Journal of Harbin Engineering University
ISSN: 1006-7043

Vol 45 No. 11
November 2024

A Comprehensive Analysis of Artificial Intelligence in Present Education system

Prof.Swarupa Arjya
[1]Computer Science Engineering, GIET, Ghangapatana, Bhubaneswar, 752054, Odisha, India
arjya.swarupa@gmail.com,

Abstract
A thorough summary of current scientific research on the disruptive impacts of artificial intelligence on education is provided by this systematic review. In order to obtain significant insights, this study examines a sample of 12 academic outputs from the post-pandemic era, taking into account the explosive growth of AI integration in education over the last three years. Despite the fact that earlier research has demonstrated the potential benefits of AI for educators and learners alike, little is known about the specific applications of AI in the classroom. Therefore, the purpose of this research article is to examine the advantages and disadvantages of integrating AI technologies into education, as well as the educational level at which these tools are most frequently used in teaching and learning, and the features of the models that are currently in use. Although there isn't many research on this important subject, the ones that are now available provide current information on the knowledge, tools, actions, and repercussions of AI systems in education. The results show that students' conceptual understanding of artificial intelligence, robotics, artificial neural networks, and computer science, as well as the development of other critical skills like creativity, literacy, cooperative learning, and emotion regulation, have all significantly improved thanks to AI tools. Lastly, new avenues for investigating AI in education are discussed.

Keywords-artificial intelligence, AI tools, education, educational technology,human-machine.

Introduction

In addition to propelling the current shift to an era of advanced manufacturing over the last ten years, digital technology has also been a major factor in the emergence of the Industrial Internet of Things, which represents the convergence of cyber-physical systems and the integration of digital technologies in industrial processes. The evolution of digital technology has, for over fifty years, been projected by Moore's law (Moore, 1998) to boost not only the efficiency and performance but also the operating capabilities of numerous devices and gadgets.

[1] As a result, technology is essential in changing people's views and behaviours toward sustainability because it can inform people about their carbon footprint and help them make more informed decisions. On the other hand, to effectively address this issue, a green IT curriculum must be implemented at the secondary school and higher education levels due to the notable lack of awareness regarding climate change concerns and their connection with digitalization and technological innovation.

However, regardless of a country's degree of development, the COVID-19 pandemic has slowed down the rate of digital transformation, as shown by its negative consequences on economic growth.[2] Among a number of variables, such as trade openness, foreign direct investment, and macroeconomic stability, the degree of digitalization stands out as one of the important determinants of competitiveness, having a major impact on a country's economic growth. However, in order to have a beneficial effect on economic development, this element needs to be handled by highly educated labour. In addition, the COVID-19 pandemic has forced educational institutions to quickly investigate creative solutions in a condensed amount of time, and the self-isolation period forced all instruction to be transferred online.

With so little time to consider the complexities of education, learning has been disrupted for about one billion pupils as a result of the global closure of schools and institutions in reaction to the pandemic.[3] The abrupt transition from traditional classroom settings to online learning environments has caused a paradigm shift in education, which has contributed to the adoption of open innovation and Education 4.0.

Thus, in terms of infrastructure, Education 4.0 refers to the availability of state-of-the-art learning environments, software, and apps that support a

new educational paradigm that is typified by interaction between humans and machines . Because it can personalize learning experiences, artificial intelligence (AI) in education has grown in popularity among educators and researchers.[4]

1.1 Rationale, Objectives, and Research Issues

With the goal of pro-actively meeting students' changing needs and wants, education is consciously incorporating new technologies and paradigms into its operations, resulting in a significant transformation of the area Furthermore, the COVID-19 pandemic has highlighted the importance of utilizing cutting-edge technologies, putting new educational approaches into practice, and rearranging traditional learning environments and procedures. This shift might be facilitated by the combined use of augmented reality and artificial intelligence, which would open up a wide range of educational opportunities and benefits.

[5] There is a lack of evidence regarding the use of artificial intelligence (AI) in education through public policies, despite the fact that many studies have examined the implications of AI for future education. Therefore, the goal of this study was to perform a systematic assessment of the literature in order to critically analyse the corpus of knowledge and research that has already been done on the application of artificial intelligence (AI) and augmented reality in education within the parameters of public policy laws. Furthermore, this systematic study investigates the implications of the COVID-19 pandemic for the prompt adoption of educational policies pertaining to the integration of education.

Research Question 1 (RQ1): What are the benefits of combining and incorporating artificial intelligence in to the classrooms.

Research Question 2 (RQ2): What are the primary dangers and threats connected to using AI into education?

Which nations have produced the largest corpus of study on this topic, according to study Question 3 (RQ3)?

Which educational phase is the application of artificial intelligence in education more frequently noticed in, according to Research Question 4 (RQ4).[6]

AI in education

The amount of research that has been published on this topic has increased in tandem with the growing use of AI technologies in education. [7], for instance, recognized four important roles that AI plays in the educational setting, improving the overall effectiveness of the processes involved in learning, training, evaluation, and management. They disclosed that AI is capable of the following: (1) assigning tasks based on a person's aptitudes; (2) facilitating conversations between humans and machines; (3) evaluating student work for helpful criticism; (4) enhancing flexibility and interactivity in the digital sphere; (5) offering adaptable teaching methods; enhance the instructional competencies of instructors; (7) facilitate the professional development of teachers; (8) offer automated assessment; (9) forecast student performance; 10) enhance the functionality of the educational unit management platform; (11) offer a convenient and customized service;

Understanding the characteristics and components of AI within the context of Education 4.0 and open innovation competences has also been partially aided by earlier research. According to Mollick and Mollick (2023), for instance, well-designed AI applications can increase teachers' capacities, improve learning, and support evidence-based teaching practices. As such, they are important tools for advancing teaching and learning practices in the classroom—as long as they are used carefully and thoughtfully. Similarly, through personalized engagement on purposeful tasks, AI-driven chatbots offer a plethora of chances for preservice teachers to enhance their pedagogical competencies.[8]

Moreover, Jiahong and Weipeng (2022) carried out a thorough analysis to examine the impact of artificial intelligence on early childhood education (ECE). The study's findings demonstrated a noteworthy improvement in kids' conceptual understanding of AI, robotics, informatics, and automated learning systems. Additionally, kids' complementary skills—like creativity, self-control, teamwork, reading comprehension, and computational problem solving—also showed improvement. These results are consistent with recent research.[9], which also showed that

learning outcomes, commitment levels, mental workload, and confidence and self-assurance of students are all significantly improved by the intelligent conversational agent, according to their model.

Furthermore, the implementation of artificial intelligence (AI) chatbots can create a positive reading environment, attract students' interest, and help them become more engaged in the learning process. The majority of ongoing research focuses on evaluating the effects of ChatGPT, an AI-powered chatbot created by OpenAI and released in November 2022.

Building on OpenAI's core models, GPT-3.5 and GPT-4, ChatGPT has been improved through the application of superintended and underlying learning methodologies. ChatGPT has a lot of potential uses in the field of education and training, such as: (1) creating engaging lesson plans and educational materials based on the needs and preferences of individual students; (2) giving students timely feedback and direction throughout their educational journey; and (3) creating educational materials that are engaging.[10]

Methodology

This section clarifies the research methodology by providing an insightful perspective on the current systematic literature review approach's selection as well as the methodical procedure that led to the development of the findings and inputs reported in this study.

Methodology Framework

A systematic review of the literature was conducted in accordance with the Statement of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards in order to address the research queries indicated above and achieve the set objectives.

[11-14] A meta-synthesis was determined to be the best course of action due to the wide variety of experimental studies, reports, assessments, recommendations, and speculative inquiries that fall under the umbrella of artificial intelligence in education. The acceptance of the PRISMA declaration was spurred by its well-established reputation as a method that is extensively used in a variety of subject areas, including education, to deliver thorough insights, in addition to its strict requirements and principles.

A thorough search approach was used, combining a wide range of terms from three well-known databases: Web of Science (WoS), SCOPUS, and Google Scholar, in order to do an investigation that adheres to scientific standards. Using the WoS and SCOPUS databases, for example, produced the most correct and pertinent documents, which is consistent with their acknowledged status as high-impact scientific databases. [15-18]

Meta-analysis Process

The data was gathered between May 2021 and May 2023 in order to cover public policy about the use of AI technologies in education before and after the pandemic crisis. A thorough and pertinent search formula was utilized to examine the body of research on artificial intelligence in education, covering a broad spectrum of subjects and educational levels. The following search term was used because of the subject's multidisciplinary nature:

"('artificial intelligence') AND ('AI') AND ('education' OR ‘school' OR 'teach' OR 'college' OR ‘student' OR 'learn' OR 'policy')”. [19-22]

Figure 1 presents the whole procedure for finding scholarly material using database searches, following the detailed stages and recommendations provided in the PRISMA 2020 Checklist. Initially, a total of 230 studies were obtained from the three databases (46 from Google Scholar, 104 from SCOPUS, and 80 from WoS). There were 152 items in the pool of papers that needed to be screened after 78 of these were determined to be copies and were removed from the study. [23,24]

The main requirements for inclusion were the joint use of AI tools and applications, direct applicability to the academic process, and the incorporation of research syntheses, educational AI tool creation, empirical investigations, or theoretical contributions. Out of the 152 documents, 117 were removed from the study because they did not fit the predefined research criteria. We were able to secure the remaining 35 documents for additional review. Eighteen more studies were excluded after supplemental examination for not meeting the predetermined research criteria.

Consequently, 17 papers in all were included in the evaluation and thoroughly examined. [25-28]

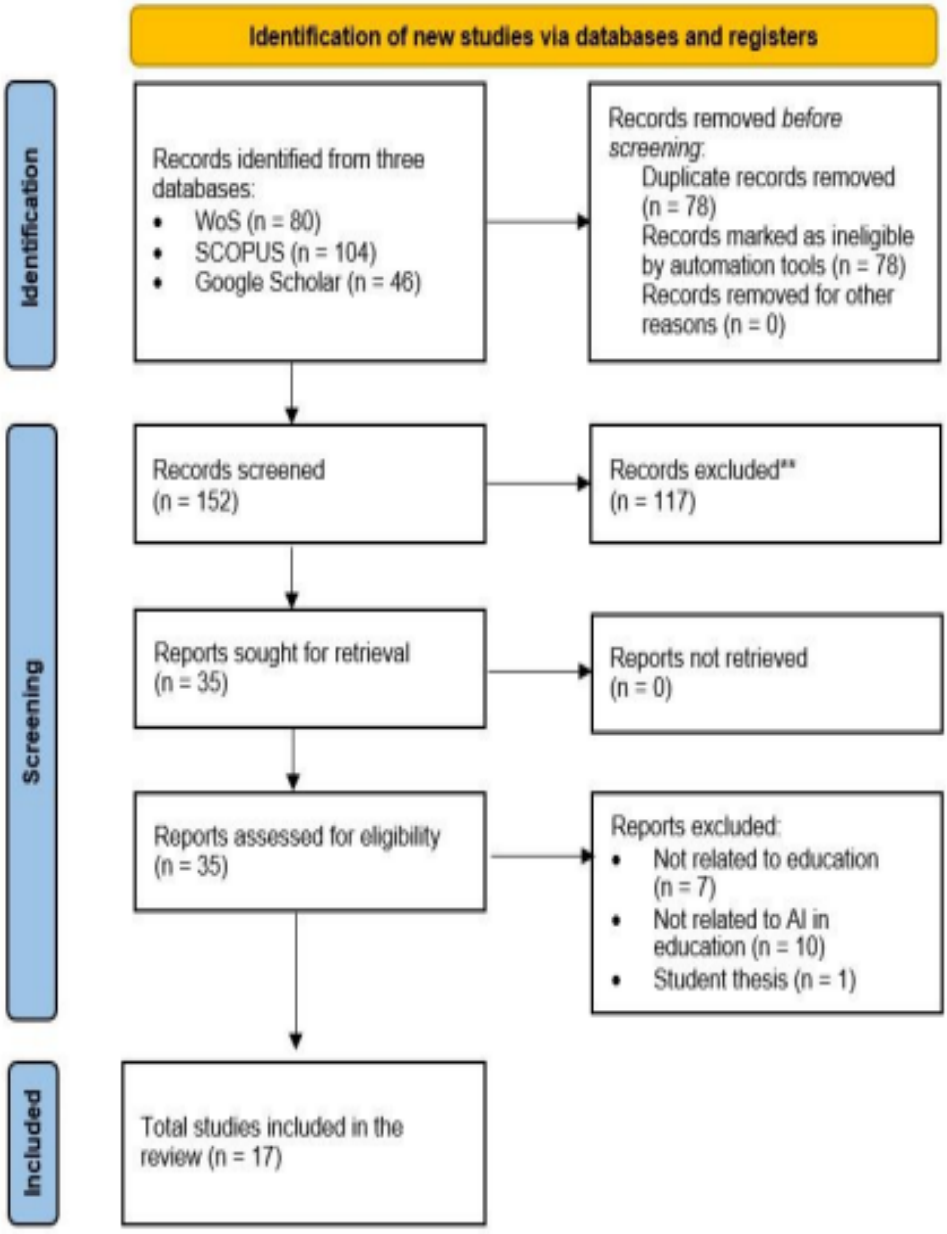

Figure-1: PRISMA flow diagram [44]

Findings

A thorough summary of the 17 papers that make up this research is given in Table 1, which also includes information on the author(s), authors' nation, publication year, study title, inquiry aims, study design, participants, AI applications used, and important results. A thorough grasp of the main features and conclusions of each study is made possible by the table, which provides a thorough description and set of features for each.

Table.1: Descriptive data of the incorporated articles [44]

Author(s)/ Year/ Country	Article title	Research Aims	Research Design	Participant(s)	AI tools	Main findings
Chiu et al. (2023), Hong Kong	Systematic literature review on opportunities, challenges, and future research recommendations of artificial intelligence in education	Understand the opportunities and challenges of AIEd by examining the literature from the last 10 years (2012–2021)	Systematic review study	N=92 studies	Assessment System, Prediction Model, Robotic language tutor, Automatic scoring tool, Chatbot, Teaching System, Braille tutor	AI technologies play numerous roles in the key educational domains. Also, they provide 7 learning aftermaths of AIEd, and 10 major provocations.
Denes (2023), UK	A case study of using AI for General Certificate of Secondary Education (GCSE) grade prediction in a selective independent school in England	AI models as assessment tools	Ofqual algorythm model, Questionnaire	N=180 students (secondary school)	Machine learning model	Numerical models alone are not yet suitable to replace public exams.
Gennari et al. (2023), Italy	Design for social digital well-being with young generations: Engage them and make them reflect	Promote education to responsible design as a key for digital social well-being	Questionnaire, interviews	N=24 students (17-18 year-olds, second-last year of high-school)	IoTgo phygital toolkit	Teens were also able to critically replicate in design for societal digital well-being.
Iku-Silan et al. (2023), Taiwan	Decision-guided chatbots and cognitive styles in interdisciplinary learning	To scrutinise the impact of this AI-based learning model on learning outcomes, enthusiasm, collective efficacy, classroom engagement, satisfaction with the learning tactic, and mental workload of learners with diverse reasoning styles.	Quasi-experiment method	N=71 students, junior high school	Decision-guided chatbot	The advantage of the contingency-based guided-exploratory learning mode to multimodal learning, which could be a good approach for cultivating students' learning achievements in multimedia learning.
Jiahong and Weipeng (2022), China	Artificial intelligence in early childhood education: A scoping review	To evaluate, synthesize and display the latest literature on AI in early childhood education.	Scoping review	N=17 articles	Zhorai, WeChat remote control, Teachable Machine, PopBots, Cognimates AI platform, and PlushPal	AI educational robots can integrate different disciplines of knowledge and multiple technologies simultaneously to greatly enrich children's learning experiences.
Jiahong and Weipeng (2023), China	A systematic review of integrating computational thinking in early childhood education	How to effectively teach and learn computational thinking in early childhood education.	Systematic review study	N=26 studies (2010-2022)	Bee-Bots, Daisy the Dinosaur, Kodable, Coding bots, Aphid's Toys, Matatalab, CHERP, and Cubetto	With age-appropriate instructional design, children could develop early concepts and skills of computational thinking, as well as other related skills such as communication, collaboration, and problem solving.

Author(s)/ Year/ Country	Article title	Research Aims	Research Design	Participant(s)	AI tools	Main findings
Joksimovic et al. (2023), Australia & Germany	Opportunities of artificial intelligence for supporting complex problem-solving: Findings from a scoping review	Investigate the opportunities of AI for supporting complex problem-solving.	Scoping review	N=38 studies (2018-2023)	Social robots, Chatbots	The collaborative interaction between humans and machines in complex problem-solving tasks exhibits promising potential for enhancing the efficiency and effectiveness of problem-solving across diverse practical domains.
Kasneci et al. (2023), Germany	ChatGPT for good? On opportunities and challenges of large language models for education	Investigate how these models can be used to create educational material, enhance student commitment and communication, and personalize education experiences.	Scoping review	N=23 studies (2018-2023)	Large language models: GPT-3, BERT, BLOOM, T5, RoBERTa	The utilisation of large language models in the field of education necessitates the cultivation of competencies and literacies by educators and learners alike, encompassing a comprehensive understanding of the technology itself, as well as its limitations and potential vulnerabilities.
Kolade and Owoseni (2022), UK	Employment 5.0: The work of the future and the future of work	To highlight often conflicting views about technology ownership, work-less utopia, education reforms and the imperative of human centricity in appropriation of technology.	Systematic review study	N=68 studies (2011-2022)	Collaborative robots, Digital twins, Cyber-physical systems, Chatbots	In addition to embedding digital skills throughout the training curricula in the formal training courses, more resources in funding and time allocation need to be injected into the programmes for continuing staff development.
Liu et al. (2022), Taiwan	An analysis of children' interaction with an AI chatbot and its impact on their interest in reading	To understand the features of a chatbot built with artificial intelligence technologies as a book talk companion, and to survey the role of the interaction in students' commitment and attention in reading.	Experiment	N=68 students (11-12 year-olds; 6 weeks)	Chatbot including 157 books (based on the Google Actions Console framework)	The engagement of students in conversational interactions with the chatbot resulted in a sustained level of situational interest pertaining to the value dimension. In contrast, students who did not engage in the book talk with the chatbot experienced a substantial decline in their level of interest.
Mizumoto and Eguchi (2023), Japan & USA	Exploring the potential of using an AI language model for automated essay scoring	To evaluate ChatGPT's reliability and accuracy in performing automated essay scoring (AES).	Experiment	N=12,100 English essays (TOEFL11)	AI language model ChatGPT	Automated essay scoring (AES) systems can leverage artificial intelligence (AI) language models, such as ChatGPT, to enhance their validity and reliability in assessing and providing feedback on written texts across various domains and contexts.
McGrath et al. (2023), Sweden	University teachers' perceptions of responsibility and artificial intelligence in higher education - An experimental philosophical study	To investigate university teachers' relationships with emerging technologies by focusing on the uptake of artificial intelligence in higher education practices.	Online survey	N=194 university teachers	Learning analytics systems, AI-driven assessment tools, Automated short-answer grading systems	AI literacy was reported to be low among the university faculty, yet a considerable proportion of them perceived AI as a potential facilitator of more inclusive student support systems. Faculty development programs may be required to enhance their awareness and understanding of the implications of AI technologies for their pedagogy, and to equip them with the skills and competencies to effectively utilise the emerging technologies in their practice.

Discussion

This study provides a comprehensive analysis of 17 WoS and Scopus publications published between 2021 and 2023 in various nations. This analysis enables us to identify whether or not artificial intelligence (AI) technologies have detrimental effects on educational outcomes as well as potential countermeasures. The examined articles, in general, demonstrate the effective integration of a variety of AI tools into instructional practices and provide a thorough explanation of the elements and traits of their AI-based chatbots that assist with decision-making. Papers use various methodological [33-37]

strategies to look into how big language models, particularly chatbots, affect teachers and students. Recognizing the current study's shortcomings is also necessary. First, the study findings could not be perfect because of the small sample size of documents used in this investigation. Second, it's possible that we overlooked significant articles from other scientific languages because our synthesis of earlier research only included English-language papers. [41-43]

Conclusion

The COVID-19 pandemic has brought to light how crucial it is for educators and students to be prepared for AI in order to use and select AI technologies intelligently. Education systems around the world must support their transition to Industry 5.0 by developing 21st century competencies like resourcefulness and logical thinking, curiosity and resilience, affective and interpersonal skills, and metacognitive skills. While the digital revolution in education gave rise to new issues like the digital divide, a lack of skills, or even misuse of AI instruments.

Digital exclusion could only be overcome by the thoughtful adoption of educational policies that regulate the integration of AI technologies in education, taking into account the social and ethnic obstacles underlying poverty and a lack of education for many people living in developing countries Thus, teaching digital skills in an integrated manner may enhance teachers' abilities in terms of classroom management, mental stimulation, and creating a happy atmosphere Furthermore, it seems that students are able to participate in the educational process at a deeper level when teachers are directly involved in digital media-related teaching activities.

We may conclude from this systematic review that there are a minimum of three approaches to integrating AI into education. Firstly, customized learning activities for students can be supported by AI-based e-learning systems (e.g., massive language models), which can also increase students' motivation and level of interest. Second, AI technology can help teachers focus more on teaching and less on developing instructional content by offering personalized lesson plans and diagnostic questions Third, AI-powered educational robots can enhance children's learning experiences and abilities through an interdisciplinary approach, particularly in the areas of complex problem solving, human-machine interaction, computational thinking, and critical thinking.

References

[1] Akimov, N., Kurmanov, N., Uskelenova, A., Aidargaliyeva, N., Mukhiyayeva, D., Rakhimova, S., Raimbekov, B., Utegenova, Z. (2023). Components of education 4.0 in open innovation competence frameworks: Systematic review, Journal of Open Innovation: Technology, Market, and Complexity, Vol. 9, 100037, https://doi.org/10.1016/j.joitmc.2023.100037.

[2] Barnes, S.J. (2020). Information management research and practice in the post-COVID- 19 world, International Journal of Information Management, 55, Article 102175. https://doi.org/10.1016/j.ijinfomgt.2020.102175.

[3] Boikova, T., Zeverte-Rivza, S., Rivza, P., Rivza, B. (2021). The determinants and effects of competitiveness: The role of digitalization in the European economies. Sustainability, 13(21), 11689, https://doi.org/10.3390/su132111689.

[4] Ceobanu, C., Cucoş, C., Istrate, O., Pânişoară, I.-O. (2022). Digital Education. Ed. II, Iaşi, Polirom.

[5] Chiu, T.K.F., Xia, Q., Zhou, X, Chai, C.S., Cheng, M. (2023). Systematic literature review on opportunities, challenges and future research

recommendations of artificial intelligence in education, Journal of Computers and Education: Artificial Intelligence, 4, 100118, https://doi.org/10.1016/j.caeai.2022.100118.

[6] Corejova, T., Chinoracky, R. (2021). Assessing the Potential for Digital Transformation. Sustainability, 13(19), 11040, https://doi.org/10.3390/su131911040.

[7] Cropley, A. (2019). Technology-fluent creativity in the age of cyber-physical systems. University of Hamburg, https://doi.org/10.13140/RG.2.2.28949.58083.

[8] De', R., Pandey, N., Pal, A. (2020). Impact of digital surge during COVID-19 pandemic: A viewpoint on research and practice, International Journal of Information Management, 102171, https://doi.org/10.1016/j.ijinfomgt.2020.10217.

[9] Denes, G. (2023). A case study of using AI for General Certificate of Secondary Education (GCSE) grade prediction in a selective independent school in England. Computers and Education: Artificial Intelligence, Vol. 4, 100129, https://doi.org/10.1016/j.caeai.2023.100129.

[10] Dwivedi, Y.K., Hughes, L., Kar, A.K., Baabdullah, Climate change and COP26: Are digital technologies and information management part of the problem or the solution? An editorial reflection and call to action. International Journal of Information Management, 63, Article 102456. https://doi.org/10.1016/j.ijinfomgt.2021.102456.

[11] Fahey, R.A., Hino, A. (2020). COVID-19, digital privacy, and the social limits on data focused public health responses, International Journal of Information Management, 102181, https://doi.org/10.1016/j.ijinfomgt.2020.102181.

[12] Gennari, R., Matera, M., Morra, D., Melonio, A., Rizvi, M. (2023). Design for social digital well-being with young generations: Engage them and make them reflect, International Journal of Human – Computer Studies, Vol. 173, 103006, https://doi.org/10.1016/j.ijhcs.2023.103006.

[13] George, G., Merrill, R.K., Schillebeeckx, S.J. (2021). Digital sustainability and entrepreneurship: How digital innovations are helping tackle climate change and sustainable development. Entrepreneurship Theory and Practice, 45(5), 999-1027, https://doi.org/10.1177/1042258719899425.

[14] Gui, M., Gerosa, T., Argentin, G., Losi, L. (2023). Mobile media education as a tool to reduce problematic smartphone use: Results of a randomised impact evaluation. Computers & Education, 194, 104705, https://doi.org/10.1016/j.compedu.2022.104705.

[15] Habibi, F., Zabardast, M.A. (2020). Digitalization, education and economic growth: A comparative analysis of Middle East and OECD countries. Technology in Society, Vol. 63, 101370, https://doi.org/10.1016/j.techsoc.2020.101370.

[16] Hatos, A. (2019). The impact of digitalization on educational achievement: a literature review from a sociological perspective. Quality of Life Journal, XXX, nr. 1, 3-16. Available at: https://revistacalitateavietii.ro/journal/article/view/146/116.

[17] Iku-Silan, A., Hwang, G.-J., Chen, C.-H. (2023). Decision-guided chatbots and cognitive styles in interdisciplinary learning, Computers & Education, 201, 104812, https://doi.org/10.1016/j.compedu.2023.104812.

[18] Jiahong, S., Weipeng, Y. (2022). Artificial intelligence in early childhood education: A scoping review, Computers and Education: Artificial Intelligence, 3. https://doi.org/10.1016/j.caeai.2022.100049.

[19] Jiahong, S., Weipeng, Y. (2023). A systematic review of integrating computational thinking in early childhood education, Computers and Education Open, 4, 100122. https://doi.org/10.1016/j.caeo.2023.100122.

[20] Joksimovic, S., Ifenthaler, D., Marrone, R., De Laat, M., Siemens, G. (2023). Opportunities of artificial intelligence for supporting complex problem-solving: Findings from a scoping review. Computers and Education: Artificial

Intelligence, Vol. 4, 100138, https://doi.org/10.1016/j.caeai.2023.100138.

[21] Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günnemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T., Nerdel, C., Pfeffer, J., Poquet, O., Sailer, M., Schmidt, A., Seidel, T., Stadler, M., Weller, J., Kuhn, J., Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. Learning and Individual Differences, 103, 102274, https://doi.org/10.1016/j.lindif.2023.102274.

[22] Kolade, O., Owoseni, A., (2022). Employment 5.0: The work of the future and the future of work, Technology in Society, 71, 102086, https://doi.org/10.1016/ j.techsoc.2022.102086.

[23] Lee, D., Yeo, S. (2022). Developing an AI-based chatbot for practicing responsive teaching in mathematics, Computers & Education,. 191, 104646, https://doi.org/ 10.1016/j.compedu.2022.104646.

[24] Liu, C.-C., Liao, M.-G., Chang, C.-H., Lin, H.-M. (2022). An analysis of children' interaction with an AI chatbot and its impact on their interest in reading. Computers & Education, 189, 104576, https://doi.org/10.1016/j.compedu.2022.104576.

[25] Marques, C., Bachega, S.J., Tavares, D.M. (2019). Framework proposal for the environmental impact assessment of universities in the context of Green IT, Journal of Cleaner Production, 241, Article 118346, https://doi.org/10.1016/j.jclepro.2019. 118346.

[26] McGrath, C., Cerratto Pargman, T., Juth, N., Palmgren, P.J. (2023). University teachers' perceptions of responsibility and artificial intelligence in higher education – An experimental philosophical study. Computers and Education: Artificial Intelligence, Vol. 4, 100139, https://doi.org/10.1016/j.caeai.2023.100139.

[27] Miller, J. (2020). Climate change solutions: The role of technology, House of Commons Library, https://commonslibrary.parliament.uk/climate-change-solutions-the-role-of- technology/.

[28] Mizumoto, A., Eguchi, M. (2023). Exploring the potential of using an AI language model for automated essay scoring, Research Methods in Applied Linguistics, Vol. 2, 100050, https://doi.org/10.1016/j.rmal.2023.100050.

[29] Mollick, E., Mollick, L. (2023). Using AI to Implement Effective Teaching Strategies in Classrooms: Five Strategies, Including Prompts, Wharton School of the University of Pennsylvania & Wharton Interactive, March 16, https://ssrn.com/abstract=4391243 .

[30] Moore, G.E. (1998). Cramming More Components Onto Integrated Circuits, Proceedings of the IEEE, 86(1), 82-85, https://doi.org/10.1109/JPROC.1998.658762.

[31] Perkins, K.M., Munguia, N., Moure-Eraso, R., Delakowitz, B., Giannetti, B.F., Liu, G., Velazquez, L. (2018). International perspectives on the pedagogy of climate change. Journal of Cleaner Production, 200, 1043-1052, https://doi.org/10.1016/j.jclepro. 2018.07.296.

[32] Perkins, M. (2023). Academic Integrity considerations of AI Large Language Models in the post-pandemic era: ChatGPT and beyond, Journal of University Teaching & Learning Practice, 20(2), https://doi.org/10.53761/1.20.02.07.

[33] Ray, P.P. (2023). ChatGPT: A comprehensive review on background, applications, key challenges, bias, ethics, limitations and future scope, Internet of Things and Cyber- Physical Systems, Vol. 3, 121-154, https://doi.org/10.1016/j.iotcps.2023.04.003.

[34] Runge, I., Lazarides, R., Rubach, C., Richter, D. (2023). Teacher-reported instructional quality in the context of technology-enhanced teaching: The role of teachers' digital competence-related beliefs in empowering learners. Computers & Education, No. 198, 104761, https://doi.org/10.1016/j.compedu.2023.104761.

[35] Schroder, A., Prockl, G., Constantiou, I. (2021). How Digital Platforms with a Social Purpose Trigger Change towards Sustainable Supply Chains, Proceedings of the 54th Hawaii

International Conference on System sciences, https://doi.org/10.24251/ HICSS.2021.580.

[36] Sipică, I.S., Toma, E. (2022). The main challenges in education in the context of the digital transformation of learning. Scientific Papers Series, Management, Economic Engineering in Agriculture and Rural Development, 22(3), https://managementjournal.usamv.ro/pdf/vol.22_3/Art73.pdf.

[37] Sloan, K. (2020). E-Learning: How the coronavirus has changed education forever. Cybint, retrieved from: https://www.cybintsolutions.com/e-learning-how-the-corona virus-has-changed-education-forever/.

[38] Tahiru, F. (2021). AI in Education: A Systematic Literature Review, Journal of Cases on Information Technology (JCIT), 23(1), 1-20, http://doi.org/10.4018/JCIT.2021 010101.

[39] Tam, G., El-Azar, D. (2020). 3 ways the coronavirus pandemic could reshape education. World Economic Forum, retrieved from: https://www.weforum.org/agenda/2020/03/3- ways-coronavirus-is-reshaping-education-and-what-changes-might-be-here-tostay/.

[40] UNESCO (2020). Global Education Coalition. COVID-19 Education Response. Retrieved from: https://en.unesco.org/covid19/educationresponse/globalcoalition.

[41] Volchik, V., Oganesyan, A., Olejarz, T. (2018). Higher education as a factor of socio-economic performance and development, Journal of International Studies, 11(4), 326-340, https://doi.org/10.14254/2071-8330.2018/11-4/23.

[42] Wand, X., Li, L., Tan, S.C., Yang, L., Lei, J. (2023). Preparing for AI-enhanced education: Conceptualizing and empirically examining teachers' AI readiness, Computers in Human Behavior, No. 146, 107796, https://doi.org/10.1016/j.chb.2023.107798.

[43] Werfhorst, H.G., Kessenich, E., Geven, S. (2022). The digital divide in online education: Inequality in digital readiness of students and schools, Computers and Education Open, Vol. 3, 100100. https://doi.org/10.1016/j.caeo.2022.100100.

[44] Moroianu, Nicolae, Silvia-Elena Iacob, and A. Constantin. "Artificial Intelligence in Education: a Systematic Review." *Sciendo EBooks* (2023): 906-921.