ECONSTOR
Make Your Publications Visible.

A Service of

ZBW Leibniz-Informationszentrum Wirtschaft
Leibniz Information Centre for Economics

Mihai, Laurențiu; Mănescu, Leonardo-Geo; Vasilescu, Laura; Băndoi, Anca; Sitnikov, Catalina Soriana

Article

A systematic analysis of new approaches to digital economic education based on the use of AI technologies

Amfiteatru Economic Journal

Provided in Cooperation with:
The Bucharest University of Economic Studies

Suggested Citation: Mihai, Laurențiu; Mănescu, Leonardo-Geo; Vasilescu, Laura; Băndoi, Anca; Sitnikov, Catalina Soriana (2024) : A systematic analysis of new approaches to digital economic education based on the use of AI technologies, Amfiteatru Economic Journal, ISSN 2247-9104, The Bucharest University of Economic Studies, Bucharest, Vol. 26, Iss. 65, pp. 201-219,
https://doi.org/10.24818/EA/2024/65/201

This Version is available at:
https://hdl.handle.net/10419/281817

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

https://creativecommons.org/licenses/by/4.0/

WWW.ECONSTOR.EU

Mitglied der Leibniz-Gemeinschaft

A SYSTEMATIC ANALYSIS OF NEW APPROACHES TO DIGITAL ECONOMIC EDUCATION BASED ON THE USE OF AI TECHNOLOGIES

Laurențiu Mihai[1*], Leonardo-Geo Mănescu[2], Laura Vasilescu[3], Anca Băndoi[4] and Cătălina Sitnikov[5]
[1)2)3)4)5)] *University of Craiova, Romania*

Please cite this article as:
Mihai, L., Mănescu, L.G., Vasilescu, L., Băndoi, A. and Sitnikov, C., 2024. A Systematic Analysis of New Approaches to Digital Economic Education Based on the Use of AI Technologies. *Amfiteatru Economic*, 26(65), pp. 201-219.

DOI: https://doi.org/10.24818/EA/2024/65/201

Article History
Received: 29 September 2023
Revised: 19 November 2023
Accepted: 20 December 2023

Abstract
Since the start of the global COVID-19 pandemic, most higher education institutions have been forced to exchange the traditional teaching environment for online education, and many chose to continue to use digital education platforms after its end, especially through the use of artificial intelligence (AI) applications and technologies. Our research represents a systematic literature review of a number of 60 scientific papers, aiming to study how the concept of digital economic education based on artificial intelligence is approached in the scientific literature, how artificial intelligence applications are used in digital economic education, and which are the critical success factors and the challenges that this domain is facing. Our findings have shown that most researchers define digital education as the use of technology to support educational activities, while highlighting artificial intelligence and its different applications as an essential element of current digital education, which has the potential to fundamentally transform the economic processes. The large-scale adoption of e-learning systems based on artificial intelligence is influenced by technology, by their superior capabilities in terms of coherently correlating the learning and studying processes, by the teachers' trust in the results generated by these technologies and by cultural factors, while facing several challenges related to the users' resistance to change, digital competences, the systems' accessibility, as well as financial issues. Furthermore, based on this research endeavour, a model system of correlations and elements has been developed, specifically for the digital economic education based on artificial intelligence. This model includes both the success factors and the unique challenges inherent in the particular application areas.

Keywords: Artificial Intelligence (AI), digital economic education, systemic model regarding digital economic education based on AI

JEL Classification: D83, I21, I23, O33

[*] Corresponding author, **Laurențiu Mihai** – e-mail: laurentiu.mihai@edu.ucv.ro

This is an Open Access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. © 2024 The Author(s).

Introduction based on the current state of knowledge

Artificial intelligence represents a critical element of the contemporary surge of emerging technologies, which, lately, have significantly transformed the landscape of economics education. Artificial intelligence (AI) refers to the ability of a software application to execute tasks commonly attributed to intelligent beings (Salas Pilco and Yang, 2022), comprising several branches, including digital communication, machine learning, big data analysis and processing, and natural language processing (Chen et al., 2020). The rapid expansion of this technology is progressively reshaping the way individuals interact, communicate, reside, acquire knowledge, and engage in professional activities.

Artificial intelligence has various applications within the realm of digital economic education. For example, AI has been included in several educational technologies, including chatbots (Kasneci et al., 2023), intelligent tutoring systems, and automated assessment software (Hwang and Tu, 2021). According to Chen et al. (2020), AI-based systems offer increased opportunity for all individuals involved in the process of economics learning and training. Previous studies have demonstrated the benefits of incorporating AI into economics education, such as enhanced collaboration among students, customised learning experiences, efficient scheduling of learning activities (Chatterjee and Bhattarcharjee, 2020), adaptive feedback on learning processes (Salas Pilco and Yang, 2022), reduced administrative burden for teachers (Xu and Ouyang, 2022), and automation of exam evaluation and other educational tasks specific to economics education (Maslova et al., 2020).

This paper focuses on AI in Education (AIED), which encompasses the use of artificial intelligence technologies, including intelligent tutoring systems, chatbots, digital assistants, and other digital automation components that contribute to the advancement and enhancement of digital economic education (Micu et al., 2021; Bearman et al., 2022). AIED possesses significant potential for enhancing learning, teaching, evaluation, and administration in economics higher learning institutions, offers the opportunity to customise and adapt the economics educational content to the specific requirements of students, while supporting academics in the educational process, making it a significant emerging technology in the field of digital economic education (Felix, 2021; Ooi et al., 2023).

The current research addresses AIED as a central element in optimising teaching-learning processes, yielding significant benefits in personalising the educational experience (Felix, 2021). AIED applications demonstrate the capacity to analyse substantial volumes of data generated during the learning process, discerning patterns and adapting content based on individual learners' needs. This adaptability and customisation of instruction represent a notable advantage of employing AIED, contributing to the optimisation of levels of knowledge assimilation (Chen et al., 2022). Thus, the use of AI in digital education opens substantial perspectives for enhancing the efficiency and relevance of the educational process in the current context characterised by accelerated technological advancements (Celik et al., 2022).

Thus, by conducting a systematic review of the relevant literature published in the last four years (2020-2023), our paper aims to contribute to the ongoing research on AIED. Our research endeavour focused on answering four research questions: (1) How is the concept of digital economic education based on AI presented in the recent literature; (2) How is AI used in digital economic education? (3) What are the critical success factors influencing the use of artificial intelligence applications? (4) What are the challenges that the use of AI applications in digital economic education is facing?

In order to answer the research questions, this study will discuss on the general features of AIED, the AI's impact on the economics learning process, the factors which affect the adoption of these technologies, the most used AIED applications as well as the challenges that these technologies have to overcome in order to be adopted on a larger scale. Consequently, the paper is structured into two main sections: Research Methodology which refers to search query used in the Web of Science database, the inclusion and exclusion criteria, the qualitative assessment and the coding process, and Results and Discussion which includes: the structure on categories of the papers included in the analysis, the concept of economics digital education based on AI, the use of AI in economics education, critical success factors affecting the use of AI applications, and the challenges which economics digital education based on AI is facing and finally, the conclusions and recommendations formulated considering the research results are presented.

1. Research Methodology

1.1. Search query used in the Web of Science database

In order to fulfil our research objective and to answer the four research questions, we have conducted a comprehensive search of papers that were related to AIED, using the Web of Science Database. The search query used the following string ((TS="e-learning" OR TS="digital economics education" OR TS="online economics learning") AND (TS="digital tools" OR TS="AI" OR TS = Artificial Intelligence")), which yielded 12,962 results.

In order to conduct a first stage analysis, we have used VOSViewer software, which has generated several bibliometric maps, based on which we concluded that the journals which have published the most papers on the subject of AIED are *Education and Information Technologies* (416 papers), followed by *Education Sciences* (370 papers) and *International Journal of Emerging Technologies in Learning* (175 papers).

At the same time, the most cited journal (as of July 2023) is *Education and Information Technologies (*2926 citations), followed by *Computer and Education* (2245 citations), *Education Sciences* (1980 citations), *International Journal of Emerging Technologies in Learning* (1209 citations), and *Interactive Learning Environments* (1128 citations).

Lastly, the most cited papers that address the topic of digital economic education based on artificial intelligence until July 2023 (Figure no.1) are Radianti et al. (2020) (419 citations), Köenig et al. (2020) (244 citations), Watermeyer et al. (2021) (310 citations), and Almaiah et al. (2020) (308 citations).

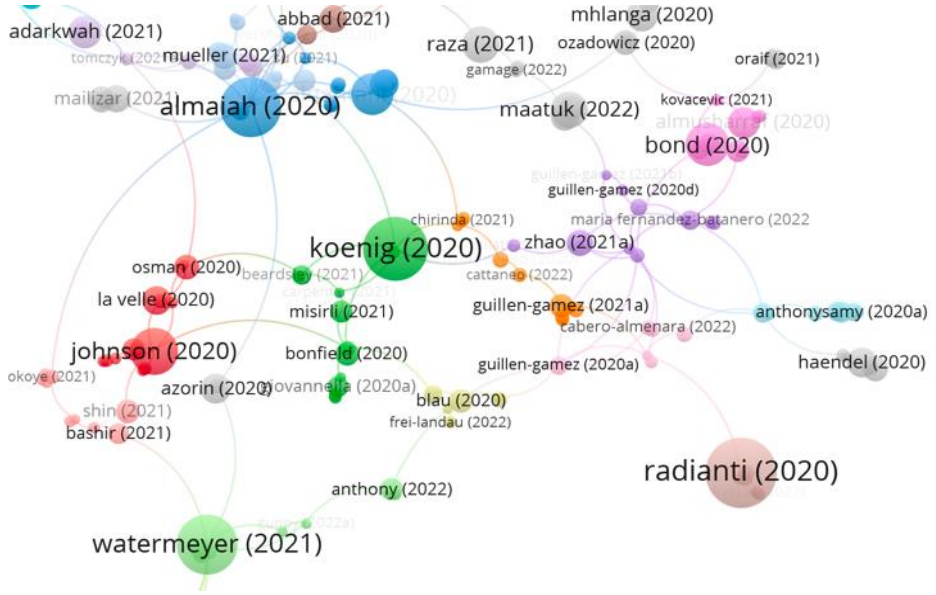

Figure no. 1. Bibliometric analysis regarding the most cited papers on the topic of AIED

1.2. Inclusion and exclusion criteria and quality assessment

In order to refine our search, only research articles, conference proceedings, and review paper (12,843 papers), published after 2020 (6,212 papers) were included, from three Web of Science categories: Education Educational Research, Education Scientific Disciplines and Social Issues or Education Special (2,379 papers), that have been written in English (2,604 papers). Moreover, we have excluded all the papers that have been published in medical journals, resulting in 1,887 papers. Finally, we limited our search only to open access papers, which yielded a final number of 915 articles. The decision to limit the search to open access articles was made based on considerations of accessibility, open access articles being available to all individuals interested in a specific thematic area, enabling them to read and analyse the content without restrictions.

Moving forward, 183 papers were allocated to each of the five authors. After reading the titles and the abstracts, those articles which were considered irrelevant to our research were excluded. In order to be considered relevant, the papers should have focused on artificial intelligence used as a digital education tool. There were excluded papers which were purely technical, focused on programming, or focused on technical, humanities, or healthcare. During this first quality assessment stage, 143 articles were identified that met the selection criteria.

Among them, each of the five authors thoroughly read 30-31 papers, conducting a critical analysis of each article, using their experience as reviewers for various scientific journals. During this second stage of quality assessment, we eliminated the papers which were found inconclusive, poorly written, employed questionable methods or in which the findings were not thoroughly presented and discussed, reaching a final number of 59 relevant articles.

Finally, we have included one more paper (Zawacki-Richter et al., 2019) in our analysis, although it was published before 2020, because it was being cited in many of the articles included in the final portfolio by July 2023 (409 citations). Therefore, 60 papers were used in this current research (Figure no. 2).

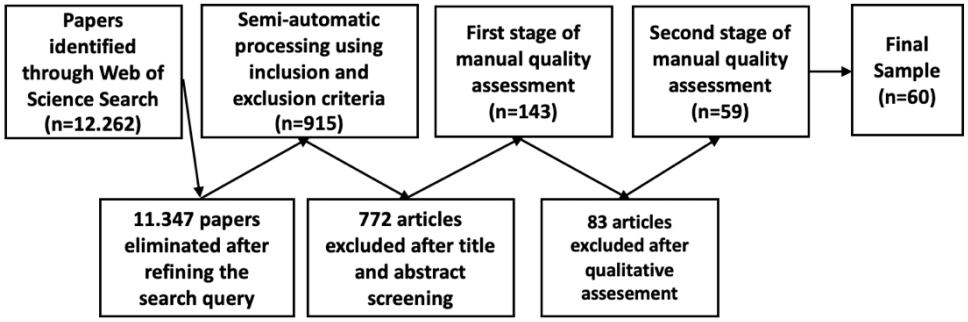

Figure no. 2. PRISMA sample design diagram for systematic evaluation

Source: adapted after Bond et al., 2020, p.9

1.3. The coding process

This stage aimed to code the 60 articles into four categories: digital education based on AI, the use of AI in digital education, and critical success factors the challenges this area is facing. The authors independently coded the selected articles, initially coding the first 10 papers based on the four categories. After establishing and testing the coding methodology, relevant information was extracted for further analysis. Other variables included the journal, the publication year, the paper type, and the digital tool type (Table no.1). All authors participated in the final coding process, coding 12-13 papers, and reached a consensus regarding the ambiguous findings.

2. Results and discussion

2.1. The structure of the papers included in the study

Our systematic review encompasses a total of 60 research papers, which have been classified into four general categories (Table no. 1). Thus, our sample consist of 22 papers categorised as "The concept digital economics education based on AI", 24 papers included in the category "The use of artificial intelligence in digital economic education", 5 papers categorised as "Critical success factors affecting the use of Artificial Intelligence applications in digital economic education" and 7 papers included in the category "Challenges facing the use of artificial intelligence applications in economic education". Moreover, one paper was found to be relevant to both the "The concept of e-learning" and "Critical influence factors" categories, while another paper was included in both the "Critical influence factors" and "Challenges" categories.

Table no.1. Paper classification

Variable	Percent	Frequency	Variable	Percent	Frequency
Publication year			*AI applications used in the paper*		
2019	1.67%	1	AI	31.66%	19
2020	41.67%	25	MOOCs, LMSs	46.67%	28
2021	25%	15	Gamification	1.67%	2
2022	23.33%	14	Blockchain	1.67%	1
2023	8.33%	5	VR	1.67%	1
Journal			Others	16.66%	10
Int. J. Emerg. Technol. Learn.	18.33%	11	Subject Category		
Educ. Inf. Technol.	18.33%	11	Digital education based on AI	38.33%	23
Educ. Sci.	8.33%	5	AI in digital educaiton	40%	24
Comput. Educ.	6.67%	4	Critical success factors	10%	6
Comput. Educ.: Artif. Intell.	5%	3	Challenges	15%	9
Others	43.34%	2			

2.2. The concept digital economic education based on AI

Digital education, also referred to as online education, e-learning, distance education, or distance learning, encompasses teaching and learning processes conducted within an online setting (El-Sabagh, 2021). O'Neill (2023) defines e-learning as *the use of technology to aid instructional activities, with the aim of achieving specified educational goals without the need for both the learner and the instructor to be physically present in the same area, and includes various elements, including technologies, educational systems, surroundings, and the primary users, namely students and teachers.*

In the last decade, the educational environment has undergone a significant shift from the traditional structure to a more engaging and stimulating learning environment (Butler-Henderson and Crawford, 2020). In this context, the global adoption of digital technologies and tools is having a profound impact on the methods and practises employed in education. Among the many digital tools that can be used in online education, artificial intelligence represents an innovative and revolutionary approach that facilitates the customisation of both educators' and students' experiences. Consequently, the use of artificial intelligence in education has the potential to enhance and adapt pedagogical practises by different forms of personalised education, intelligent content delivery, automation of educational tasks, tutoring, and ensuring inclusive educational opportunities for students with special requirements.

In order to properly implement an AIED-based platform, several elements need to be considered such as the students' involvement (Bond et al., 2020; Theresiawati et al., 2020; El-Sabagh, 2021; Chiu et al., 2021; Ng et al., 2023), digital literacy (Falloon, 2020; Köenig et al., 2020; Muammar et al., 2023), satisfaction (Giray, 2021; Shams et al., 2021; Zhao et al., 2021), overall students s' performance (Butler-Henderson and Crawford, 2020; Rakic et al., 2020; Rajabalee and Santally,

2021), and local factors such as technological resources and internet connectivity (Anthony et al., 2020; Khalil Awan et al., 2021; Lloret-Irles et al., 2022).

Several authors argue that the concept of e-learning is closely associated with student engagement (Bond et al., 2020; Theresiawati et al., 2020; Chiu et al., 2021; El-Sabagh, 2021; Ng et al., 2023), which is driven by motivation, which is, in turn, influenced by the students' autonomy, competency, and relatedness. Thus, there is a need to enhance student involvement in terms of behaviour, affect, and cognition, which should be a primary focus for educators (Ng et al., 2023). Bond et al. (2020) revealed that the most often identified variables are behavioural, affective, and cognitive engagement. El Sabagh (2021) highlighted that students' engagement is closely related to the personalisation of the learning process according to their individual learning styles, which also positively influences their academic performance. AI applications have an essential role in this adaptive approach to e-learning, which aims to promote direct learning, facilitate knowledge development, and enhance the overall learning experience (Theresiawati et al., 2020; El Sabagh, 2021).

Another element under discussion is the level of student satisfaction which is influenced by the platforms' quality (Dangaiso et al., 2020; Shams et al., 2022), design (Giray, 2021) and accessibility (Shams et al., 2020), as well as the way they are implemented (Almusharraf and Kharo, 2020). Theresiawati et al. (2020) and Giray (2021) suggest three fundamental elements which influence the quality of an AI based e-learning system: quality of teaching staff, the learning management system's quality, and content quality. Students' engagement and satisfaction have been shown to be closely related, as highlighted by Rajabalee et al. (2020), while Rakic et al. (2020) indicate a noteworthy correlation between students' academic performance and the utilisation of AI as a digital education tool.

Several papers examined the educators' experience with AI-based e-learning platforms, as well as their perception regarding their efficiency as a learning instrument, highlighting several drawbacks, such as limited time available for teachers to enhance their digital literacy (Köenig et al., 2020; Khalil Awan et al., 2021), inadequate training (Zhao et al., 2021; Ng et al., 2023), and improper management of technical issues (Dhillon and Murray, 2021; Cranfield et al., 2021).

The accelerated adoption of e-learning systems based on artificial intelligence has led to the recognition of the importance of educators' digital competence (Falloon, 2020; Köenig et al., 2021; Zhao et al., 2021). In their works, Ng et al. (2023) and Muammar et al. (2023) have discussed the DigCompEdu framework, a guiding principle for educators in effectively integrating resources and designing AI-based learning programmes. The model includes several elements such as interaction, digital resources (including AI applications), teaching and learning, assessment, empowering students, and enabling learners' digital proficiency (Ng et al., 2023), while aiming to evaluate the academic community's ICT proficiency and their current digital and AI related competences (Muammar et al., 2023).

2.3. The use of AI in digital economics education

Our research has shown that several types of digital tools can be used in order to properly implement an e-learning system, among which AI is highlighted as having the potential to transform the educational process. Hillmayr et al. (2020) identified five categories of AI-based digital education tools: exercise and practice programmes, tutoring systems,

hypermedia systems, intelligent tutoring systems and simulations, the last two being the most effective. Bonfield et al. (2020), discusses other four types of AI applications: smart campuses, digital assistants, massive open online courses (MOOCs), and Learning Management Systems (LMSs).

Lizcano et al. (2020) highlighted the existence of a number of other blockchain-based applications, which enable the decentralised validation of students' acquisition of economics competencies, ensuring that their training aligns with the prevailing job landscape and the market demands. Radianti et al. (2020) focuses on virtual reality economics educational applications, which are shown to be an excellent educational instrument for higher education but are still in an experimental stage. Abdulaziz Alsuhbhi et al. (2020) dealt with the topic of introduction of game elements in economics learning systems, which includes the use of levels, experience points, badges, dashboards, progress bars, content unlocking, and leader boards. Futhermore, Mhlanga and Moloi (2020) aimed to study the use of AI technologies in the economics educational sector and their findings suggest that the COVID-19 pandemic determined the development of virtual learning platforms, the use of educational applications and websites, the establishment of STEM digital schools, but also a widespread transition to distance learning.

Bearman et al. (2022) defined artificial intelligence used as a digital education tool (AIED) as a digital technology capable of revolutionising conventional education, offering more dynamic and enhanced educational approaches using highly personalised, scalable, and cost-effective alternative solutions. Xu and Ouyang (2022) defined AIED as an emerging interdisciplinary domain that uses AI applications to transform educational design and enhance student learning. According to Lameras and Arnab (2022), AIED covers the development, implementation, and assessment of tools, pedagogical models, instructional frameworks, ethical considerations, and teaching staff competencies. Chen et al. (2020) states that the development and execution of AIED technologies involves the collaboration of system designers, data scientists, product designers, statisticians, linguists, cognitive scientists, psychologists, education experts, and numerous other professionals. Felix (2021) highlights cost and time saving as two main significant advantages of AIED, which is particularly relevant in the current economic climate characterised by limited financial resources and the need for effective time management. Using AI to assume some aspects of the educational process has the potential to minimise salary costs, while allowing faculty members to focus on other areas, such as teacher-student interpersonal relationship or academic research which contributes to their professional reputation.

Kasneci et al. (2023) as well as Chen et al. (2020) discussed several AIED systems, such as natural language processors, collaborative robots, large language models, and chatbots, designed to either assist teachers in their tasks or operate autonomously, carrying out activities similar to those of an educator. Xu and Ouyang (2022) argue that AI has the potential to serve as an educational tool, functioning as a tutor or instructor, thus altering the dynamics of the instructor-student relationship, shifting the paradigm from an instructor-centred to a student-centred approach.

Huang (2021) identified three key competencies that students need to develop to properly benefit from AIED: knowledge competence, team competence, and learning competence. Huang's (2021) findings show a negative correlation between teamwork competence and human-tool collaboration competence and AI course contents, however, being contradicted

by Sanusi et al. (2022), findings which have proven the significance of teamwork and human-tool collaboration in AIED literacy.

AI applications have been shown to support educators in performing their administrative tasks much faster, through exam automation (Celik et al., 2022), task evaluation and grading (Chen et al., 2020), student performance assessment (Zawacki-Richter, 2019; Chiu et al., 2023), feedback and design support (Zawacki-Richter, 2019; Salas-Pilco and Yang, 2022) and customisation (Chen et al., 2020). AI-enhanced grading systems have shown superior objectivity, accuracy, efficiency, and security in evaluating language writing, speaking, and mathematical assessments compared to human instructors (Chiu et al., 2023), as well as providing constructive feedback (Salas-Pilco and Yang, 2022; Southworth et al., 2023).

Our research has shown that AI technologies can support the economics learning and instruction processes through providing adaptive teaching strategies and customised content (Celik et al., 2022; Lameras and Arnab, 2022), analysis of learner engagement, understanding, and integrity (Zawacki-Richter, 2019), diagnosing learning difficulties and student specific problems and addressing them in a timely manner (Hwang and Tu, 2021; Celik et al., 2022), calculating the odds of students dropping out of school (Salas-Pilco and Yang, 2022), analysing the course material and providing feedback regarding its development (Chen et al., 2020; Chiu et al., 2023). Chiu et al. (2023) and Salas-Pilco and Yang (2022) also highlight the use of AI in the teachers' own professional development, through real-time evaluation of their teaching behaviour during regular classes. Moreover, the implementation of AIED offers a potential means to overcome the physical limitations, by making educational resources accessible through the Internet, (Chen et al., 2020; Felix, 2021; Salas-Pilco and Yang, 2022), facilitating communication (Lameras and Arnab, 2022) and virtual collaboration and cooperation between students, as well as between students and teachers (Zawacki-Richter, 2019), regardless of their geographical location.

Chen et al. (2020) presented various examples of AIED, such as Interactive Learning Environments (ILEs), adaptive learning systems (ALSs), intelligent tutoring systems (ITSs), which can facilitate administrative tasks, instructions, and educational activities. These ILEs and ALSs are used to oversee performance, offer feedback, and facilitate interactions between teachers and students. Additionally, ITSs such as ACTIVE Math, MATHia, Why2Atlas, Comet, Viper, TurnItIn, Ecree, and Knewton are used to enhance the accuracy and objectivity of task and exam grading (Celik et al., 2022) and to detect plagiarism and ethical issues (Chen et al., 2020). Zawacki-Richter (2019) as well as Huang (2021) describe four models that are often integrated in intelligent tutoring systems: the student model, the teacher model, the domain model, and the diagnosis model, which evaluates errors and defects based on the domain model.

Furthermore, chatbots, large language models (LLMs), and interactive books are used as tools for facilitating student-machine dialogues (Huang, 2021; Lameras and Arnab, 2022; Chiu et al., 2023; Kasneci et al., 2023) and have been shown to positively impact low-achieving students by enhancing their confidence and sense of usefulness while reducing feelings of embarrassment. One of the most popular LLMs is OpenAI's GPT-4, which has been used to generate tests and quizzes as well as an educational agent meant to foster curiosity and critical thinking among students (Bhavani, 2020; Lameras și Arnab, 2022; Kasneci et al., 2023).

Nevertheless, AIED education has its shortcomings, such as limited reliability and technical capacities, lack of adequate infrastructure in schools and universities, limited efficiency in evaluation of text structure, content logic and coherence, a lack of understanding and interest of teachers in the use of AI, as well as security and privay risks (Chatterjee and Bhattacharjee, 2020; Celik et al., 2022; Kasneci et al., 2023). According to Felix (2021), students may be sceptical toward AI or at the least possess a limited comprehension of its capabilities, which might lead to a broader sense of mistrust towards instructors or the educational system. On the other hand, too much trust placed in inappropriate contexts may result in the student preferring the AI above that of their educators or classmates. Many educators possess insufficient knowledge about the operational mechanisms of these systems (Chiu et al., 2023), expressing a sense of reduced control (Chatterjee and Bhattacharjee, 2020), leading them to see their job as operating inside an opaque system.

AIED, like most innovative technologies used in a traditional setting, may be seen as a disruptive force and thus, users need to adopt new behaviours to be able to efficiently use it. Thus, Bearman et al. (2022) found that students need to acquire and enhance their critical abilities in the use and assessment of information while Chatterjee and Bhattacharjee (2020) found that the users' attitude plays a key role in their intention to adopt and use AI and that their attitude is influenced by the perceived utility of AI technologies as well as its accessibility. This implies that, in order to implement the large-scale adoption of AIED, it is essential for designers, developers, and system administrators in higher education institutions to prioritise the functionality and practicality of the system. Thus, it is essential that the authorities demonstrate a high level of commitment in correctly communicating the final users' needs to the developers and the choice of technology should align more consistently with the requirements and preferences of the users. At the same time, the users should be informed about the functionalities and capabilities of the system through product documentation, training, and live demonstrations (Chatterjee and Bhattacharjee, 2020).

Even though the research on AIED is extensive, not many studies focus on the ethical aspects of this phenomenon, which presents a basic concern about how the educational technology community, including developers, designers, policy makers, and educators, can behave ethically in order to mitigate or limit ethical drawbacks that may affect students' learning experiences (Lameras and Arnab, 2022). Among these ethical issues we must mention copyright and plagiarism issues with AI generated text, students and teachers relying too much on AI, difficulty in distinguishing AI generated text, difficulty in verifying the validity of AI generated text (Holmes et al., 2022; Kasneci et al., 2023).

2.4. Critical factors influencing the successful use of artificial intelligence applications in digital business education

Alqahtani and Rajkhan (2020, p.4) define the critical success factors as "characteristics, conditions, or variables that, when properly sustained, maintained, or managed, can have a significant impact" on the students' and teachers' intent to adopt AI technologies in the competency-based educational process. Our research has revealed five categories of factors that affect the large-scale adoption of AI based digital economics education: technological factors, quality factors, trust factors, self-efficacy factors, and cultural aspects.

Technological factors include technical skills among students and instructors (Almaiah et al., 2020; Alqahtani and Rajkhan, 2020) and appropriate hardware and software requirements,

as well as adequate internet connectivity, which are needed for the correct functioning of AI- based online education systems. Additionally, it is crucial for universities to supply the required technical resources to ensure consistent maintenance and upgrading.

When talking about quality factors, Almaiah et al. (2020) and Obeng and Coleman (2020) found that many users agree that an efficient AIED application needs to be intuitive, reliable, flexible and accessible for all types of users, especially those with less technical skills. According to Almaiah et al. (2020), accessibility is particularly important, as there is a direct correlation between the system's accessibility and utility and the students' intention to adopt it. In this regard, AIED applications designers and developers must focus on a user-friendly, accessible, and straightforward system, tailored to its' users' needs and expectations (Nguyen et al., 2020; Obeng and Coleman, 2020).

Almaiah et al. (2020) highlight trust as one of the most important factors that influence the adoption of AIED systems, which refers to the system's security, privacy, and general reliability, as well as the provision of efficient, effective, and transparent mechanisms for engaging in e-learning activities within the online education framework (Nguyen et al., 2020).

Almaiah et al. (2020) and Nguyen et al. (2020) argue that users need to be self-efficient to be able to properly use an AIED application, in order to be able to set challenging goals, persevere in the face of obstacles, and bounce back from failures. In order to develop these capabilities, several authors (Almaiah et al., 2020; Alqahtani and Rajkhan, 2020; Nguyen et al., 2020; Zhao, 2021) recommended that universities establish training programmes aimed at enhancing their digital skills, properly presenting the e-learning systems' and the AI applications' features as well as clearly communicating the rules and regulations that govern them.

Several other authors have mentioned culture as a critical factor that may increase an AI educational applications' adoption rate. Thus, Almaiah et al. (2020) argues about the importance of connecting with students through various social media applications. Social media serves as an easy and effective way of engaging students (Elumanai et al., 2020), and, at the same time, can facilitate communication between faculty members and students (Obeng and Coleman, 2020).

2.5. Challenges facing the use of artificial intelligence applications in skills-based economic education

Several authors highlight resistance to change as one of the biggest challenges regarding the large-scale adoption of AIED applications in the competency-based economics education. Humans are inherently resisting to change, not willing to leave their comfort zone, and thus, hindering the transition from traditional to digital education (Liu and Yu, 2022). This resistance can be attributed to trust issues regarding assignment submission and online examinations (Almaiah et al., 2020; Mercader and Gairin, 2020), as well as lack of motivation (Mercader and Gairin, 2020), awareness (Almazova et al., 2020) and trust regarding the AIED applications' features (Watermeyer et al., 2021).

In order to mitigate these challenges, economics universities need to set up and communicate clear policies and procedures (Nuere and de Miguel, 2021) to properly train its users on how to efficiently use these AI based systems (Watermeyer et al., 2021). At the same time, it is important to note that the methodological work employed by educators in a digital educational setting differ greatly from traditional modes of instruction (Nuere and de Miguel, 2021), teachers needing to employ active collaborative strategies and to assist students in developing their own unique learning approaches (Almazova et al., 2020) and overcome challenges associated with electronic communication (Liu and Yu, 2022. They need to prioritise students' engagement (Nuere and de Miguel, 2020), support the development of critical thinking abilities and self-reflection and online collaboration (Tomczyk and Walker, 2021). Moreover, Turnbull et al. (2021) talk about the issue of cheating and plagiarism, which is more prevalent in AI based online learning than in traditional education.

Other challenges are related to the fact that users have different technical skills (Tomczyk and Walker, 2021) and may have different perception regarding the AIED applications' characteristics (Maatuk et al., 2022), aspects which forces universities to provide additional support for those users which are facing technical difficulties (Turnbull et al., 2021; Watermeyer et al., 2021). Almazova's et al. (2020) and Mercader and Gairin's (2020) findings show that academic staff older than 55 years old are facing more difficulties in properly using the e-learning systems than their younger colleagues. Moreover, it is imperative for educators to acquire proficiency in online pedagogy, which relates to designing and delivering AI-assisted educational courses (Turnbull et al., 2021), as well as being able to properly communicate and collaborate with their peers (Nuere and de Miguel, 2021).

Another barrier that hinders the large-scale adoption of AIED applications is related to adequate financial support. A professional custom-made AI software is not cheap (Maatuk et al., 2022), and some universities may have trouble securing the proper funding needed to implement it (Almazova et al., 2020). This might also lead to improper infrastructure (Tomczyk and Walker, 2021), which might be able to withstand heavy network traffic, leading to latency issues which disrupt the learning process (Maatuk et al., 2022). At the same time, some students might not have the adequate hardware equipment needed for these applications (Liu and Yu, 2022) or Internet connection (Turnbull et al., 2021; Almazova et al., 2020).

Considering the aforementioned factors, the present study has successfully developed a model for a system of correlations and elements in the realm of digital economic education based on AI. This model incorporates the use of artificial intelligence and effectively integrates key success factors and unique challenges within a cohesive framework, built on specific domains of application (Figure no. 3).

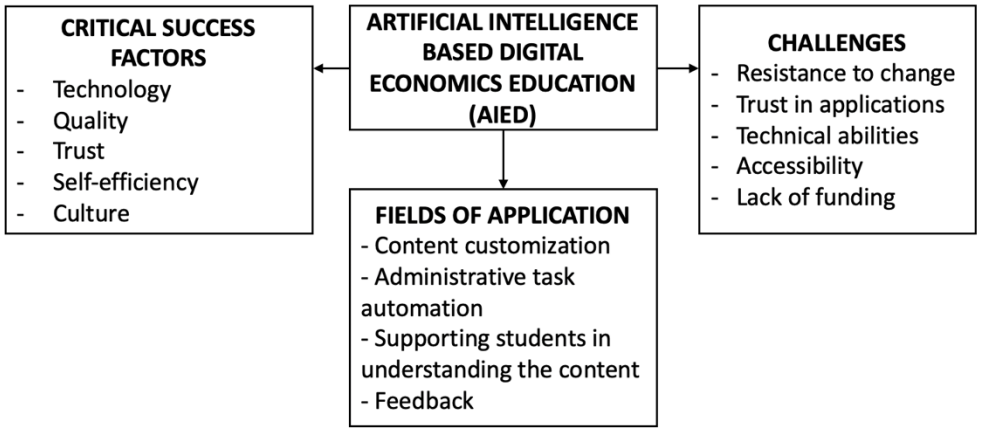

Figure no. 3. A systemic model for digital economics education based on AI

Conclusions

This study aimed to contribute to the broadening existing literature regarding to digital economic education based on the AI platforms and applications, through a systematic review of 60 papers published between 2019 and 2023. Thus, we tried to highlight how the concept of digital economics education based on AI (AIED) presented in recent literature is, the specific fields of application of AIED, and what are the factors and challenges which influence the large-scale adoption of AIED applications. Most of the authors defined AIED as an emerging interdisciplinary area that uses AI applications to transform education and develop the learning process.

Our findings have shown that AI can support teachers in carrying out administrative tasks, enhance the instruction and learning process through a task grading, exam automation, performance evaluation and feedback, creating personalised content and facilitating communication.

Moreover, our study has revealed five categories of factors which can influence AIED applications: technology, quality, trust, self-efficacy, and culture. Most of the authors stress the importance of digital literacy as a key element of artificial intelligence applications, as well as proper training and setting up adequate policies and procedures.

The papers included in our research identified several challenges that educational AI applications are facing, such as the users' resistance to change, barriers related to the accessibility, availability, usability and quality, different levels of digital literacy among its users, and adequate financial support and funding.

Among the limitations of our study, we should mention the narrow period in which we have focused (2020-2023), which restrained the number of papers included in the review (60), and thus, directing them toward the use of AI educational applications after the start of the global COVID-19 pandemic, the concept of digital economics education in general, as well as the use of AI and other digital tools in economics education being a topic that has been addressed both in practice and in research well before the start of the pandemic, which, however, accelerated their adoption and development. A recommendation is addressed to researchers

who want to study the concept of digital economics education to address the evolution of this topic in the decades before the COVID-19 pandemic, as well. At the same time, we recommend that the topic of digital economic education based on AI should be further studied, considering its numerous areas of application and the fact that it is still in the development phase and significant progress is achieving constantly.

Acknowledgements

The research within this paper was conducted within and with the support of the Interdisciplinary Research Center for Economic and Social Sciences, INCESA (Research Infrastructure in Applied Sciences), University of Craiova.

References

Abdulaziz Alsuhbhi, M., Sahari, N. and Tengku Wook, T.S.M., 2020. A Conceptual Engagement Framework for Gamified E-Learning Platform Activities. *International Journal of Emerging Technologies in Learning*, [e-journal] 15(22), pp. 4-23. https://doi.org/10.3991/ijet.v15i22.15443.

Almaiah, A.M., Al-Khasawneh, A. and Althunibat, A., 2020. Exploring the critical challenges and factors influencing the E-learning system usage during COVID-19 pandemic. *Education and Information Technologies,* 25, pp. 5261-5280.

Almazova, N., Krylova, E., Rubstova, A. and Odinokaya, M., 2020. Challenges and Opportunities for Russian Higher Education amid COVID-19: Teachers' Perspective. *Education Sciences,* [e-journal] 10(12), article no. 368. https://doi.org/10.3390/educsci10120368.

Almusharraf, N.M and Khahro, S.H., 2020. Students' Satisfaction with Online Learning Experiences During the COVID-19 Pandemic. *International Journal of Emerging Technologies in Learning,* [e-journal] 15(21), pp. 246-267. https://doi.org/10.3991/ijet.v15i21.15647.

Alqahtani, A.Y and Rajkhan, A.A., 2020. E-learning Critical Success Factors during the COVID-19 Pandemic: A comprehensive Analysis of E-Learning Managerial Perspectives. *Education Sciences,* [e-journal] 10(9), article no. 216. https://doi.org/10.3390/educsci10090216.

Anthony, B., Kamaludin, A., Romli, A., Raffei, A.F.M, Eh Phon, D.N.A.L., Abdullah, A. and Ming, G.L., 2022. Blended Learning Adoption and Implementation in Higher Education: A Theoretical and Systematic Review. *Technology, Knowledge and Learning,* [e-journal] 27, pp. 531-578. https://doi.org/10.1007/s10758-020-09477-z.

Bearman, M., Ryan, J. and Ajjawi, R., 2023. Discourses of artificial intelligence in higher education: a critical literature review. *Higher Education,* [e-journal] 86, pp. 369-385. https://doi.org/10.1007/s10734-022-00937-2.

Bhavani, G., 2020. Artificial Intelligence: Simulations in Audit Education. In: s.n., *11th International Conference on Computing, Communication and Networking Technologies (ICCCNT).* N.d. Kharagpur, India. S.l.: s.n.

Bond, M., Buntins, K., Bedenlier, S., Zawacki-Richter, O. and Kerres, M., 2020. Mapping research in student engagement and educational technology in higher education: a systematic evidence map. International *Journal of Educational Technology in Higher Education*, [e-journal] 17, article no. 2. https://doi.org/10.1186/s41239-019-0176-8.

Bonfield, C.A., Salter, M., Longmuir, A., Benson, M. and Adachi, C., 2020. Transformation or evolution?: Education 4.0, teaching and learning in the digital age. *Higher Education Pedagogies*, [e-journal] 5(1), pp. 223-246. https://doi.org/10.1080/23752696.2020.1816847.

Butler-Henderson, K. and Crawford, J., 2020. A systematic review of online examinations: A pedagogical innovation for scalable authentication and integrity. *Computers & Education*, [e-journal] 159, article no. 104024. https://doi.org/10.1016/j.compedu.2020.104024.

Celik, I., Dindar, M., Muukkonen, H. and Järvelä, S., 2022. The Promises and Challenges of Artificial Intelligence for Teachers: a Systematic Review of Research. *TechTrends*, [e-journal] 66, pp. 616-630. https://doi.org/10.1007/s11528-022-00715-y.

Chatterjee, S. and Bhattacharjee, K.K., 2020. Adoption of artificial intelligence in higher education: a quantitative analysis using structural equation modelling. *Education and Information Technologies*, [e-journal] 25, pp. 3443-3463. https://doi.org/10.1007/s10639-020-10159-7.

Chen, L., Chen, P. and Lin, Z., 2020. Artificial Intelligence in Education: A Review. In: *IEEE Access*, [e-journal] 8, pp. 75264-75278. https://doi.org/10.1109/ACCESS.2020.2988510.

Chiu, T.K.F., Xia, Q., Zhou, X., Chai, S.C., and Cheng, M., 2023. Systematic literature review on opportunities, challenges, and future research recommendations of artificial intelligence in education. *Computers and Education: Artificial Intelligence*, [e-journal] 4, article no. 100118. https://doi.org/10.1016/j.caeai.2022.100118.

Chiu, T.K.F., 2022. Applying the self-determination theory (SDT) to explain student engagement in online learning during the COVID-19 pandemic. *Journal of Research on Technology in Education*, [e-journal] 54(Sup1), pp. S14-S30. https://doi.org/10.1080/15391523.2021.1891998.

Cranfield, D.J., Tick, A., Venter, I.M., Blignaut, R.J. and Renaud, K., 2021. Higher Education Students' Perceptions of Online Learning during COVID-19 – A Comparative Study. *Education Sciences*, [e-journal] 11, article no. 403. https://doi.org/10.3390/educsci11080403.

Dangaiso, P., Makudza, F. and Hogo, H., 2022. Modelling perceived e-learning service quality, student satisfaction and loyalty. A higher education perspective. *Cogent Education*, [e-journal] 9(1), article no. 2145805. https://doi.org/10.1080/2331186X.2022.2145805.

Dhillon, S. and Murray, N., 2021. An Investigation of EAP Teachers' Views and Experiences of E-Learning Technology. *Education Sciences*, [e-journal] 11(2), article no. 54. https://doi.org/10.3390/educsci11020054.

El-Sabagh, H.A, 2021. Adaptive e-learning environment based on learning styles and its impact on development students' engagement. *International Journal of Educational Technology in Higher Educatio*n, [e-journal] 18, article no. 53. https://doi.org/10.1186/s41239-021-00289-4.

Elumalai, K.V., Sankar, J.P., Kalaichelvi, R., John, J.A., Menon, N., Alqahtani, M.S.N. and Abumelha, M.A., 2020. Factors affecting the quality of e-learning during the COVID-19 pandemic from the perspective of higher education students. *Journal of Information Technology Education: Research*, [e-journal] 19, pp. 731-753. https://doi.org/ 10.28945/4628.

Falloon, G., 2020. From digital literacy to digital competence: the teacher digital competency (TDC) framework. *Education Technology Research and Development*, [e-journal] 68, pp. 2449-2472. https://doi.org/10.1007/s11423-020-09767-4.

Felix, C.V., 2020. The Role of the Teacher and AI in Education. In: E. Sengupta, P. Blessinger and M.S. Makhanya eds., 2021. *International Perspectives on the Role of Technology in Humanizing Higher Education* (*Innovations in Higher Education Teaching and Learning*. Bingley: Emerald Publishing Limited, pp. 33-48. https://doi.org/10.1108/S2055-364120200000033003.

Giray, G., 2021. An assessment of student satisfaction with e-learning: An empirical study with computer and software engineering undergraduate students in Turkey under pandemic conditions. *Education and Information Technologies*, [e-journal] 26, pp. 6651-6673. https://doi.org/10.1007/s10639-021-10454-x.

Hillmayr, D., Ziernwald, L., Reinhold, F., Hofer, S.I. and Reiss, K.M, 2020. The potential of digital tools to enhance mathematics and science learning in secondary schools: A context-specific meta-analysis. C*omputers & Education*, [e-journal] 153, article no. 103897. https://doi.org/10.1016/j.compedu.2020.103897.

Holmes, W., Porayska-Pomsta, K., Holstein, K., Sutherland, E., Baker, T., Buckingham Shum, S., Santos, O.C., Rodrigo, M.T., Cukurova, M., Bittencourt, I.I. and Koedinger, K.R., 2022. Ethics of AI in Education: Towards a Community-Wide Framework. *International Journal of Artificial Intelligence in Education*, [e-journal] 32, pp. 504-526, https://doi.org/10.1007/s40593-021-00239-1.

Huang, X., 2021. Aims for cultivating students' key competencies based on artificial intelligence education in China. *Education and Information Technologies*, [e-journal] 26, pp. 5127-5147, https://doi.org/10.1007/s10639-021-10530-2.

Hwang, G.J. and Tu, Y.F., 2021. Roles and Research Trends of Artificial Intelligence in Mathematics Education: A Bibliometric Mapping Analysis and Systematic Review. *Mathematics*, [e-journal] 9, article no. 584. https:// doi.org/10.3390/math9060584.

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. and Kasneci, G., 2023. ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, [e-journal] 103. https://doi.org/10.1016/j.lindif.2023.102274.\.

Khalil Awan, R., Afshan, G. and Bano Memon, A., 2021. Adoption of E-Learning at Higher Education Institutions: A Systematic Literature Review. *Multidisciplinary Journal for Education, Social and Technological Sciences*, [e-journal] 8(2), pp. 74-91. https://doi.org/10.4995/muse.2021.15813.

Köenig, J., Jäger-Biela, D.J. and Glutsch, N., 2020. Adapting to online teaching during COVID-19 school closure: teacher education and teacher competence effects among early career teachers in Germany. *European Journal of Teacher Education*, [e-journal] 43(4), pp. 608-622. https://doi.org/10.1080/02619768.2020.1809650.

Lameras, P. and Arnab, S., 2022. Power to the Teachers: An Exploratory Review on Artificial Intelligence in Education. *Information*, [e-journal] 13, article no. 14. https://doi.org/10.3390/info13010014.

Liu, M. and Yu, D., 2023. Towards intelligent E-learning systems. *Educational and Information Technologies*, [e-journal] 28, pp. 7845-7876. https://doi.org/10.1007/s10639-022-11479-6.

Lizcano, D., Lara, J.A., White, B. and Aljawarneh, S., 2020. Blockchain-based approach to create a model of trust in open and ubiquitous higher education. *Journal of Computing in Higher Education*, [e-journal] 32, pp. 109-134. https://doi.org/10.1007/s12528-019-09209-y.

Lloret-Irles, D., Sefura-Heras, J.V., Nogues-Pedregal, A.M., Saumell- Castelló, C and Akita-Udrea, M., 2022. Digital skills of Valencian university students. In: Universitat Politecnica de Valencia, *8th International Conference on Higher Education Advances (HEAd'22)*. N.d., Valencia, Spain. S.l.: Universitat Politecnica de Valencia.

Maatuk, A.M., Elberkawi, E.K., Aljawarneh, S., Rashaideh, H. and Alharbi, H., 2022.The COVID-19 pandemic and E-learning: challenges and opportunities from the perspective of students and instructors. *Journal of Computing in Higher Education*, [e-journal] 34, pp. 21-38. https://doi.org/10.1007/s12528-021-09274-2.

Maslova, I., Burdina, G., and Krapotkina, I. 2020. The Use of Electronic Educational Resources and Innovative Educational Technologies in University Education. *International Journal of Emerging Technologies in Learning*, [e-journal] 15(16), pp. 68-79. https://doi.org/10.3991/ijet.v15i16.14909.

Mercader, C. and Gairín, J., 2020. University teachers' perception of barriers to the use of digital technologies: the importance of the academic discipline. *International Journal of Educational Technology in Higher Education*, [e-journal] 17(4). https://doi.org/10.1186/s41239-020-0182-x.

Mhlanga, D. and Moloi, T., 2020. COVID-19 and the Digital Transformation of Education: What Are We Learning on 4IR in South Africa? *Education Sciences*, [e-journal] 10(7), article no. 180. https://doi.org/10.3390/educsci10070180.

Micu, A., Micu, A.E., Geru, M., Căpăţînă, A., Muntean, M.C., 2021. The Impact of Artificial Intelligence Use on the E-Commerce in Romania. *Amfiteatru Economic*, [e-journal] 23(56), pp. 137-154. http://dx.doi.org/10.24818/EA/2021/56/137.

Muammar, S., Hashim, K.F.B. and Panthakkan, A., 2023. Evaluation of digital competence level among educators in UAE Higher Education Institutions using Digital Competence of Educators (DigComEdu) framework. *Education and Information Technologies*, [e-journal] 28, pp. 2485-2508. https://doi.org/10.1007/s10639-022-11296-x.

Ng, D.T.K., Leung, J.K.L., Su, J., NG, R.C.W. and Chu, S.K.W., 2023. Teachers' AI digital competencies and twenty-first century skills in the post-pandemic world. *Education Technology Research and Development*, [e-journal] 71, pp. 137-161. https://doi.org/10.1007/s11423-023-10203-6.

Nguyen, H.T.H., Pham, H.V., Vu, N.H. and Hoang, H.T., 2020. Factors Influencing Students' Intention to Use E-learning System: A Case Study Conducted in Vietnam. *International Journal of Emerging Technologies in Learning*, [e-journal] 15(18), pp. 165-182. https://doi.org/10.3991/ijet.v15i18.15441.

Nuere, S. and de Miguel, L., 2021. The Digital/Technological Connection with COVID-19: An Unprecedented Challenge in University Teaching. *Technology, Knowledge and Learning*, [e-journal] 26, pp. 931-943. https://doi.org/10.1007/s10758-020-09454-6.

O'Neill, A., 2023. Was humpty dumpty right?: Towards a functional definition of e-learning. *Education and Information Technologies*, [e-journal]. https://doi.org/10.1007/s10639-023-11900-8

Obeng, A.Y and Coleman, A., 2020. Evaluating the effects and outcome of technological innovation on a web-based e-learning system. *Cogent Education*, [e-journal] 7(1). https://doi.org/10.1080/2331186X.2020.1836729.

Ooi, K.B, Wei-Han Tan, G., Al-Emran, M., Al-Sharafi, M.A., Capatina, A., Chakraborty, A., Dwivedi, Y.K., Huang, T.L., Kar, A.K., Lee, V.H., Loh, X.M., Micu, A., Mikalef, P., Mogaji, E., Pandey, N., Raman, R., Rana, N.P., Sarker, P., Sharma, A., Teng, C.I., Wamba, S.F. and Wong, L.W., 2023. The Potential of Generative Artificial Intelligence Across Disciplines: Perspectives and Future Directions. *Journal of Computer Information Systems*, [e-journal]. https://doi.org/10.1080/08874417.2023.2261010.

Radianti, J., Majchrzak, T.A., Fromm, J. and Wohlgenannt, I., 2020. A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. *Computers & Education*, [e-journal] 147, article no. 103778. https://doi.org/10.1016/j.compedu.2019.103778.

Rajabalee, Y.B. and Santally, M.I., 2021. Learner satisfaction, engagement and performances in an online module: Implications for institutional e-learning policy. *Education and Information Technologies*, [e-journal] 26, pp. 2623-2656. https://doi.org/10.1007/s10639-020-10375-1.

Rakic, S., Tasic, N., Marjanovic, U., Softic, S., Lüftenegger, E., and Turcin, I., 2020. Student Performance on an E-Learning Platform: Mixed Method Approach. *International Journal of Emerging Technologies in Learning*, [e-journal] 15(02), pp. 187-203. https://doi.org/10.3991/ijet.v15i02.11646.

Salas-Pilco, S.Z. and Yang, Y., 2022. Artificial intelligence applications in Latin American higher education: a systematic review. *International Journal of Educational Technology in Higher Education*, [e-journal] 19(21). https://doi.org/10.1186/s41239-022-00326-w.

Sanusi, I.T., Olaleye, S.A Agbo, F.J. and Chiu, T.K.F., 2022. The role of learners' competencies in artificial intelligence education. *Computers and Education: Artificial Intelligence*, [e-journal] 3, article no. 100098. https://doi.org/10.1016/j.caeai.2022.100098.

Shams, M.S., Niazi, M.M., Gul, H., Mei, T.S. and Khan, K.U., 2022. E-Learning Adoption in Higher Education Institutions During the COVID-19 Pandemic: A Multigroup Analysis. *Frontiers in Education*, [e-journal] 6, article no. 783087. Https://doi.org/10.3389/ feduc.2021.783087.

Southworth, J., Migliaccio, K., Glover, J., Glover, J.'N., Reed, D., McCarty, C., Brendemuhl, J. and Thomas, A., 2023. Developing a model for AI Across the curriculum: Transforming the higher education landscape via innovation in AI literacy, *Computers and Education: Artificial Intelligence*, [e-journal] 4, article no. 100127. https://doi.org/10.1016/j.caeai.2023.100127.

Theresiawati, T., Seta, H.B., Hidayanto, A.N. and Abidin, Z., 2020. Variables affecting e-learning services quality in Indonesian higher education: Students' perspectives. *Journal of Information Technology Education: Research*, [e-journal] 19, pp. 259-286. https://doi.org/10.28945/4489.

Tomczyk, Ł. and Walker, C., 2021. The emergency (crisis) e-learning as a challenge for teachers in Poland. *Education and Information Technol*ogy, [e-journal] 26, pp. 6847-6877. https://doi.org/10.1007/s10639-021-10539-7.

Turnbull, D., Chugh, R. and Luck, J., 2021. Transitioning to E-Learning during the COVID-19 pandemic: How have Higher Education Institutions responded to the challenge?. *Education and Information Technol*ogy, [e-journal] 26, pp. 6401-6419. https://doi.org/10.1007/s10639-021-10633-w.

Watermeyer, R., Crick, T., Knight, C. and Goodall, J., 2021. COVID-19 and digital disruption in UK universities: afflictions and affordances of emergency online migration. *Higher Education*, [e-journal] 81, pp. 623-641. https://doi.org/10.1007/s10734-020-00561-y.

Xu, W. and Ouyang, F., 2022. A systematic review of AI role in the educational system based on a proposed conceptual framework. *Education and Information Technol*ogy, [e-journal] 27, pp. 4195-4223. https://doi.org/10.1007/s10639-021-10774-y.

Zawacki-Richter, O., Marín, V.I., Bond, M. and Gouverneur, F., 2019. Systematic review of research on artificial intelligence applications in higher education – where are the educators?. *International Journal of Educational Technology in Higher Education*, [e-journal] 16(39). https://doi.org/10.1186/s41239-019-0171-0.

Zhao, Y., Pinto Llorente, A.M. and Sánchez Gómez, M.C., 2021. Digital competence in higher education research: A systematic literature review. *Computers & Education*, [e-journal] 168, article no. 104212. https://doi.org/10.1016/j.compedu.2021.104212.

Zhou, L., 2021. Effect Evaluation and Influencing Factors of E-Learning Training in Colleges. International *Journal of Emerging Technologies in Learning*, [e-journal] 16(22), pp. 73-86. https://doi.org/10.3991/ijet.v16i22.26877.