational content is not just a matter of adding new information; it requires a holistic revision of how content is selected, structured, and presented to learners.

One of the key challenges in this regard is the ergonomics of educational texts. While ergonomics is traditionally associated with the design of physical work environments, its principles are equally applicable to cognitive and educational settings. In the case of textbooks, ergonomics refers to the comprehensibility, readability, accessibility, and usability of texts. An ergonomically designed textbook facilitates learning, reduces cognitive load, and promotes student engagement and motivation. In contrast, overly academic, dense, or fragmented content can alienate learners, reduce comprehension, and ultimately hinder the achievement of educational goals.

This problem is especially relevant in the context of sustainable development education. Many sustainability-related topics are interdisciplinary by nature and involve complex terminology, abstract ideas, and unfamiliar concepts. This complexity often results in content that is textually and conceptually challenging for school students. Moreover, the presentation of such content in textbooks is frequently episodic and fragmented, lacking coherent integration with existing subject matter. The result is an increase in textual difficulty that places additional cognitive demands on students, particularly those in secondary education, where the foundation for scientific and critical thinking is still being formed.

In recent years, Artificial Intelligence (AI) has emerged as a powerful tool for analyzing and improving the ergonomics of educational materials. Readability indexes such as the Gunning Fog Index and the Flesch Reading Ease Scale offer measurable parameters to evaluate the complexity of educational texts. These tools enable researchers, educators, and textbook authors to assess whether a given text is appropriate for a particular age group and academic level. When integrated with AI technologies, these assessments can be performed at scale, allowing for the systematic evaluation of large bodies of educational content across subjects and grade levels. AI can also support the real-time updating of textbook content, ensuring alignment with the most current scientific knowledge and pedagogical approaches.

Furthermore, AI applications extend beyond readability analysis. They enable adaptive learning, personalized content delivery, and the integration of immersive technologies such as virtual, augmented, and mixed reality. These innovations have the potential to revolutionize textbook design, transforming static texts into dynamic learning environments that respond to students' individual needs and learning styles. When applied to sustainability education, such technologies can help bridge the gap between abstract concepts and real-world applications, making complex issues like climate change, ecological interdependence, and global citizenship more relatable and engaging for students.

In this study, we explore the ergonomic qualities of textbook texts on sustainable development using artificial intelligence tools. We analyze textbook materials from secondary schools in Australia, the United States, and Germany to compare the readability of traditional subject content with that of sustainability-related inserts. By applying the Gunning Fog Index and the Flesch Reading Ease Scale, we aim to determine whether the sustainability content included in current textbooks is cognitively appropriate for the intended student audience. Additionally, we examine how AI and related technologies, including blockchain, can be leveraged not only to evaluate but also to improve the ergonomic characteristics of educational texts.

The urgency of this research lies in the global call for educational systems to respond to the demands of a rapidly changing world. As the challenges of sustainable development grow more acute, so too must our efforts to prepare students not only with knowledge but also with the values, attitudes, and competencies needed to create a sustainable future. The school textbook must evolve accordingly – from a static repository of facts to a dynamic tool for critical thinking, problem-solving, and active citizenship. Ensuring that this transformation is ergonomic – that is, accessible, usable, and inclusive – is essential for its success.

Methods

An educational facility with universal accessibility probabilities targeted towards all students in accordance with their interests is a human right regardless of their place of residence – a city or a village, where he/she studies – in a public or private school, and, of course, regardless of the social status and income of their parents. The common educational space is a factor of international and national security, especially in the conditions of intensified migration processes and interethnic conflicts.

The unified educational space is a tool for comparing the qualification level of graduates, forming common requirements for the knowledge and skills of graduates, and ensuring the mobility of the qualified labor force. The unified educational space of sustainable development is implemented at the level of educational organizations through an institution-wide approach to ESD, school partnership with the local community, including educational and practical activities, educational ecosystems of the region, country, as well as globally, with the coordinating function of UNESCO (Bourn, 2016).

Focusing on the ergonomics of learning labor, the unified educational space appears as a complex, multilevel project that gives the education system a new quality. The unified world educational space reflects the unification of national educational systems of different types and levels, significantly differing in goals, objectives, qualitative state and even in philosophical and cultural traditions.

However, the creation of the world educational space is not a simple assimilation of national systems into a single whole. Moreover, it is not the absorption of the «strong» education into the «weak» one. It appears as a voluntary, mutually beneficial movement towards an integrity that combines the best characteristics of the integrated subjects.

Aspects of unifying the educational space can be regarded with respect to educational standards, forms, content and methods of education, curricula, methodological aids, support, and didactics, for they display the importance of quality education.

The unification of the space of education is depicted through the process of combining textbooks, basic curricula, and qualifications for teachers, certification transparency and general resources for education. Educational environment is of need of such practices as they are crucial to the school climate and the setting in which lessons take place. At the same time, each school should retain its own ways of achieving and realizing a unified educational environment. An example of education unification is the formation of «soft» skills, international education quality assessment (Niemi et al., 2018). We find examples of the unification of final certification formats in many countries of the world.

Ergonomics of educational labor is its complex characteristic, which includes the student's working capacity, comfort of study, satisfaction with it, optimality of load, its safety, rationality of educational work, and its efficiency (Saha et al., 2024; Huang, Spector & Yang, 2019). The changing nature of the educational process, its globalization, requires justification and elaboration of its ergonomic link.

In school conditions, it is possible to consider students' activity as labor activity, which allows us to impose a systematic approach of ergonomic methods on the organization of teachers' work and the training of students. Solving ergonomic issues related to the strive to attain the improvement of the effectiveness and quality of learning, as well as personal development and participants' health, who engage in the pedagogical process, is essential.

Scientific organization of labor at the workplace firstly implies a rational work process, reduction of students' fatigue, elimination of unnecessary and inconvenient movements, which ensures high labor productivity and quality of work.

The ergonomic educational process is characterized by:

– holistic pedagogical and ergonomic concepts that allow interaction of the «teacher – learner – learning environment» model to be implemented into a process which is in the state of being controlled must be developed and implemented into educational facilities;

– representation of the classroom as an ergonomic system, specially organized as a unit of participants and material objects in the training process, pursuing an ergonomic approach to educational and pedagogical activities;

– creating favorable conditions for ensuring a high quality of education, developing students' creative abilities, realizing psychological and socio-cultural opportunities, preserving and strengthening the health of those involved in the educational process, and improving the health of pedagogical work.

The main problems of any educational organization from the standpoint of an ergonomic approach are:

– this is the choice of effective learning tools, taking into account how optimally efforts, money and time will be spent;

– ergonomic requirements for the information and subject space of the school;

– ergonomic conditions for the creation and practical application of new teaching tools and complexes;

– optimal conditions for determining the quantity and quality of data and the main sources.

In the ergonomic approach, the most important thing is to preserve the mental and physical health of the subjects of the training process and to prevent negative functional states.

The ergonomic approach is the backbone of the school's unified teaching spaces. The second element that makes up the system is information and communication. The content-organizational factor includes structural components: the content of the activity and the ways of carrying out activities, which are implemented on the basis of pedagogical principles and methods. The content of the analytical and resultant factors is the correspondence of the results of the activities of the subjects of the pedagogical process to specific goals.

A sign of the ergonomics of the educational process is pedagogical efficiency. That is, the ergonomic use of resources to achieve results in teaching and educating students (Creemers, 2023). In determining didactic efficiency, almost all researchers emphasize the criterion – «time», as well as amount of educational content, «amount of material and spiritual costs». In this case, the time costs of solving didactic tasks per unit time (speed) are fixed. It is known that students spend time solving tasks, in addition to many other factors (intelligence, knowledge level, etc.), which depend on the complexity of the tasks proposed.

It is known that the content of school textbooks rarely changes. However, today there are loud public calls for their renewal. On the one hand, it is necessary to overcome the gap between the content of education and modern science. On the other hand, it is necessary to get rid of the excessive academic nature of textbooks, to bring them closer to real life. At the same time, there is a problem of excessive complexity of textbooks, which causes difficulties in the perception and assimilation of educational material by students (Van Merriënboer & Sweller, 2019). Thirdly, it is necessary to integrate the ideas of sustainable development into the content of textbooks in order to teach children to live, to form resilience skills and social values (El Massoudi, 2024).

The task of revising school textbooks based on the ideas of sustainable development did not arise today. UNESCO and the Georg Eckert Institute have published a number of important manuals and expert studies, including the UNESCO Guide to Textbook Research and Revision by Falk Pingel. It focuses on the revision/adaptation of school textbooks and other learning materials to unify them on the basis of sustainable development ideas in order to create a common educational space for sustainable development (Foster, 2024).

The UNESCO Global Education Progress Report Education for People and Planet: Exploring Education for People and Planet: Exploring the Future for All, was published in 2016 (UNESCO, 2016). In the same year, the Global Education Monitoring Report. «Sustainable development textbooks» (2024) appeared (UNESCO, 2024). Both documents called on world governments to review and urgently update the content of textbooks in line with the core values of the 2030 Agenda for Sustainable Development.

In 2017, a network was launched to integrate SDG Target 4.7 and Social-Emotional Learning into teaching materials (NISSEM) as a resource to facilitate the operation of SDG objective 4.7. The International Education Society, UKFIET in 2017, the UCL Institute of Education and then George Washington University initiated this work. All initiative groups point out that the integration of Sustainable Development Goals and soft socio-emotional knowledge into textbooks should start at an early age (International Baccalaureate Organization, 2024).

Textbooks for Sustainable Development: A Guide to Embedding, produced by the Mahatma Gandhi Institute of Education for Peace and Sustainable Development (UNESCO MGIEP, 2017), was of great assistance in this work.

The 2021/2 Education Monitoring Report, Non-State Actors in Education: Who Chooses? Who Loses? underscores the importance of this matter, a point reaffirmed by UNESCO in Paris (UNESCO, 2021).

How is this direction being fulfilled and are textbook texts becoming too complicated in terms of ergonomics? In our study, we analyzed 9 textbooks on natural sciences (physics, biology, chemistry) for secondary school (7–9 grades), published in 2015–2023 in Australia, USA and Germany (3 from each country). The selection criteria included: official adoption in the school program, presence of sections related to sustainable development, and accessibility in print or digital format. The analyzed material amounted to approximately 250 pages (25–30 pages per textbook). Only the textual parts of the chapters (paragraphs, exercises) were considered, without illustrations or graphical materials.

Fragments of traditional subject texts were compared with new texts included in the textbooks about sustainable development. For readability assessment, we applied the Gunning Fog Index and Flesch Reading Ease, using the Python 3.11 library textstat (v. 0.7.3). Additional metrics such as average sentence length, word count per paragraph, and the share of specialized terminology were calculated.

Using artificial intelligence capabilities, we applied the Gunning Fog Index, or simply the FOG index (Dzyatkovskaya, Nesterova and Dlimbetova, 2020), and the Flushing Reading Ease Scale. Automated analysis was carried out with tools developed by the software company PLATINUM, whose contribution consisted of creating a preprocessing module for text normalization, integrating readability metrics, and designing a user interface for displaying results. Their role was technical implementation rather than conceptual design. The capabilities of artificial intelligence for analyzing educational content were evaluated with the help of specialists from the software development company PLATINUM.

Results and discussion

The Fog Readability Index is a measure of the difficulty of the reader's perception of a text. The readability index can be calculated based on several parameters: length of sentences, words, specific number of the most frequent (or rare) words, etc., using the formula: readability index = 206.835- (84.6 x average word length)- (1.015 x average sentence length). The Flesch Reading Ease Scale, designed for the English language, is assessed using the formula: FRE = 206.835 - 1.015 ASL - 84.6 ASW, where ASL represents the average sentence length and ASW denotes the average number of syllables per word. Scores ranging from 90 to 100 indicate that the text is easily comprehensible for elementary school students, scores between 60 and 70 suggest it is suitable for high school graduates, while texts with scores from 0 to 30 are intended for individuals with a higher level of education. The results of the analysis are presented in Table 1.

Table 1. Results of a comparison of traditional textbook texts and sustainability texts using the Gunning Fog Index and the Flesch reading ease scale

Methods	Traditional textbook texts	Sustainability texts
Gunning – fog – index	10.62	12.11
Flesch reading ease scale	61.23	52.68

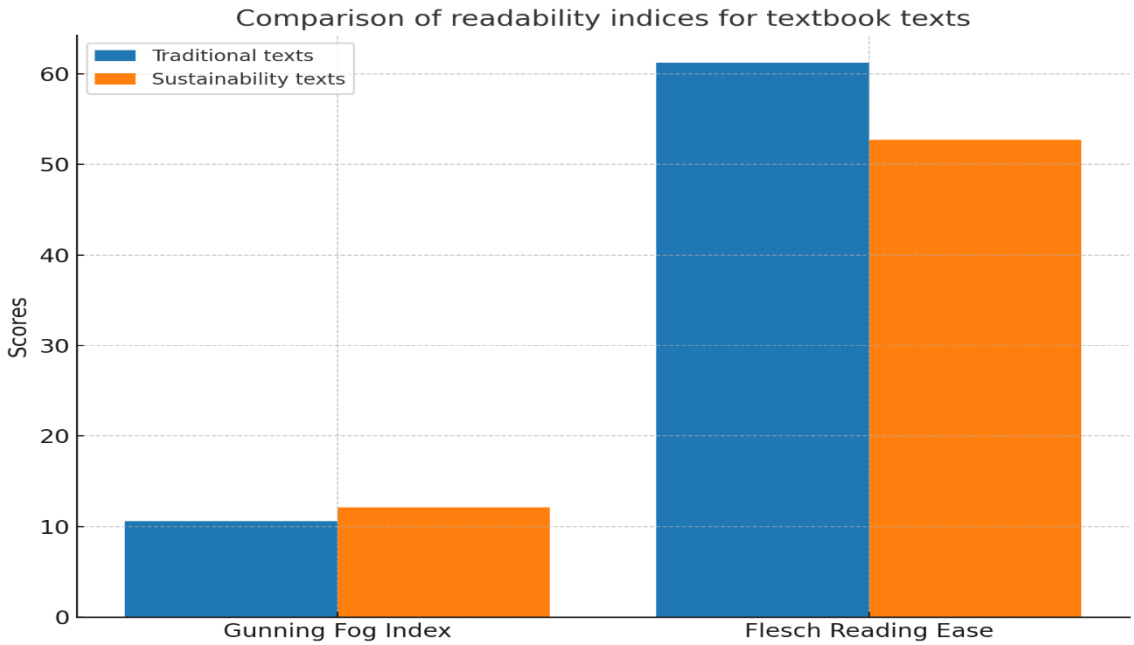

Figure 1. Readability comparison of traditional and sustainability texts using the Gunning Fog Index and the Flesch Reading Ease Scale

The figure 1 visualizes the data from Table 1, showing that sustainability texts have higher complexity (Gunning Fog Index) and lower accessibility (Flesch Reading Ease Scale) compared to traditional textbook texts. The analysis of textbook texts revealed significant differences in their readability levels, as demonstrated by the results summarized in Table 1. The Gunning Fog Index for traditional textbook texts was 10.62, indicating that these texts require a reading level approximately corresponding to the tenth or eleventh grade of schooling. In contrast, the sustainability-focused texts demonstrated a higher Gunning Fog Index of 12.11, suggesting that they are notably more complex and demand a higher level of cognitive ability from readers, roughly equivalent to a first-year university student.

The Flesch Reading Ease Scale further confirms this trend. Traditional textbook texts scored 61.23, which falls within the range considered accessible for high school graduates. This suggests that such texts are generally comprehensible for secondary school students. However, sustainability texts scored 52.68, placing them closer to the threshold of difficulty appropriate for readers with advanced reading skills.

These findings highlight a critical challenge in the integration of sustainability concepts into school curricula. While the subject matter is essential for fostering global citizenship and environmental awareness, its presentation often remains overly academic and less accessible to the intended school-aged audience. The increased complexity of sustainability texts could hinder comprehension and reduce student engagement, potentially undermining the educational goals associated with sustainability education (Bansiong, 2019).

Overall, the results emphasize the importance of applying readability analysis in the development of educational materials. They suggest the need for targeted adaptations of sustainability content to align with the reading abilities and cognitive development levels of secondary school students.

It is concluded that the texts intended for understanding the ideas of sustainable development are quite complex and difficult to read compared to other parts of the textbook. It is assumed that the reason for this lies in their foreignness to the subject content.

The topics on global problems of mankind are contained in all textbooks. The number of textbooks in which information on the concept of sustainable development was found is 75% of all textbooks analyzed.

However, textbooks rarely recognize the contributions of scientists whose work formed the foundation of sustainable development. Similarly, they often overlook the efforts of individuals who played key roles in organizing and leading the UN Conference on Environment and Development, as well as those who have been instrumental in implementing «green» initiatives and projects at the national level.

The idea that the socio-economic development of any country is determined by the laws of the biosphere (the ecological imperative) is vaguely traceable. However, much attention has been paid to biodiversity issues. Much attention is also given to issues of cultural diversity, but they have little connection with the challenges of preserving natural diversity. Nevertheless, in a number of textbooks, the ideas of sustainable development are presented holistically and in a cross-cutting rather than episodic way. These are issues of green economy, global problems of climate, biodiversity, pollution, etc.

Studies have shown that the inclusion of sustainable development ideas in school textbooks is not systematic and continuous. Not a single textbook has been completely redesigned in the sustainable development paradigm. The topics of sustainable development are considered in different textbooks in isolation from each other, in the context of their subject matter. The idea that the socio-economic development of any country is determined by the laws of the biosphere (ecological imperative) is vaguely traced. However, much attention is paid to biodiversity issues. Much attention is also given to cultural diversity issues, but they have little to do with the challenges of preserving natural diversity. Nevertheless, in a number of textbooks, the ideas of sustainable development are presented holistically and in a cross-cutting rather than episodic way. These are issues of the green economy, global problems of climate, biodiversity, pollution, etc.

Texts on sustainable development included in textbooks are fragmentary and scattered. It is obvious that textbook authors have difficulties in incorporating sustainable development ideas into the content of textbooks due to their interdisciplinary nature. Texts on sustainable development rely on scientific terms. Vivid images, metaphors and allegories are rare, as is their sensual-emotional representation. Ideas of sustainable development are not illustrated by cultural traditions, beliefs, legends, myths, or codes of behavior fixed in the collective unconscious.

Artificial intelligence in the form of a program built into Microsoft Word to calculate the Gunning-Fog Index and the Flesch Reading Ease Scale has proven useful for controlling the readability and comprehensibility of text in textbooks. However, the possibilities of using AI by the authors do not end with this. How is it possible to update textbook content based on SDGs using artificial intelligence?

Research shows that artificial intelligence, together with blockchain, can play a key role in adapting sustainability textbooks to suit the needs of the subject and the age of the students. It provides the ability to capture data on sustainable development from different sources, make connections between them, identify areas where this information will be needed, link it to real-time, take into account the changing knowledge base in subject areas and ensure that it is relevant to course content.

AI is capable of analyzing texts and drawing conclusions. Allied with blockchain, it can harness big data, analyze it, visualize it, and improve the accuracy of information.

Future research should explore how advancements in artificial intelligence can be combined with virtual, augmented, and mixed reality to enhance the learning process. These technologies hold significant potential to make educational content more immersive and engaging, for example, by allowing students to virtually leave the classroom and explore different locations or historical events in an interactive way.

Conclusion

The study highlights the urgent need for a systematic, interdisciplinary revision of school textbooks to align them with the contemporary challenges of sustainable development (Leal Filho et al., 2025). Despite numerous global initiatives and policy recommendations, including those articulated by UNESCO and other international educational bodies, the process of embedding sustainability content into school curricula and textbooks remains fragmented, inconsistent, and often superficial.

The research confirms that while topics related to global challenges such as biodiversity, climate change, and the green economy are increasingly present in educational texts, they are rarely interconnected into a coherent narrative. Instead, these topics appear as isolated inserts, often lacking integration with the subject content and failing to convey the systemic nature of sustainability issues. Furthermore, these inserts tend to be characterized by excessive academic language, making them difficult to comprehend, particularly for younger students.

The application of artificial intelligence, including readability analysis tools such as the Gunning Fog Index and the Flesch Reading Ease Scale, revealed that sustainability-focused texts are generally more complex and less accessible than traditional textbook content. This confirms the hypothesis that current sustainability texts are not sufficiently adapted to the cognitive and emotional capacities of schoolchildren. Artificial intelligence, therefore, holds significant potential for improving the ergonomic qualities of educational texts, making them more understandable and engaging. Moreover, when combined with blockchain technology, AI can support the dynamic updating of textbook content, ensuring that it reflects the evolving body of scientific knowledge and remains relevant to students' lives.

The study further emphasizes that ergonomics in education should not be limited to the physical design of learning spaces and materials but should extend to the content and structure of the educational texts themselves. An ergonomic textbook is one that facilitates comprehension, encourages critical thinking, and supports the holistic development of learners. It must be accessible not only in terms of readability but also in cultural, social, and emotional dimensions.

Achieving this requires a collaborative, multidisciplinary approach involving educators, curriculum developers, scientists, and information technology experts. Authors of textbooks must assume social responsibility for the humanization of education and the dissemination of values aligned with sustainable development goals. National governments and educational institutions should support this work, recognizing the role of textbooks as a critical tool for shaping the worldview of future generations.

In conclusion, the integration of sustainable development into educational content must become a foundational element of school education. This integration should not be superficial or sporadic but systemic, affecting the entire educational process. The principles of sustainable development need to permeate subject content, teaching methods, and assessment systems. By

employing advanced technologies, including AI and virtual reality, educational materials can be made not only more relevant and scientifically accurate but also more engaging, accessible, and meaningful for students across diverse socio-cultural contexts (Voultsiou & Moussiades, 2025).

Thus, the process of revising educational texts in the context of sustainable development is not merely an academic or methodological challenge but a socially significant task that reflects the responsibility of education systems to contribute to the formation of a sustainable, equitable, and humane global society.

Contribution of the authors

A.D. Dziatkovsky – conceptual planning, data interpretation, introduction, literature review and conclusions, intellectual tone of the entire manuscript. The author participated in the editing of the article, in the intellectual content.

G.K. Dlimbetova – prepared the section «Materials and methods», developed a research methodology and provided its rigorous scientific justification. The author ensured the logical consistency of the materials and the academic value of the manuscript.

E.N. Dziatkovskaya – formation of an analytical research base, description of educational technologies. The author detailed the main results of the study, provided a comprehensive analysis and scientific interpretation.

K.I. Zhumazhanova – collection of information and organization of questionnaires. The author developed survey tools and analyzed the primary data.

G.B. Zhukenova – interpretation and detailed analysis of the practical results obtained. The author structured the research results and participated in the formulation of the final conclusions.

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Жасанды интеллект арқылы оқулық мәтіндерінің эргономикасын талдау

Аңдатпа. Мақалада тұрақты даму идеяларын мектеп оқулықтарына енгізудің өзекті мәселесі және оларды шешу жолдары ашылады. Бір жағынан, білім мазмұны мен қазіргі ғылым арасындағы алшақтықты жою қажет. Екінші жағынан, оқулықтардың шамадан тыс академиялық деңгейінен арылу керек, оларды нақты өмірге жақындату керек. Үшіншіден, балаларды өмір сүруге, өміршеңдік дағдылары мен әлеуметтік құндылықтарды қалыптастыруға үйрету үшін Тұрақты даму идеяларын оқулық мазмұнына біріктіру қажет. Австралия, АҚШ және Германия орта мектептеріне арналған жаратылыстану оқулықтары талданды. Фогтың Ганнинг индексі мен Флешті оқудың қарапайымдылық шкаласын қолдана отырып, дәстүрлі оқулықтар мен тұрақтылық мәтіндерін салыстыру нәтижелері көрсетілген. Авторлар жасаған зерттеулер жасанды интеллект блокчейнмен бірге тұрақтылық оқулықтарын пәннің қажеттіліктері мен оқушылардың жасына сәйкес бейімдеуде шешуші рөл атқара алатынын көрсетті. Бұл әртүрлі көздерден тұрақты даму деректерін жинауға, олардың арасында байланыс орнатуға, осы ақпарат қажет болатын аймақтарды анықтауға, оны нақты уақытқа байланыстыруға, пәндік салалардағы өзгермелі білім қорын ескеруге және оның курс мазмұнына сәйкестігін қамтамасыз етуге мүмкіндік береді. Жасанды интеллект арқылы виртуалды, кеңейтілген және аралас шындықты қолданатын оқу мазмұны білім беруді түбегейлі өзгертіп, оқу процесін қызықты әрі қызықты ете алады деген қорытындыға келді.

Түйін сөздер: эргономика, мектеп оқулығы, тұрақты даму, жасанды интеллект

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Анализ эргономики текстов учебников с использованием искусственного интеллекта

Аннотация. В статье раскрывается актуальная проблема включения идей устойчивого развития в школьные учебники и пути их решения. С одной стороны, необходимо преодолеть разрыв между содержанием образования и современной наукой. С другой стороны, необходимо избавиться от излишней академичности учебников, приблизить их к реальной жизни. В-третьих, необходимо интегрировать идеи устойчивого развития в содержание учебников, чтобы научить детей жить, сформировать навыки жизнестойкости и социальные ценности. Были проанализированы учебники по естественным наукам для средних школ Австралии, США и Германии. Показаны результаты сравнения текстов традиционных учебников и текстов по устойчивому развитию с использованием индекса Ганнинга Фога и шкалы легкости чтения Флеша. Сделанные авторами исследования показали, что искусственный интеллект вместе с блокчейном могут сыграть ключевую роль в адаптации учебников по устойчивому развитию в соответствии с потребностями предмета и возрастом учащихся. Это дает возможность собирать данные по устойчивому развитию из различных источников, устанавливать связи между ними, определять области, где эта информация будет необходима, привязывать ее к реальному времени, учитывать меняющуюся базу знаний в предметных областях и обеспечивать ее соответствие содержанию курса. Был сделан вывод, что благодаря искусственному интеллекту учебный контент с использованием виртуальной, дополненной и смешанной реальности может радикально изменить образование, сделав процесс обучения более захватывающим и увлекательным.

Ключевые слова: эргономика, школьный учебник, устойчивое развитие, искусственный интеллект.

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