Journal of Future Artificial Intelligence and Technologies

E-ISSN: 3048-3719

Review Article

Advanced and AI Embedded Technologies in Education: Effectiveness, Recent Developments, and Opening Issues

Minh T. Nguyen and Thuong TK. Nguyen *

Thai Nguyen University of Technology, Thai Nguyen University, Thai Nguyen city, Viet Nam;
e-mails: nguyentuanminh@tnut.edu.vn; nguyenthikimthuong@tnut.edu.vn
* Corresponding Author: Thuong TK. Nguyen

Abstract: This paper offers a brief analysis highlighting the effectiveness of several well-known Artificial Intelligence (AI) technologies applied in education, particularly in teaching and learning. It provides an overview of how modern classrooms can benefit from more effective teaching strategies that encourage students to engage in hands-on learning. Advanced technologies are changing how knowledge is found and shared, as well as how teaching is delivered. Memorization has been emphasized in educational models as a crucial learning skill until relatively recently. The technologies alter how knowledge is accessed and taught in schools today. Based on that, most knowledge is readily available, quickly accessible, and available online. The skills of reading, sharing, listening, and acting are now prerequisites for schooling. Most recent developments in advanced technologies in education are provided. Some analyses related to opening issues and challenges are shown for future work.

Keywords: Artificial Intelligence; Augmented Reality; Automated Assessments; Cloud computing; Education; Internet of Things; Learning and Teaching; Virtual Reality.

1. Introduction

The quick development of electronics, information, and communication technologies has resulted in the creation of a wide range of infrastructure and services, from specific applications like banking, education, or health to telecommunications like voice, data, and media services to the introduction of electronic government [1]–[4]. Numerous cutting-edge technologies are recently been used in education to support educational activities [5], [6] efficiently. Schooling in a world of developing advanced technologies challenges theoretical frameworks for both teaching and learning. Technology has made it possible for and spurred a major paradigm shift in education: the move from instructor-based to learner-based programs.

Currently, advanced technologies can support the demands of all educational levels, regardless of time and place. Today, many individuals might learn through technology and e-learning media, which can increase student participation and save time and effort in such classrooms. Technologies and e-learning media have been developed to assist a great number of individuals in their studies. They also make classes interactive and reduce the amount of time and effort required for learning. The digital revolution is affecting all aspects of work, including the types of jobs, duties, and abilities, as well as how people live and learn [7], [8]. The phrase "advanced technologies" encompasses a wide range of goods and services that incorporate artificial intelligence (AI), wearable technology, like head-mounted displays and sensors, virtual reality (VR), augmented reality (AR) and the Internet of Things (IoT), etc. that can be applied into education fields as shown in Table 1.

The literature indicates that various studies have been conducted with an emphasis on the applications of emerging technologies in education. The focus of [8]'s writers is on adaptive learning technologies from the standpoint of profound learning, where goals may be demonstrated by learning analytics that are developed and whose associations can result in consistent, verifiable blockchains. Study [9] looks at how technologies influence creativity in

Received: September, 10th 2024
Revised: October, 2nd 2024
Accepted: October, 10th 2024
Published: October, 15th 2024
Curr. Ver.: October, 15th 2024

the body of current literature, classifies the many forms of evolving technology, and evaluates the extent of technology integration in classrooms. The requirement to thoroughly grasp the research on creativity in environments that use digital educational technologies inspires several studies.

Table 1. Advanced techniques in different scenarios supporting education.

No	Different scenarios applying in Education	Possible advanced techniques
1	Remote education: Online and mobility;	Real-time analysis, edge computing, and virtual personal assistants;
2	Building curricumlums	Clustering techniques; deep learning or machine learning technologies; Big data analysis;
3	Personalizing intelligent teaching	Learning analytics; Bayesin knowledge interference or data mining; intelligent teaching systems;
4	Schools of Intelligence	Technologies of hearing and sensing; Virtual laboratories; A/R; V/R;
5	Evaluate and Grade	Predicting systems; computer vision; image processing and recognizing;
6	Assessment to students and als schools	Adapted learning methods; approaches of personalized learning; Academic analytics;

Pedagogical factors and other learning/teaching issues unique to a field must be considered when using such technology in education. Study [10] encourages critical thinking on the digitalization of education and datafication, where advanced technologies play a significant part among engineering education's stakeholders, including policy-makers, administrators, researchers, teachers, and students. The critical issues with instructional methods, ethical obligations, sociocultural dimensions of education, and the usage of big data in the existing educational systems can only be resolved with the help of these technologies. The research methodology for a digitally enhanced lead to fostering creativity is presented in article [11]. Using the newest extended reality technology, techno-self-enhanced learning provides learner-centered approaches to creativity in learning. The cultural sector interpretation strategy is then looked at to engage students and further develop new involvement techniques. The agile project development technique is then put into practice. Research [12] systematically analyzes various multimedia tools in educational processes, including teaching and learning, to investigate how different technologies have shown to be a viable approach for accessing high-quality education and enhancing learner performance. The technology and elements incorporated into creating the different multimedia tools have helped them succeed when applied to different target audiences and topics. The level of readiness that higher education institutions currently have for the digital transformation of their operations is examined in study [13]. The purpose of the study is to investigate the existing comparative metrics and the challenges higher educational institutions face in adjusting to the digital transformation of their operations.

This work provides an overview of using advanced and AI-embedded technologies in education. Different advanced techniques are briefly defined and explained for teaching and learning tasks. We analyze the applications' effectiveness and provide recent developments in the use of new technologies in the fields. In addition, we suggest that as developing technologies provide more customized learning and teaching experiences, they have the potential to enhance teaching and learning methodologies greatly. In higher education, for example, students can practice writing with developing technology and gain further insight into the audience they are writing for. Thanks to the epidemic phase and the new normal, more educators can now experiment with cutting-edge technologies like computer vision, artificial intelligence, telepsychiatry, and cloud computing [14]–[16]. It is anticipated that these types of research studies will play a critical role in assisting educators in identifying the benefits of new technologies and actively integrating them into classroom settings.

The rest of this paper is organized as follows. The effectiveness of utilizing advanced technologies for education is addressed in Section 2. Recent developments of some emerging

technologies for education are analyzed in Section 3. In Section 4, opening issues and challenges are discussed. Finally, Section 5 contains conclusions and future work.

2. The Effectiveness of Advanced Technologies in Education

This section discusses the effectiveness of some specific uses of advanced technologies in education. Each technology benefits education environments in specific ways, as follows.

2.1. AI-powered Learning Environments

Artificial intelligence (AI)-enabled technologies, like machine learning, facial recognition, and natural language processing, are increasingly utilized in classrooms to facilitate and enhance learning [17]. Moreover, AI-powered learning environments allow teachers to customize classes to each student's needs and give students tailored learning experiences [18]. Therefore, it's safe to assume that artificial intelligence (AI) is quickly finding its way into educational tools, and that its influence will undoubtedly be felt in the years to come.

2.2 Virtual Reality (VR) and Augmented Reality (AR)

Regardless of the setting, VR and AR may provide immersive and captivating learning experiences. They could be employed more frequently as useful tools for experiential and immersive education [17], [18]. This also allows learners to practice assignments, explore virtual activities, and join in simulations catering to specific demands. Both of the effects of technology on education will be difficult to overlook as they become more widely used.

2.3. Automated Assessments

It sounds impossible to address the impact of automation in the sphere of education. Evaluating pupils' development will increasingly depend on automated assessment tools [19]. This provides an improvement in the understanding of pupil performance and opportunities for growth for either administrators or educators.

In addition, data analysis from automated assessment technologies can support students in recognizing and improving their weak fields [20]. This supports teachers to grade assignments more quickly and precisely with automatic grading tools. This also help to saves time on the tasks.

2.4. Cloud Computing

Since cloud computing makes it easier for them to access and retain data, it will remain a valuable tool for educators [21]. In addition, since cloud-based books are freely accessible from everywhere, learners can spend less money on expensive hard-copy books. Cloud computing could be a new trend in education technologies that provide robust authentication features to support students with secured data. This is also simple for teachers and learners to teach/study together.

2.5. Social Media in Learning

Social media tools have a huge effect on how students can learn. These provide students with new ways to interact, access, and exchange knowledge with one another. Currently, the ways teachers use social media tools have also been significantly impacted. They have equipped instructors with useful additional resources to connect and involve students [22]. Social media use in education still provides a lot of benefits. This will continue to significantly impact education, specifically teaching and learning, in the years to come.

2.6. Learning in Portable Devices

2.6.1. Mobile Learning

As students can continue their studies wherever they are with mobile devices, they are increasingly adopting these tools for educational purposes. Educational content is now being customized at a growing rate for mobile platforms [23]. Traditional learning approaches are being replaced by portable devices such as tablets and smartphones, which offer mobile e-learning solutions that promote continuous learning.

2.6.2. Wearable Technology

The growing popularity and adaptability of wearable technology is significantly impacting learning environments. This technology monitors student progress, provides performance feedback, and delivers personalized real-time guidance [24]. Moreover, wearable devices like VR headsets and smartwatches enable students to record voice notes, listen to audio lectures, and receive class notifications. This increased accessibility benefits students, teachers, and parents by improving learning effectiveness.

2.6.3. Gamification of Learning

A rising trend in many educational institutions is the gamification of learning. By incorporating game design elements into education, the primary goal is to make learning more engaging and enjoyable. Examples include earning virtual points for assignments, competing with peers on a virtual leaderboard, and other gamified elements[25]. By making learning more interactive and fun, students can learn more efficiently and enjoyably acquire new skills.

2.7. Digital Content Platform

With the global outbreak of the COVID-19 pandemic, e-learning platforms have gained substantial popularity. Learners and educators worldwide can now access high-quality instructional materials through these platforms[26]. Additionally, various educational content is available for instructors and students on digital content platforms[27]. The influence of these platforms on how students learn and engage with instructional content is expected to expand as digital content platforms continue to grow in prominence.

2.8. Adaptive Learning

The ability to customize courses to meet the specific needs of students has made adaptive learning a significant emerging trend in educational technology[28]. A growing number of academic institutions are adopting this data-driven, cutting-edge approach to support personalized learning outcomes. Through this method, educators are better equipped to meet the diverse needs of students and improve learning results. Teachers may also use this approach to tailor learning paths and speeds according to individual student requirements.

3. Recent Developments

This section describes recent applications that benefit education in teaching and learning. Some explanations are provided to clarify how the technologies can support the educational systems.

3.1. Virtual Reality

Virtual reality (VR) is a technology that generates an interactive, computer-based experience and creates a simulated environment in an artificial digital world. This technology can be used to design a fantasy environment that allows for experiences that are impossible in traditional physical reality, or it can replicate real-world settings[29]. VR enhances students' enthusiasm for learning by offering novel methods that integrate sensory information through this innovative approach. It can also be applied to depict functions or activities with higher accuracy[30]. One of the most recognizable components of virtual reality is the head-mounted display (HMD). Since humans rely heavily on visual perception, the main difference between immersive virtual reality systems and conventional user interfaces often lies in the display technology. An example of accessible VR is Google Cardboard, a wireless, foldable viewer with a smartphone. Google Expeditions, offered on this platform, helps students grasp complex social and scientific topics. In one application, Tilt Brush provides a 3D painting environment, making lessons more engaging, with the instructor being real. Google Expedition is an example of this approach. Researchers[31] explored the use of virtual reality tools in geography lessons. They developed a VR platform in [32], utilizing a VR game to teach civil engineering concepts to pre-university students. According to a virtual medical coaching website, VR training is reported to be three to four times faster than traditional methods, with training sessions lasting just 30 minutes. A meta-analysis indicates that students trained using VR are more likely to pass exams compared to those taught via conventional methods [33].

3.2. Augmented Reality

Three qualities have been defined as the definition of augmented reality (AR): (1) Integrates virtual and actual worlds; (2) actual-time interaction; and (3) three-dimensional registration [34]. Augmented reality technologies enable simultaneous interaction between the real and virtual worlds. The actual environment is overlayed with digital material (text, music, photos, video, and 3D objects) to create the illusion that it is a part of it [35]. AR has several benefits for both teaching and learning, offering a range of learning opportunities[36]. Smartwatches, bracelets, virtual reality glasses, smart glasses developed from the Google Glass project, smart optical lenses, and headphones are examples of wearable technology. The study looks at how employing augmented reality books (AR books) affects students' academic performance as well as how they perceive their environment. One unique strategy that has been studied is using augmented reality in multimedia apps for medical education. This study aims to ascertain medical faculty students' opinions on using "mobile augmented reality technology" for anatomy instruction[37]. ARCore is used by the Augment smartphone application to show 3D models in augmented reality that are concurrently scaled and positioned in their real-world environments. The impact of this application on technical drawing instruction was examined by the writers[38]. Among the web 2.0 applications that utilize augmented reality technology is Aurasma. The Aurasma web 2.0 tool may freely create interactive virtual reality content. These materials make it possible to provide helpful knowledge outside of the classroom and provide more effective education.

3.3. Artificial Intelligence

Using intelligent tutors or teachable agents (TAs), educational software has digitally executed the pedagogical concept of learning by teaching. Teachable agents, sometimes known as intelligent tutors, offer students timely, individualized resources, direction, and feedback [6]. The conditions for a thorough examination were met by just a small number of research projects despite the wide range of applications for AI and machine learning. This potent AI technology made possible the effective identification of shifts in English as a second/foreign language (ESL/EFL) learning meth-odologies across several grades[39]. The study of computer-assisted learning (CAL) creates substitutes for traditional teaching methods by utilizing artificial intelligence (AI) and digital technology. AI can help map out each student's individual learning plans and trajectories, taking into account their learning preferences and activities, as well as their strengths and limitations, more expensive but easier to comprehend or learn courses. AI may help instructors and schools by utilizing algorithms to direct students via different curriculum routes, which can customize learning and improve chances for students [40]. The results of the Structural Equation Modeling demonstrated that task interest predicted future course interest for application partners but not chatbot partners[41]. According to research conducted with American high school students, connecting math to students' extracurricular activities can enhance learning via an intelligent tutoring system[42]. Thus, very tailored modification might be beneficial for pupils' success.

3.4. Internet of Things (IoT)

Technology significantly influences people's lives, careers, leisure, and learning, particularly in education. The term Internet of Things (IoT) refers to a wide range of interconnected devices and technology that change how education is delivered. By using online IoT techniques, such as Kahoot and exchanging grades with students via Google Docs and Telegram, teachers can assess students more quickly[43]. Instructors also provide their students with access to valuable online resources. Teachers' abilities and expertise can be evaluated, and management can monitor developments and take appropriate action based on the input received. However, universities without IoT devices face challenges in staff and student management, as well as excessive energy, heating, and water use[44]. A study developed a learning kit to integrate blockchain and IoT principles into STEM education. This kit, using a project-based learning approach, provides students with practical experience. It includes parts for the "cloud," "muscle," and "brain" to cover all aspects of blockchain and IoT technology. Teaching students about blockchain and IoT principles is crucial to preparing them for the Fourth Industrial Revolution [45]. A framework for developing IoT-enabled "smart campuses" is proposed in the article[46]. Using a content analysis approach, the model synthesizes data

from relevant books, papers, research, and websites, connecting six modules, a set of databases, two types of settings, and two user interface roles (teachers and students) in both classroom and personal contexts. Smart classrooms are created by addressing challenges with green IoT techniques in engineering education[47]. Engineering education emphasizes the sustainability of IoT resources, motivating all institutional members to operate responsibly.

3.5. Cloud Computing

Conventional online learning techniques, such multimedia and live teaching, must adapt to the demands of modern experimental education. A rendering and storage system that operates entirely on the cloud is introduced to solve these issues and provide low-latency, high-quality learning experiences [48]. The experimental scenes were divided into two groups: interactive models and backdrop. Gamification has generated a lot of attention in cutting-edge teaching strategies because of its potential to improve students' learning processes. After doing research, the writers [49] offered answers. The main goal is to outline the overall strategy for gamifying an area. It has been demonstrated that the following seven criteria are beneficial for educational purposes: motivation, goal clarity, idea testing, cheating scenario monitoring, task optimization for long-term progress, and overall lose/win results of games. This research [50] has attempted to address technological issues using cloud computing technology, such as learning module updates and scalability. It may create games with motivational and instructional goals by utilizing the infrastructure. Cloud computing has made a significant contribution to online collaborative learning in the educational field. They found that cloud computing technologies are used for collaborative learning tasks, including editing, sharing, discussing, and communicating. The authors [51] create an interactive, multimodal, cloud-based mobile learning platform that allows users to engage in the way that best suits their learning preferences. This tool enhances children with special needs' learning capacity by about 30% by using functional adjustments that meet their learning objectives. For experimental VR teaching, study [52] develops a cloud-to-end rendering and storage system with backdrop and interactive models. The cloud server renders the background, and the end terminal receives the final result as a video stream. Interactive models are then merged and light-rendered at the end terminal. A more recent 3D warping and hole-filling technique is also recommended to improve image quality when the user's point of view changes.

4. Challenges and Opening Issues

4.1. Virtual Reality (VR)

Numerous studies have shown that virtual reality (VR) holds great potential for enhancing learning outcomes by providing a more engaging environment that appeals to various senses, including touch, taste, smell, olfactory, and haptic perception. Nevertheless, there are still several disadvantages to utilizing VR technology in the classroom. Head-mounted displays (HMDs), the foundation of contemporary VR technologies, provide complete immersion through a 3D virtual world that closely mimics reality. One of the major issues that has to be resolved with the new features shortly is the lack of visual realism and the realism of the dynamics and interaction. The techniques available now for producing VR graphics and display technology are very limited. Be advised that the human brain's psycho-visual structure makes it possible for us to detect even minutely incorrect features, which can swiftly break the immersion. Thus, optimizing reality's presentation in the virtual reality realm is a never-ending endeavor. Consumers should be aware that prolonged use of some products may have negative health impacts, including motion sickness, disorientation, and loss of balance. These are caused by head motions when using an HMD, which also results in high latencies, sluggish picture display rates, and high pixel persistence. The first has to do with the possibility that immersion may significantly reduce interpersonal communication, especially among students. Dealing with a real person is far more satisfying than dealing with an avatar. Interactions on screens can never fully take the place of real-world interactions. Maintaining student-teacher engagement must be done at all costs. Technology-assisted content delivery and traditional classroom education must coexist together. The other limitation is the expense of these resources.

4.2. Augmented Reality (AR)

Investigating possible solutions is crucial for challenges pertaining to the technology components of augmented reality apps (e.g., file size, GPS inaccuracy, sensitivity trigger to recognition). Further study on the development and deployment of augmented reality apps is necessary since, despite technological advancements, students may still find it difficult to use augmented reality applications. Investigating students' perceptions of usability and preferences in AR-based learning environments is therefore vital. To meet the pedagogical issues of AR, researchers can develop comprehensive models and (empirically proven) design principles for AR environments. Future studies may examine the best practices for utilizing augmented reality (AR) applications to support ubiquitous, collaborative, and informal learning. More research can be done to examine the impacts of AR applications. Researching the integration of AR applications with new technologies, including eyeglasses and educational outcomes, is essential to uncover potential advantages. A closer examination of the ways in which students resolved the problems they ran across when engaging with the environment in location-based augmented reality (AR) applications may be helpful. More studies on student satisfaction, motivation, interactions, and engagement may be necessary to fully comprehend the advantages of augmented reality in educational settings.

Certain issues and advantages in the literature appear to contradict one another. For example, some studies found that augmented reality is difficult to use, while others found that simplicity had advantages. Likewise, this applies to the question of whether AR apps cause cognitive stress. Investigating the elements (subject, age group, interface features, etc.) that lead to the problem of cognitive overload in AR technology applications is therefore, imperative. More studies are required to fully comprehend the relationship between multisensory experiences and augmented reality apps and how they affect learning results. A detailed explanation of the materials development process and design concerns would make the job of anyone who might want to use this technology in their future research easier.

4.3. Artificial Intelligence

AI in education holds great potential for teaching and learning. They serve as a source of creative research ideas and methods, make use of state-of-the-art instruments and technology for data collection and analysis, and ultimately establish themselves as accepted research paradigms. Still, a lot of educators and scholars find them fresh and unique. In addition to the exciting new possibilities, we have also highlighted the important issues and trends in AI development in education, which are reflected in industry, government policy, and scholarly research. The following are a few of the difficulties artificial intelligence presents for education. The one-size-fits-all approach to education is progressively replaced by in-dividualized and precision learning. A specific area of intelligent computer technology is the focus of AI research in education.

Furthermore, the development of machine-generated data should be done with due consideration for its goal, meaning, and structure. Traditional formal education institutions are undergoing major transformations in digitally driven knowledge economies, maybe even a paradigm shift. It is still early to see how effective AI-based learning systems are. In light of the different ways that artificial intelligence is being used in the classroom, we are also reframing and reexamining contemporary notions of education. More guidance on state-of-the-art AI-supported learning or assessment methods is needed. Rethinking and reevaluating how to use the current learning tools in conjunction with AI-assisted material has to be done. In order to use AI in educational contexts, we also need to develop best practices, ethical norms, and large-scale learning systems.

The collaboration between apps and AI is the final but equally important problem. An interdisciplinary study combining educators and educational scholars might produce practical advice and outstanding examples for other educators. To fully realize the promise of AI in teaching and learning, joint research focusing on AI technology applications that might influence learning outcomes in real educational settings is essential.4.4. Internet of Things (IoT)

Wearable technology enables students to track and document their academic activities, enhancing the interactive learning environment. The Internet of Things (IoT) has the potential to serve as an effective teaching tool for students who leverage technology to address various problems. However, the use of IoT in education is not without challenges. Educa-

tional institutions should focus on improved strategies, such as incorporating IoT into curricula, organizing orientation sessions for staff to highlight its advantages, offering professional development plans for professors, and educating students on the wide range of IoT applications. IoT developers and engineers must consider these factors to ensure successful IoT adoption.

Although there have been numerous studies on augmented reality and learning analytics within IoT-based education, the widespread adoption of these m-learning applications still requires further research and development. As noted by several researchers, security and privacy concerns remain significant obstacles to IoT adoption in education. Therefore, future efforts to implement IoT in educational settings must address these issues to overcome the challenges identified in prior research and maintain its relevance. Furthermore, wearable technology, including devices like Google Glass, is extensively used in medical education, emphasizing the need for researchers to examine how these technologies are applied in various fields.

5. Conclusions

This work firstly provides the effectiveness of almost all advanced technologies that can strongly support educational tasks. The understanding of how to apply the technologies in teaching and learning is addressed. In addition, the recent developments in those advanced technologies have been provided and updated. These can confirm surely that the technologies are significantly suitable for supporting educational fields. It is quite obvious that almost the technologies are close to each other to support teachers and students. They still have different points of usage in various teaching methods. In other words, each of them can assist teachers, learners, and institutions in different ways. Hence, we are still researching to improve the techniques. Research directions as opening issues are provided for potential future work.

Author Contributions: Conceptualization: Minh T. Nguyen and Thuong TK. Nguyen; Methodology: Thuong TK. Nguyen; Software: Minh T. Nguyen; Validation: Minh T. Nguyen and Thuong TK. Nguyen; Formal analysis: Minh T. Nguyen; Investigation: Thuong TK. Nguyen; Resources: Thuong TK. Nguyen; Data curation: Minh T. Nguyen; Writing—original draft preparation: Thuong TK. Nguyen; Writing—review and editing: Minh T. Nguyen; Visualization: Minh T. Nguyen; Supervision: Thuong TK. Nguyen.

Funding: This research received no external funding.

Acknowledgments: The author would like to thank Thai Nguyen University of Technology, Viet Nam.

Conflicts of Interest: The authors declare no conflict of interest

References

[1] A. F. AlMulhim, "The impact of administrative management and information technology on e-government success: The mediating role of knowledge management practices," *Cogent Bus. Manag.*, vol. 10, no. 1, Dec. 2023, doi: 10.1080/23311975.2023.2202030.

[2] M. T. Nguyen, L. H. Truong, and T. T. H. Le, "Video Surveillance Processing Algorithms utilizing Artificial Intelligent (AI) for Unmanned Autonomous Vehicles (UAVs)," *MethodsX*, vol. 8, p. 101472, 2021, doi: 10.1016/j.mex.2021.101472.

[3] Z. Huang, C. Xiong, H. Ni, D. Wang, Y. Tao, and T. Sun, "Standard Evolution of 5G-Advanced and Future Mobile Network for Extended Reality and Metaverse," *IEEE Internet Things Mag.*, vol. 6, no. 1, pp. 20–25, Mar. 2023, doi: 10.1109/IOTM.001.2200261.

[4] M. T. Nguyen, L. H. Truong, T. T. Tran, and C.-F. Chien, "Artificial intelligence based data processing algorithm for video surveillance to empower industry 3.5," *Comput. Ind. Eng.*, vol. 148, p. 106671, Oct. 2020, doi: 10.1016/j.cie.2020.106671.

[5] T. T. Nguyen, M. T. Nguyen, and H. T. Tran, "Artificial intelligent based teaching and learning approaches: A comprehensive review," *Int. J. Eval. Res. Educ.*, vol. 12, no. 4, p. 2387, Dec. 2023, doi: 10.11591/ijere.v12i4.26623.

[6] M. Garlinska, M. Osial, K. Proniewska, and A. Pregowska, "The Influence of Emerging Technologies on Distance Education," *Electronics*, vol. 12, no. 7, p. 1550, Mar. 2023, doi: 10.3390/electronics12071550.

[7] M. Grimus, "Emerging Technologies: Impacting Learning, Pedagogy and Curriculum Development," in *Emerging Technologies and Pedagogies in the Curriculum*, 2020, pp. 127–151. doi: 10.1007/978-981-15-0618-5_8.

[8] F. Martin, Y. Chen, R. L. Moore, and C. D. Westine, "Systematic review of adaptive learning research designs, context, strategies, and technologies from 2009 to 2018," *Educ. Technol. Res. Dev.*, vol. 68, no. 4, pp. 1903–1929, Aug. 2020, doi: 10.1007/s11423-020-09793-2.

[9] Y. Li, M. Kim, and J. Palkar, "Using emerging technologies to promote creativity in education: A systematic review," *Int. J. Educ. Res. Open*, vol. 3, p. 100177, 2022, doi: 10.1016/j.ijedro.2022.100177.

[10] B. K. Jesiek, M. Borrego, and K. Beddoes, "Advancing global capacity for engineering education research: relating research to practice, policy and industry," *Eur. J. Eng. Educ.*, vol. 35, no. 2, pp. 117–134, May 2010, doi: 10.1080/03043791003596928.

[11] L. Jin and K. Forrest, "Fostering creativity via technoself enhanced learning with emerging technologies," in *11th International Conference on Education and New Learning Technologies*, Jul. 2019, pp. 3247–3254. doi: 10.21125/edulearn.2019.0872.

[12] T. M. Cavanagh and C. Kiersch, "Using commonly-available technologies to create online multimedia lessons through the application of the Cognitive Theory of Multimedia Learning," *Educ. Technol. Res. Dev.*, vol. 71, no. 3, pp. 1033–1053, Jun. 2023, doi: 10.1007/s11423-022-10181-1.

[13] Y. Limani, E. Hajrizi, L. Stapleton, and M. Retkoceri, "Digital Transformation Readiness in Higher Education Institutions (HEI): The Case of Kosovo," *IFAC-PapersOnLine*, vol. 52, no. 25, pp. 52–57, 2019, doi: 10.1016/j.ifacol.2019.12.445.

[14] A. Almufarreh and M. Arshad, "Promising Emerging Technologies for Teaching and Learning: Recent Developments and Future Challenges," *Sustainability*, vol. 15, no. 8, p. 6917, Apr. 2023, doi: 10.3390/su15086917.

[15] Z. Huang, E. Kougianos, X. Ge, S. Wang, P. D. Chen, and L. Cai, "A Systematic Interdisciplinary Engineering and Technology Model Using Cutting-Edge Technologies for STEM Education," *IEEE Trans. Educ.*, vol. 64, no. 4, pp. 390–397, Nov. 2021, doi: 10.1109/TE.2021.3062153.

[16] V. Bozalek, D. Ng'ambi, and D. Gachago, "Transforming teaching with emerging technologies: implications for higher education institutions," *South African J. High. Educ.*, vol. 27, no. 2, pp. 419–436, 2013, doi: 10.10520/EJC144269.

[17] M. Rizvi, "Investigating AI-Powered Tutoring Systems that Adapt to Individual Student Needs, Providing Personalized Guidance and Assessments," *Eurasia Proc. Educ. Soc. Sci.*, vol. 31, pp. 67–73, Oct. 2023, doi: 10.55549/epess.1381518.

[18] A. Chochia and E. G. N. Sicat, "Ethics and Modern Technologies: Example of Navigating Children's Rights in an AI-Powered Learning Environment," in *Digital Development of the European Union*, Cham: Springer International Publishing, 2023, pp. 129–141. doi: 10.1007/978-3-031-27312-4_9.

[19] J. C. Paiva, J. P. Leal, and Á. Figueira, "Automated Assessment in Computer Science Education: A State-of-the-Art Review," *ACM Trans. Comput. Educ.*, vol. 22, no. 3, pp. 1–40, Sep. 2022, doi: 10.1145/3513140.

[20] N. A. A. Tuah, "Is Online Assessment in Higher Education Institutions during COVID-19 Pandemic Reliable?," *Siriraj Med. J.*, vol. 73, no. 1, pp. 61–68, Dec. 2020, doi: 10.33192/Smj.2021.09.

[21] A. Gupta, B. D. Mazumdar, M. Mishra, P. P. Shinde, S. Srivastava, and A. Deepak, "Role of cloud computing in management and education," *Mater. Today Proc.*, vol. 80, pp. 3726–3729, 2023, doi: 10.1016/j.matpr.2021.07.370.

[22] J. Mao, "Social media for learning: A mixed methods study on high school students' technology affordances and perspectives," *Comput. Human Behav.*, vol. 33, pp. 213–223, Apr. 2014, doi: 10.1016/j.chb.2014.01.002.

[23] M. L. Bernacki, J. A. Greene, and H. Crompton, "Mobile technology, learning, and achievement: Advances in understanding and measuring the role of mobile technology in education," *Contemp. Educ. Psychol.*, vol. 60, p. 101827, Jan. 2020, doi: 10.1016/j.cedpsych.2019.101827.

[24] S. L. Chu, B. M. Garcia, and N. Rani, "Research on wearable technologies for learning: a systematic review," *Front. Educ.*, vol. 8, Nov. 2023, doi: 10.3389/feduc.2023.1270389.

[25] Z. Zainuddin, S. K. W. Chu, M. Shujahat, and C. J. Perera, "The impact of gamification on learning and instruction: A systematic review of empirical evidence," *Educ. Res. Rev.*, vol. 30, p. 100326, Jun. 2020, doi: 10.1016/j.edurev.2020.100326.

[26] M. Decuypere, E. Grimaldi, and P. Landri, "Introduction: Critical studies of digital education platforms," *Crit. Stud. Educ.*, vol. 62, no. 1, pp. 1–16, Jan. 2021, doi: 10.1080/17508487.2020.1866050.

[27] B. Williamson, "Making markets through digital platforms: Pearson, edu-business, and the (e)valuation of higher education," *Crit. Stud. Educ.*, vol. 62, no. 1, pp. 50–66, Jan. 2021, doi: 10.1080/17508487.2020.1737556.

[28] S. Wang *et al.*, "When adaptive learning is effective learning: comparison of an adaptive learning system to teacher-led instruction," *Interact. Learn. Environ.*, vol. 31, no. 2, pp. 793–803, Feb. 2023, doi: 10.1080/10494820.2020.1808794.

[29] R. Sun, Y. J. Wu, and Q. Cai, "The effect of a virtual reality learning environment on learners' spatial ability," *Virtual Real.*, vol. 23, no. 4, pp. 385–398, Dec. 2019, doi: 10.1007/s10055-018-0355-2.

[30] P. Smutny, "Learning with virtual reality: a market analysis of educational and training applications," *Interact. Learn. Environ.*, vol. 31, no. 10, pp. 6133–6146, Dec. 2023, doi: 10.1080/10494820.2022.2028856.

[31] C. Prisille and M. Ellerbrake, "Virtual Reality (VR) and Geography Education: Potentials of 360° 'Experiences' in Secondary Schools," in *Modern Approaches to the Visualization of Landscapes*, 2020, pp. 321–332. doi: 10.1007/978-3-658-30956-5_18.

[32] F. M. Dinis, A. S. Guimaraes, B. R. Carvalho, and J. P. Pocas Martins, "Development of virtual reality game-based interfaces for civil engineering education," in *2017 IEEE Global Engineering Education Conference (EDUCON)*, Apr. 2017, pp. 1195–1202. doi: 10.1109/EDUCON.2017.7943000.

[33] G. Zhao, M. Fan, Y. Yuan, F. Zhao, and H. Huang, "The comparison of teaching efficiency between virtual reality and traditional education in medical education: a systematic review and meta-analysis," *Ann. Transl. Med.*, vol. 9, no. 3, pp. 252–252, Feb. 2021, doi: 10.21037/atm-20-2785.

[34] J. Buchner and M. Kerres, "Media comparison studies dominate comparative research on augmented reality in education," *Comput. Educ.*, vol. 195, p. 104711, Apr. 2023, doi: 10.1016/j.compedu.2022.104711.

[35] S. Jiang, B. Moyle, R. Yung, L. Tao, and N. Scott, "Augmented reality and the enhancement of memorable tourism experiences at heritage sites," *Curr. Issues Tour.*, vol. 26, no. 2, pp. 242–257, Jan. 2023, doi: 10.1080/13683500.2022.2026303.

[36] H. Altinpulluk, "Determining the trends of using augmented reality in education between 2006-2016," *Educ. Inf. Technol.*, vol. 24, no. 2, pp. 1089–1114, Mar. 2019, doi: 10.1007/s10639-018-9806-3.

[37] M. Akçayır and G. Akçayır, "Advantages and challenges associated with augmented reality for education: A systematic review of the literature," *Educ. Res. Rev.*, vol. 20, pp. 1–11, Feb. 2017, doi: 10.1016/j.edurev.2016.11.002.

[38] C. Avila-Garzon, J. Bacca-Acosta, Kinshuk, J. Duarte, and J. Betancourt, "Augmented Reality in Education: An Overview of Twenty-Five Years of Research," *Contemp. Educ. Technol.*, vol. 13, no. 3, p. ep302, Apr. 2021, doi: 10.30935/cedtech/10865.

[39] B. Williamson, "The Social life of AI in Education," *Int. J. Artif. Intell. Educ.*, vol. 34, no. 1, pp. 97–104, Mar. 2024, doi: 10.1007/s40593-023-00342-5.
[40] F. Pedró, M. Subosa, A. Rivas, and P. Valverde, "Artificial intelligence in education: challenges and opportunities for sustainable development," 2019. [Online]. Available: https://unesdoc.unesco.org/ark:/48223/pf0000366994
[41] L. K. Fryer, M. Ainley, A. Thompson, A. Gibson, and Z. Sherlock, "Stimulating and sustaining interest in a language course: An experimental comparison of Chatbot and Human task partners," *Comput. Human Behav.*, vol. 75, pp. 461–468, Oct. 2017, doi: 10.1016/j.chb.2017.05.045.
[42] C. Walkington and M. L. Bernacki, "Personalizing Algebra to Students' Individual Interests in an Intelligent Tutoring System: Moderators of Impact," *Int. J. Artif. Intell. Educ.*, vol. 29, no. 1, pp. 58–88, Mar. 2019, doi: 10.1007/s40593-018-0168-1.
[43] M. T. Nguyen, "An energy-efficient framework for multimedia data routing in Internet of Things (IoTs)," *EAI Endorsed Trans. Ind. Networks Intell. Syst.*, vol. 6, no. 19, p. 159120, Jun. 2019, doi: 10.4108/eai.13-6-2019.159120.
[44] S. K. Shrestha and F. Furqan, "IoT for Smart Learning/Education," in *2020 5th International Conference on Innovative Technologies in Intelligent Systems and Industrial Applications (CITISIA)*, Nov. 2020, pp. 1–7. doi: 10.1109/CITISIA50690.2020.9371774.
[45] M. Kassab, J. DeFranco, and P. Laplante, "A systematic literature review on Internet of things in education: Benefits and challenges," *J. Comput. Assist. Learn.*, vol. 36, no. 2, pp. 115–127, Apr. 2020, doi: 10.1111/jcal.12383.
[46] A. Majeed and M. Ali, "How Internet-of-Things (IoT) making the university campuses smart? QA higher education (QAHE) perspective," in *2018 IEEE 8th Annual Computing and Communication Workshop and Conference (CCWC)*, Jan. 2018, pp. 646–648. doi: 10.1109/CCWC.2018.8301774.
[47] Y. Ding, Y. Li, and L. Cheng, "Application of Internet of Things and Virtual Reality Technology in College Physical Education," *IEEE Access*, vol. 8, pp. 96065–96074, 2020, doi: 10.1109/ACCESS.2020.2992283.
[48] H. Zhang, J. Zhang, X. Yin, K. Zhou, Z. Pan, and A. El Rhalibi, "Cloud-to-end Rendering and Storage Management for Virtual Reality in Experimental Education," *Virtual Real. Intell. Hardw.*, vol. 2, no. 4, pp. 368–380, Aug. 2020, doi: 10.1016/j.vrih.2020.07.001.
[49] B. Morschheuser and J. Hamari, "The Gamification of Work: Lessons From Crowdsourcing," *J. Manag. Inq.*, vol. 28, no. 2, pp. 145–148, Apr. 2019, doi: 10.1177/1056492618790921.
[50] S. Hakak *et al.*, "Cloud-assisted gamification for education and learning – Recent advances and challenges," *Comput. Electr. Eng.*, vol. 74, pp. 22–34, Mar. 2019, doi: 10.1016/j.compeleceng.2019.01.002.
[51] W. G. Alghabban, R. M. Salama, and A. H. Altalhi, "Mobile cloud computing: An effective multimodal interface tool for students with dyslexia," *Comput. Human Behav.*, vol. 75, pp. 160–166, Oct. 2017, doi: 10.1016/j.chb.2017.05.014.
[52] S. M. Rajagopal, S. M., and R. Buyya, "FedSDM: Federated learning based smart decision making module for ECG data in IoT integrated Edge–Fog–Cloud computing environments," *Internet of Things*, vol. 22, p. 100784, Jul. 2023, doi: 10.1016/j.iot.2023.100784.