EMERGING TECHNOLOGIES IMPLEMENTING ICT AND AI FOR SMART LEARNING: A SURVEY

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Abstract:
This paper explores the literature review offers valuable insights into integrating emerging technologies into smart learning, including Information and Communication Technology (ICT) and Artificial Intelligence (AI). This rapidly evolving field has significant implications for education. Studies emphasize VR's ability to provide immersive learning experiences, allowing students to explore complex environments and scenarios and enhancing engagement and comprehension in subjects like history, science, and medicine. AR overlays digital information onto the real world, facilitating interactive learning and providing context-sensitive information and interactive elements to enhance student understanding. IoT in education involves interconnected devices that collect and share data. Literature reviews emphasize its role in creating smart classrooms that adapt to students' needs, improve resource management, and support remote learning. LMS platforms like Moodle and Canvas are central to ICT in education, providing a structured environment for course management, content delivery, and communication. Research shows that LMS improves resource accessibility, student engagement, and administrative efficiency.

Keywords: Artificial Intelligence, Communication Technology, IoT, Moodle and Canvas

1. INTRODUCTION

Smart learning, a key player in the contemporary era of emerging technologies, is heavily influenced by Information and Communication Technology (ICT) and Artificial Intelligence (AI). These advanced technologies are utilized to enhance the learning experience, making it more personalized, interactive, and efficient. AI algorithms, data analytics, and machine learning are the backbone of smart learning platforms, enabling them to adapt to individual learning styles and preferences and provide customized content and feedback. The significance of smart learning is in its ability to cater to the diverse needs of learners, offering flexibility in terms of pacing, content delivery, and assessment methods. It promotes self-directed learning, critical thinking, and problem-solving skills by engaging students in interactive activities and simulations. Additionally, smart learning facilitates continuous feedback and assessment, enabling educators to track student progress in real time and provide targeted interventions when needed. Moreover, given the rapid advancements in ICT and AI, smart learning equips learners with the digital skills and competencies required to thrive in the digital age, a responsibility that educators must take seriously. It prepares individuals to navigate complex information landscapes, utilize digital tools effectively, and adapt to changing technological environments. By integrating smart learning practices into education, institutions can better prepare students for future challenges and opportunities in the digital era.

2. EMERGING TECHNOLOGIES

This section provides an overview of the emerging technologies essential for smart learning, as they are transforming traditional education methods and enhancing the learning experience. These technologies include artificial intelligence, virtual and augmented reality, gamification, and adaptive learning systems. Palanivel [2] shifted from traditional to smart education systems, which require technologies like IoT, augmented reality, AI, blockchain, cloud computing, mobile internet, and deep learning. The study explores how these technologies can create pervasive, intelligent, and intuitive learning environments. These innovations aim to revolutionize educational models by improving teaching, collaboration, and real-time learning experiences. They establish more effective and efficient learning ecosystems integrating interactive pedagogy, learning analytics, and smart teaching for a comprehensive smart education solution. Almufarreh and Arshad [5] examined how AI, IoT, VR, and AR transform education. It outlines the advantages of each, such as improved communication, enhanced engagement, and personalized learning. The study highlights the importance of robust governance and strategic planning for educational institutions to leverage these new technologies effectively. Its findings underscore the capacity of these technologies to update teaching strategies and create collaborative, interactive learning environments, which are essential for addressing current and future educational challenges. Siraj et al. [14] emphasized the transformative potential of artificial intelligence (AI) in higher education and emphasized AI's critical role in computer education. Utilizing supervised machine learning and Bloom's taxonomy, it addresses the increasing demand for ICT adoption to enhance Course Learning Outcomes (CLO) in the context of the COVID-19 pandemic. The ICT framework produced promising results, with an accuracy rate of 83%, which were validated by statistical analysis and self-assessment surveys. It underlines the importance of aligning educational reform with AI capabilities to ensure ongoing quality enhancement and cybersecurity protocols to safeguard academic integrity in future intelligent learning environments.

Kotsiopoulos et al. [27] assert that the use of Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL) in production underpins a paradigm-shifting technological advance known as Industry 4.0. The study focuses on efficiency and effectiveness, mainly using ML, DL algorithms, and AI in smart grids. These models will be validated in future predictive maintenance and anomaly detection projects, such as SDN-microSENSE and SPEAR. Additionally, Leoste et al. [44] underscore the potential and strengths of emerging technologies (ETs), such as robots and artificial intelligence (AI), in higher education, highlighting their potential revolutionary impact. Drawing on real data from essays, the study examines the positive attitudes that university instructors have toward the integration of ETs. However, it also acknowledges the lack of discussion on potential adverse effects. To ensure the sustainable integration of ETs into teaching practices, the study emphasizes the need for comprehensive training and broad teacher engagement.

Salinas et al. [46] introduced the Incorporation of Emerging Technologies in the Classroom (MIETC) paradigm to enhance instructional methods. It focuses on technology-mediated, student-centered learning and emphasizes the importance of motivation and perceived utility for effective use. The model encourages dialogical communication and pedagogical flexibility to support dynamic teaching strategies. Okwu and Nsirim [47] highlighted the importance of ICT skills for librarians in developing technology in Rivers State, Nigeria, university libraries. Their correlational study revealed that proficient ICT abilities enhance information management procedures. Despite this, the survey found that librarians use ICT minimally despite its significance. To strengthen the delivery of library services, it is recommended to focus on continuing education to improve fundamental computer, information retrieval, and web 2.0 skills. Chanaa and Faddouli [55] emphasized the challenges in processing the vast data produced in e-learning through traditional manual techniques. They suggested a customized e-learning approach that combines process mining with deep learning to customize learning materials to individual learner preferences, emphasizing the importance of using deep learning to automate data handling and improve the effectiveness of intelligent e-learning systems. Peng et al. [58] combined customized learning with adaptive learning to create a customized adaptive learning framework. This framework focuses on customizing learning experiences to meet individual learner requirements, promoting competency-based advancement, and utilizing learner profiles. The model aims to enhance educational practices and advance educational technology research and applications by tailoring learning experiences to the needs of each learner.

Uskov et al. [72] focused on collecting, analyzing, and assessing educational data from various sources. Smart learning analytics aims to enhance academic institutions' ability to organize, self-learn, sense, inference, and predict. The study presents its findings on conceptual modeling and the development of intelligent learning analytics systems in a publication from Bradley University's InterLabs Study Institute. Khlaif and Farid [76] explored the pros and cons of the Smart Learning initiative in 30 Palestinian public schools using qualitative research methods. Their research highlights positive student and curriculum impacts while identifying teacher responsibilities and school management changes. To enhance smart learning efforts in Palestine, the Ministry of Education and Higher Education (MOEHE) should further improve educational materials and guidelines, as recommended by the findings, which also underscore the potential for local support.

3. INDUSTRY 4.0

Industry 4.0 pertains to the automation and data exchange trend in manufacturing technologies. It encompasses cyber-physical systems, the Internet of Things, cloud computing, and cognitive computing. The relevance of Industry 4.0 to smart learning in education lies in how technology can enhance and transform the learning process. Smart learning in education leverages technologies such as artificial intelligence, machine learning, big data analytics, and virtual reality to personalize learning experiences, improve student engagement, and provide real-time feedback to students and teachers. Furthermore, integrating Industry 4.0 technologies with smart learning can revolutionize traditional teaching methods, making education more personalized, efficient, and effective for students and educators. Salem and Nikitaeva [22] demonstrated the increasing importance of artificial intelligence (AI) in improving machine learning and computational intelligence (CI) approaches for smart digital education. It explores CI paradigms to enhance the efficacy and efficiency of smart teaching systems, such as ontological engineering and case-based reasoning. However, creating intelligent e-learning systems presents multidisciplinary problems that require advancements in science and technology. To enhance online education and training procedures while addressing cloud integration issues, future efforts should focus on integrating AI, machine learning, knowledge engineering, and IoT to develop reliable web-based e-learning systems.

4. SMART LEARNING

A literature review on smart learning is important for several reasons. This section provides a comprehensive understanding of existing knowledge and research on smart learning. By reviewing previous studies, theories, and findings, researchers can identify gaps in the current knowledge and build upon existing research. Penalvo et al. [3] emphasized the increasing importance of using artificial intelligence in education, particularly in light of the COVID-19 pandemic's impact on international educational institutions. This special issue highlights the innovative developments in educational technology that utilize AI, big data, machine learning, and deep learning. These technologies aim to improve mixed and online learning settings by reducing teachers' workload without replacing them. Transitioning to SaaS, PaaS, and IaaS cloud services is essential as it lowers IT expenses and enhances accessibility and user experience in learning environments. IoT technologies also accelerate the digital revolution in education, leading to smart campuses and creative educational opportunities. Tabuenca et al. [4] examined using an artificial intelligence of things (AIoT) system in three case studies in education. The first example involves tracking plant health in environmental activities in elementary education using an intelligent dashboard. The second study analyzes environmental elements to enhance learning environments in higher education. In the third example, plants detect human presence in educational settings.

Khan and Alotaibi [10] have improved teaching methods, and this paper systematically examines various applications of soft computing in m- and e-learning environments. Learning environments based on Artificial Intelligence (AI) are designed to provide personalized learning experiences and enhance the abilities of both instructors and students through the integration of AI models such as ANN, RNN, and CNN. Singh and Miah [11] investigated the changes in the field of smart education and introduced the Students Career Assistance System (SCAS) as an innovative approach. They synthesized findings from a comprehensive literature review, emphasizing smart education's rapid developments and technological foundations. SCAS is a mobile-based solution that integrates professional development and student learning, addressing the demands of modern education for flexibility and usability.

Dehbi et al. [17] discussed the innovative potential of integrating cloud computing, IoT, and AI into online learning environments. They proposed an IoT-based architecture and Smart Learning Environment model that introduces Online Exam Management, Automated Paper Correction, and "Smart Evaluation" for online tests. Their study compared IoT-enabled exam management with traditional methods using the Mann-Whitney U test, showing statistically significant improvements. This invention ensures fairness and consistency while also streamlining assessment processes. Future developments aim to enhance fraud detection capabilities and security using AI and data mining across various learning contexts. Aldulaimi et al. [18] emphasized the necessity of adapting teaching strategies to meet the needs of modern students, particularly in online learning. They suggested integrating Smart Learning Environments (SLE) into legislative frameworks, school culture, and stakeholder cooperation before implementing them in Iraqi high schools. The research highlighted the challenges of transforming educational settings.

Lorenzo and Gallon [23] raised the issue of pedagogy in the digital age, addressing changes in social interaction and cognition through artificial intelligence (AI) and intelligent educational agents. International organizations such as UNESCO and the OECD advocate for natural learning concepts to meet sustainable development objectives. Educators must adopt a humanistic approach as they navigate the paradigm shift of Industry 4.0 toward personalized, AI-driven learning environments. Dehbi et al. [17] discussed the innovative potential of integrating cloud computing, IoT, and AI into online learning environments. They proposed an IoT-based architecture and Smart Learning Environment model that introduces Online Exam Management, Automated Paper Correction, and "Smart Evaluation" for online tests. Their study compared IoT-enabled exam management with traditional methods using the Mann-Whitney U test, showing statistically significant improvements.

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Gallon [23] addressed social interaction and cognition changes in the digital age, focusing on using artificial intelligence (AI) and intelligent educational agents in pedagogy. International organizations such as UNESCO and the OECD advocate for natural learning concepts to meet sustainable development objectives. Educators must adopt a humanistic approach to navigate the paradigm shift of Industry 4.0, towards personalized, AI-driven learning environments. Pedagogy must adapt by rethinking educational roles, effectively integrating emerging technology, and promoting interactive, collaborative learning experiences to prepare students for a future of coexistence between humans and machines. Sulkowski et al. [25] examined how higher education changes in response to Economy 5.0 and Society 5.0, emphasizing the move toward remote and digital learning. It stresses the importance of including technology to fulfill upcoming economic needs and enhance the personalization and flexibility of education. However, this shift faces obstacles such as the necessity for extensive institutional modifications, teacher duties in a digital age, and technology adaptation. The suggested approach provides a roadmap for colleges to equip students with marketable skills for future career environments.

Dinara et al. [41] explored the crucial role of EFL instructors in smart learning environments (SLEs), using educational technology to customize instruction, modify evaluations, and establish real-world learning environments. SLEs aim to incorporate real-world experiences into the classroom to improve student engagement and prepare them for professions and lifelong learning. However, to truly modernize education, more than technology is required.

Ha and Lee [43] highlighted the importance of considering primary teachers' perspectives when creating effective smart learning environments. Positive attitudes toward smart learning, ICT competency, and instructors' educational views were correlated. The findings emphasized the importance of educators' strong ICT competencies and student-centered values for a positive view on using technology in education.

Tabuenca et al. [59] note that advancements in cloud computing and mobile devices have increased the development of Sensor-based learning environments (SLEs). However, there is a lack of consensus in defining SLEs in the educational technology literature, which hinders their clarity and usability. This systematic literature review (SLR) outlines the essential functions of SLEs – sensing, analyzing, and reacting – and examines their technical foundations and capabilities. In another study, Ouf et al. [60] explored the impact of incorporating virtual reality (VR) in higher education, focusing on how technology could enhance learning outcomes and student engagement. VR offers immersive experiences that simulate real-world environments, thereby enhancing the accessibility and interactivity of complex subjects. However, challenges such as cost, the need for specialized instructor skills, and technical readiness hinder widespread implementation

In a study by Wijanarko et al. [62], the authors investigated the creation of a system using textual data from forums and an online learning library at Bina Nusantara. The results, confirmed by statistical analysis and a Naive Bayes classifier, revealed significant differences in cognitive taxonomy levels between discussion forum topics and learning objectives. In another study, Sharma et al. [63] explored how online learning replaces traditional classroom instruction by leveraging current IT developments to provide access from anywhere at any time. The study suggests an EEG-based method to track and evaluate attention levels to address the challenge of maintaining learners' attention in online environments, mainly focusing on MOOCs. The system aims to enhance learning effectiveness by providing real-time feedback. Future improvements may involve extending EEG applications into other domains and utilizing machine learning for personalized video lecture recommendations.

Wang et al. [64] utilized a comprehensive framework that integrates social presence, TAM, and learning satisfaction to examine the factors affecting active online learning in smart learning environments. The study emphasizes the benefits of intelligent interaction, real-time feedback, and customization for active online learning. While social isolation and learning complaints hinder engagement, perceived utility and ease of use enhance it. Slotanpoor and Yavari [65] presented CoALA, an IoT-based system to improve the efficiency of Smart Learning Analytics (LA) in education. CoALA combines data gathering, profiling, analytics, and intelligent feedback to address LA's scalability, performance, and efficiency concerns, offering a strong solution for educational settings. Finally, Kindi and Khanjari [79] examined how information and communication technology (ICT) has revolutionized learning settings and emphasized the need for intelligent educational systems in higher education. The study proposed integrating smart technology with conventional Learning Management Systems (LMSs) to create a personalized Smart Learning Management System (SLMS). In a study by Shi et al. [68], an enhanced approach called CIAP (Conceptual, Intelligent, Action, and Process levels) was presented for college students in an innovative learning environment. This approach suggests using blended learning focusing on specialized subjects, intelligent learning environments, interactive exercises, creative learning procedures, prompt feedback, and well-designed assessments.

Sood and Singh [71] addressed the issue of engineering graduates' unemployment by proposing a clever learning framework that utilizes cloud computing. This framework evaluates students' employability early in their academic careers using data monitoring, classification algorithms, and e-learning to improve skill sets. Budhrani et al. [74] conducted a descriptive content study of Korean educational academics' definitions and conceptions of "smart learning" between 2010 and 2018. The study analyzed 37 papers from RISS, Korean Citation Index, and Google Scholar to identify essential components, including the learner, pedagogy, and the smart learning environment.

4.1 Smart Learning Education

Smart learning in education refers to using advanced technologies and data-driven approaches to enhance teaching and learning processes. Its goal is to create more personalized, efficient, and effective educational experiences. Demir [7] explains that these technologies are structured in a layered architecture and contribute to developing specific smart education courses. This has led to establishing a Smart Education Framework following extensive research. A literature study has validated the framework for its ability to characterize current smart education systems. Despite the challenges of ICT adoption in education, this framework is an important reference for future system designs. To realize the idea of smart education, the framework emphasizes the need for strong integration and innovative learning methodologies, including customized, blended, and collaborative learning in conjunction with advancing technology. Future studies aim to expand the framework's use in various learning environments, including BYOD/BYOT paradigms.

Adel [16] conducted a comprehensive analysis using data from 78 sources to demonstrate how innovative technologies are integrated into smart education for Industry 5.0. The analysis highlights how AI, machine learning, robots, AR/VR, and smart education can help prepare a workforce for the future. In addition to focusing on individualized and immersive learning experiences, it addresses issues such as AI biases, digital equity, and data privacy. To facilitate the creation and implementation of successful smart education solutions, the paper stresses the importance of collaboration between educators, legislators, and business leaders. Attention is drawn to new trends and research possibilities to ensure that education remains relevant and effective in the face of Industry 5.0's demands. Wang and Kwok [32] emphasized adaptability and efficacy by incorporating a variety of ideas, such as collaborative learning, adaptive learning, and customized learning. Smart learning environments continuously evolve due to constant breakthroughs in pedagogical ideas and technology. This editorial outline these ideas and highlights the latest smart learning research advancements. It emphasizes the importance of investigating design frameworks, educational theories, learner behaviors, assessment methods, and learning outcomes assessments further to improve smart learning settings and practices through future research.

In a study by Spector et al. [61], researchers from various fields, including learning sciences, computer science, AI, educational technology, and neuroscience, collaborated on presentations about next-generation artificial intelligence and computational neuropsychology. These presentations explored the impact of cutting-edge learning technology on education, its associated challenges, and society's future demands on education. The synthesis of their findings highlighted the common principles prioritizing the right to education and the need for changes in educational systems. However, differences were observed in adopting technologies such as MOOCs, affective computing, cloud-based resources, and advances in artificial intelligence. Chen et al.

Finally, Uskov et al. [75] focused on learning analytics, describing the creation of Bradley University's InterLabs smart learning analytics system. This system is designed to enhance academic performance within the Computer Science and Information Systems curriculum by incorporating ideas from the Partner's Analytics Ascendancy Model and using various types of analytics, including descriptive, diagnostic, predictive, and prescriptive analytics.

4.2 Smart Learning Environment

This section discusses integrating technology and data to create adaptive, efficient, and engaging educational experiences in a smart learning environment. The first study focuses on using distributed ledger technology (DLT) in underdeveloped nations' traditional educational systems and emphasizes the factors influencing the adoption of blockchain for e-learning. The second study emphasizes integrating ICT to enhance teacher-student relationships and positive classroom dynamics. It introduces a coding system, OOTIAS, to examine interaction levels in smart classrooms with digital resources and mobile devices. The third study explores the potential effects of AI on Serbian and Romanian educational systems, highlighting both the prospects and the problems. It discusses the promises and obstacles of AI in improving educational quality. The final study addresses the shortcomings of conventional and online learning approaches and promotes creating a SMART learning environment specifically designed for cybersecurity professionals in Mauritius. It utilizes backpropagation algorithms and artificial neural networks to tailor learning materials to each learner's specific requirements and past knowledge, aiming to enhance ongoing cybersecurity professional development and support the national goals of economic growth through enhanced skills development in ICT sectors.

Hu et al. [26] emphasized using AI-driven learning analytics dashboards in smart learning environments (SLEs) to improve learning outcomes through precision teaching. By utilizing technology, it seeks to maximize students' learning behaviors and results. However, the study's modest sample size has limitations and indicates the need for larger-scale research to confirm findings in various educational contexts. Future studies should examine other variables affecting educational results to increase the efficiency of AI-supported SLEs in changing conventional classrooms. Agbo et al. [28] provided bibliometric analysis to provide a thorough overview of smart learning environments, emphasizing themes, productivity, and trends in academic literature. It highlights the dominance of the United States in research production while identifying influential publications and eminent professors.

Cheung et al. [29] highlighted how technology merges flexibility, customization, and engagement in smart learning environments (SLEs) to change education. However, because of new ideas and changing definitions, the definition of SLEs is still ambiguous. Practical applications differ even though much research has been produced and adopted in postsecondary education. One of the limitations is the difficulty of uniformly integrating various pedagogical and technology components across educational situations. However, continuing research seeks to improve learning outcomes using immersive technology and adaptive systems, refining and implementing SLEs more successfully. Dron [30] highlighted the importance of defining smart learning settings and comparing them to less successful traditional ones. It makes the case that adaptive and perceptive participant interactions enhance learning in smart settings. These settings recognize the complexity of educational institutions and the necessity for holistic design, emphasizing successful learning over simple technology integration.

Katashi [31] highlighted the importance of having an advanced physical-digital learning environment to help students enhance their presentation and conversation skills. Interactive whiteboards and touch panel tables can make talks and digital poster presentations more effective, with features for data mining and digital poster creation to improve assessment skills. However, while initial assessment results are promising, challenges include smoothly integrating technology and the need for comprehensive validation through studies to demonstrate improvements in students' presentation abilities over time. Akour and Das [33] proposed a framework that combines advanced techniques such as gamification and animated tutorials for both on-campus and online learning in a post-pandemic education setting. Utilizing IoT and 5G technologies, this framework aims to provide a revolutionary learning experience accessible to a diverse range of global learners. Ilkou and Signer [34] introduced a smart learning environment that uses technology to identify and address each student's knowledge gaps by combining established learning routes with a knowledge graph. The primary aim is to enhance learning paths and assessment methods, particularly in mathematics teaching. This approach relies on customized learning paths and a comprehensive assessment pool, categorized according to knowledge requirements, to promote deep learning across various academic and professional settings. By offering technology-driven suggestions, educators gain effective tools to recognize and address their students' learning needs. Serban and Loan [35] proposed a new theory advocating for learner-centered instruction, with teachers serving as advisors. With the increasing popularity of remote learning and technological advancements, smart learning environments facilitated by e-learning platforms such as QLearn have become a crucial area of research.

Finogeev et al. [36] studied lifecycle management in intelligent learning environments to enhance specialized instruction. They achieved important results, including formalizing lifecycle models for educational components, synchronizing these models, integrating a smart environment for education convergence, and resolving difficulties related to specialized training. The system supports individualized learning pathways, combines platforms like Moodle and Alfresco, and updates instructional materials to match standards and corporate requirements. Hwang and Fu [37], designed to offer tailored and efficient learning experiences, have emerged due to the swift development of contemporary technology. They noted a notable increase in research in computer science, engineering, mathematics, and the social sciences in recent decades.

Important technology elements that improve capabilities include learning analytics, educational Big Data, and mobile technologies.

Zhao [38] emphasized encouraging student creativity in intelligent learning environments by reviewing the literature and conducting empirical research. A quasi-experimental study was conducted to assess the model's influence on students' creativity, showing a favorable impact on measures of creativity such as originality, fluency, and adaptability. However, the study is limited by its small-scale experimental scope and the need for more extensive validation across larger samples. Future research will focus on improving the model in various smart learning environments to enhance the efficacy of creative training.

Deev and Finogeev [39] underscored the importance of using a convergent learning model on an open educational platform to provide specialized training effectively. The techniques center on proactive management, using technologies that facilitate competence clustering, data-driven analysis, and automated resource adaption for education. The study highlights the practical restriction of needing thorough validation in general educational situations. Yu et al. [42] highlighted the importance of efficient ways to assess how teachers behave in real-world classroom settings in smart learning environments. It presents lag sequence analysis (LSA) as a cutting-edge method for identifying different teaching styles within learning analytics (LA). However, LSA primarily uses quantitative analysis, and future studies might benefit from combining observational and interview-based mixed methodologies. Freigang et al. [57] examined how the Internet of Things (IoT) and Smart Learning Environments (SLEs) are integrated, focusing on an interdisciplinary approach that combines computer science, architecture, and education.

Zhuang et al. [66] studied learning environments in smart cities, focusing on lifelong and global learning outside traditional educational settings. The study, conducted in 68 locations, examined the connections between job, school, family, community, and museum environments. It found significant relationships between schools, communities, and museums; families, workplaces, and museums; and communities, museums, families, and schools. The research highlights the museum as a public area that connects these different environments. Dai et al. [69] explored the use of information and communication technology (ICT) to transform higher education settings into smart learning spaces, focusing on the benefits and challenges of personalized study. They evaluated CCNU's smart learning environments using AHP-FCE and GA-BP neural network algorithms. The findings indicate that AHP-FCE produces comprehensive but subjective results, while GA-BP simplifies evaluation and improves fault tolerance.

Santos [70] examined the often-overlooked role of psychomotor learning in tailored support within intelligent learning environments. The study emphasized the importance of mastering motor skills for various tasks, such as playing an instrument or performing surgery, within educational contexts. Akhrif et al. [83] highlighted the importance of collaborative learning in Smart Universities (SU) and Smart Cities (SC), promoting knowledge exchange and acquisition through apt interactions between students. The study emphasized the need for productive teamwork based on learner profiles and assessments, with plans involving the development of an ontological framework to define learners' responsibilities systematically. The aim is to improve participation and cooperation in learner teams, consequently maximizing the collaborative learning environment in intelligent learning environments.

5. INFORMATION COMMUNICATION TECHNOLOGY

A review of ICT for smart learning is essential to understand how technology shapes education and identify areas for improvement. Balaban et al. [1] urged educational institutions to use technology to enhance teaching and learning, accelerating the adoption of fully online or blended learning environments. Although there is a wealth of data from learning management systems, its potential to enhance educational efficiency remains largely untapped. This Special Issue explores innovative approaches to integrating robots, AI, and new technology to create more intelligent and inclusive learning environments. It includes a range of studies highlighting the current use of ICT in educational settings. Mazyuta et al. [12] studied the impact of smart technology on professional competence development and academic achievement, particularly in blended and remote learning contexts. The study underscores the need for further research into the effectiveness of smart technologies in various educational contexts and with commonly used tools. Understanding how digital technologies are shaping modern learning environments is crucial as these tools become increasingly prevalent in the classroom, supporting ongoing efforts to optimize the use of digital technology in higher education for efficient mass training.

Abersek and Flogie [24] underscored the urgency of adapting education to fit Industry 4.0 and Society 5.0 through intelligent learning systems and innovative ICT-based teaching techniques. It highlights the need for a comprehensive overhaul of the educational system to keep pace with evolving social demands. The papers in this Special Issue cover important issues such as dropout rates, personalized adaptive learning, ubiquitous learning in virtual institutions, skills alignment with market demands, and immersive robotics education. Despite implementation challenges and varying institutional readiness, these innovations aim to enhance educational effectiveness and responsiveness to contemporary social needs.

Goosen et al. [45] emphasized the qualitative use of developing technologies in open and distance learning (ODL) settings, particularly for information and communication technology modules. It draws attention to issues such as social isolation and physical distance, arguing that while technology in the classroom might help bridge these gaps, it may also require greater student effort. Ebad [48] highlighted the consistently high rates of ICT project failures in emerging nations, especially in Saudi Arabia (SA). It identifies key causes of project failures as critical management variables such as poor planning, resistance to change, and misinterpretation of user needs. Even with government support, financial and technological factors have a lesser impact. These findings are crucial for IT stakeholders seeking to improve project success in similar scenarios. Hermawan et al. [49] stressed that ICT integration in Indonesian education is essential for the country's competitiveness and economic progress despite numerous challenges. Progress is hindered by disparities in the quality of education, insufficient teacher competency, and infrastructure deficiencies outside of Java Island. In contrast, Singapore and Hong Kong are prime examples of sophisticated ICT integration due to their superior technology and highly skilled labour force.

Babu and Sridevi [50] have enhanced learning environments and promoted collaboration, making it crucial for global education. With its multitude of resources and opportunities for international connectivity, it transforms traditional teaching into student-centered learning. However, challenges persist with teacher readiness and institutional infrastructure when integrating ICT into higher education. Chatfield et al. [51] drew insights from 30 industry interviews across Europe to explore its adoption within the commercial ICT sector, focusing on healthy aging. Financial concerns indicate a lack of consensus and difficulties adopting Responsible Research and Innovation (RRI). Despite challenges, some businesses balance moral and financial objectives, suggesting that RRI can succeed in business. By identifying adoption catalysts and obstacles to corporate responsibility, the study supports practitioners and helps shape future RRI frameworks and tools. Gupta and Hayath[52] underscore the critical role of IT infrastructure in enhancing ICT-based online education systems globally. Effective implementation benefits students and teachers, improving accessibility, communication, and learning efficiency. However, shortcomings in IT infrastructure can impact the success of online learning. It is vital to bridge these gaps using advanced technology such as security software and high-speed internet. Aloini et al. [53] have found that various perspectives and approaches have gained popularity in Open Innovation (OI). They define inbound, outbound, and linked processes as the three primary modes of OI constituting a macro-process. Despite its momentum, limitations include its conceptual nature, lack of implementation validation, and limited generalizability.

Dahal et al. [54] examined how new ICT technologies may be integrated into online and remote learning to teach mathematics synchronously and asynchronously. Benefits like group projects and evaluations utilizing Google and Moodle applications are highlighted. Notwithstanding useful advantages, including a smaller workload and improved peer learning, the study's short duration and lack of thorough validation are its main drawbacks. All things considered, integrating these technologies promotes efficient virtual teaching and learning platforms, improving instruction quality in online environments. Tokareva et al. [56] enhanced student skills and needed greater instructor credentials; ICT implementation in higher education is essential nowadays. By conducting interviews with 218 students and 196 instructors, Moscow City University can assess the predictors of ICT readiness. It draws attention to issues including outdated schooling preferences and unequal access to the internet. Information and Communication Technology (ICT) can potentially improve academic achievement, although its influence on these outcomes is small.

6.ARTIFICIAL INTELLIGENCE

A comprehensive review of AI for smart learning provides a thorough understanding of how AI technologies are utilized in education, their impact on learning outcomes, and the challenges associated with their implementation. By examining current practices, assessing effectiveness, and exploring future directions, stakeholders can make informed decisions about adopting and improving AI solutions to enhance educational experiences. Jaiswal and Arun [6] discuss the shift from conventional teaching techniques to intelligent learning solutions by integrating Artificial Intelligence (AI) in Indian education. Through recommendation engines, adaptive tests, and customized learning, this change seeks to improve students' educational experiences. The report highlights AI's potential to transform education in developing nations like India by examining views from educational technology companies and AI specialists. Even with the advancements in customized education today, artificial intelligence (AI) technologies like facial recognition and natural language processing still have much-unexplored potential to improve teaching and learning. The potential for this combination of human instruction and AI skills to improve student growth and educational quality is enormous.

Toyokawa et al. [8] developed artificial intelligence (AI), which has the potential to improve inclusive education by meeting the demands of a wide range of learners. Using AI-driven Active Reading activities, the study conducted in Japan employed the Learning and Evidence Analysis Framework (LEAF) to assess learning patterns in a resource room setting. This study highlighted AI's difficulties and possible uses in supporting inclusive teaching methods. Parents and educators are excited about AI's potential to enhance tailored learning, but issues like gaining consent and encouraging data literacy still need to be addressed. Future work will focus on utilizing national data initiatives to create AI algorithms that support inclusive education methods that are both equitable and successful.

Hashim et al. [9] improved personalized learning environments by tailoring instructional strategies and content to the requirements of specific students. Malaysia, meanwhile, has trouble successfully incorporating AI into educational environments. The systematic literature review emphasized the need for flexibility in teaching methodologies and materials to maximize learning results, highlighting noteworthy advances in AI technology for individualized learning. Although there have been significant breakthroughs in higher education worldwide, more widespread implementation in Malaysia is necessary to equip students for collaborative workplaces. To stay competitive in the face of global economic developments, teaching methodologies must be adjusted to include AI while cultivating interpersonal skills. Malaysia should embrace these innovations in education.

Pikhart [13] needed artificial intelligence to be included in language learning applications, even though it is widely used in other domains like data mining and marketing. It criticizes existing applications for using antiquated algorithms and failing to use machine learning or deep learning capabilities. The competitiveness and sustainability of language education worldwide are threatened by this negligence, which stifles innovative thinking in education in the twenty-first century. The report urges IT firms to grasp this chance for increased profitability and asks universities to collaborate to create AI-enabled applications to improve teaching methods. Chen et al. [15] assessed the effects of AI on education by employing a literature analysis and a qualitative study methodology. Adopting AI in the administrative, instructional, and learning domains inside educational institutions was the major emphasis of the study. Analysis was done on how AI developed from simple computer systems to web-based platforms and embedded technologies like chatbots and robotics. The study emphasized how AI may improve student learning experiences, accuracy of grading, and instructional efficiency. AI has a significant impact on modern education, but it also has drawbacks. These include the necessity for constant modification to enable successful integration and ethical issues in educational contexts despite its revolutionary advantages.

Ahmad et al. [19] have enhanced learning accessibility and addressed contemporary issues. They have introduced breakthroughs that are revolutionizing instructional techniques and educational technology, such as intelligent tutoring systems (ITS), social robots (SR), and smart learning (SL). However, the industry must overcome the challenge of successfully integrating these technologies and ensuring their widespread acceptance. Statistical testing is essential to validate findings and fully understand AI's impact on education. The potential of artificial intelligence (AI) to overcome learning obstacles and enhance educational outcomes through various intelligent technologies beyond SL and ITS, such as virtual facilitators and learning analytics, makes its adoption in education inevitable despite some obstacles. Agbo et al. [20] have highlighted the contributions of Beijing Normal University and the United States by including significant publications, active researchers, and influential organizations in the field. Emerging themes such as digital storytelling and cutting-edge technologies like deep learning and blockchain are emphasized in the report, underlining their importance and development in creating intelligent learning environments. While the study provides researchers with valuable insights and guides future research directions, it acknowledges the need for further work to integrate these themes with smart learning environments effectively.

Mamani et al. [21] have emphasized the critical nature of integrating innovation and artificial intelligence (AI) into Kurdish educational institutions to promote contemporary education, which is essential for competitiveness in the global market. It underscores the importance of intelligent learning as a mediator in strengthening this connection. The results indicate an improvement in educational quality due to innovation and AI. However, narrowly focusing on AI and innovation without considering broader educational elements such as parental engagement and instructional materials is one of the limitations. Future studies should investigate broader educational processes and extrapolate findings beyond the Kurdish environment. Ge and Hu [78] have influenced the social and economic landscape, which has sparked interest in using these technologies in higher education administration. With its intelligent, individualized, and precise solutions, artificial intelligence presents a new way to modernize college and university teaching techniques. China is still in the early stages of implementing AI in education compared to other industries, despite significant progress in this area. Developments focus on building an AI ecosystem for higher education, improving teaching methods, faculty development, and student management, all elevatingeducational management standards.

7. INTERNET OF THINGS

The Internet of Things (IoT) and smart learning intersect innovatively and transformatively. IoT involves the network of interconnected devices that communicate and exchange data via the internet, and its integration into education can significantly enhance the learning environment. Lister [40] focused on individualized, geographically relevant learning and highlighted the necessity of improving the knowledge commons within smart learning environments. It highlights the difficulty of efficiently mapping and transmitting such knowledge and offers solutions using the Open Graph meta-property architecture. Encouraging unrestricted access to digital knowledge resources is essential for learning design and interactions. However, there are a lot of drawbacks to using proprietary platforms for educational metadata standards. The goal of using RESTful APIs to leverage popular frameworks like the Facebook Open Graph is to improve accuracy and fairness while democratizing access to online educational information.

Perdana et al. [73] progressed towards an intelligent learning factory incorporating improved device monitoring and learning capabilities to achieve accurate product results. Jig detection, which uses five ultrasonic sensors in a scanning manner, reaches 100% accuracy at 25 cm distances at a rate of 50µs each reading cycle. This procedure transfers data to an IoT Gateway with 99.4% performance over WiFi, then stores it in the IoT Cloud with 100% dependability. The Smart Learning Factory environment's operations and learning procedures are intended to be optimized by these changes. Alsharif et al. [91] emphasized the supervised and unsupervised machine learning methods essential for analyzing IoT smart data. It examines methods such as PCA for anomaly detection and SVM for classification and regression, highlighting their functions in handling high-speed data and obtaining important characteristics. The capacity of clustering techniques like K-means is emphasized to handle big datasets from various sources. Neural networks are noted for their effectiveness in function approximation and category prediction. The study reviews these techniques, discussing their advantages, limitations, and implications for future research in IoT data analysis.

8. Conclusion

ICT tools such as Google Docs, Microsoft Teams, and Slack facilitate real-time collaboration among students and teachers. Studies demonstrate that these tools enhance group work, peer interaction, and collaborative problem-solving. Learning analytics involve analyzing data from educational activities to inform instructional decisions, and research highlights its effectiveness in tracking student progress, identifying at-risk learners, and improving educational outcomes. AI-driven adaptive learning platforms personalize educational content based on individual student performance and can significantly enhance learning efficiency and outcomes by providing tailored instruction. AI chatbots and virtual assistants offer instant support and information to students, reducing the burden on educators and providing students with 24/7 assistance. From the review of the literature, it is understood that enhancing chatbots with more features like voice assistant integration, Google calendar integration, browser integration, editor integration, email platform integration, and the ability to open applications and perform search operations on knowledge websites like Wikipedia, besides finding real-time weather reports, can further increase the smart learning experience for students.

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