Smart Learning Environments: A Comprehensive Review on Artificial Intelligence and Learning Theories

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ABSTRACT

The term "smart learning" is now commonly used to describe online education. It shows how learners can use knowledge and skills more easily, successfully, and simply because of modern technologies. The goal is to create a smart learning environment that is relevant, timely, and efficient, allowing students to learn more effectively and successfully. By setting realistic goals, focusing on the big picture, and ensuring a clear timeline for task completion, a smart learning environment can provide a more engaging and efficient educational experience for students. The term "smarttechnology" describes remote-controllable and internet-connected devices that are used in smart learning environments (SLEs) to personalize and improve the educational experience for each student. This research paper explores the use oftechnology, specifically artificial intelligence, in creating a smart learning environment. A comprehensive review has been conducted in two dimensions, thedimension of AI in smart learning and the learning theories for smart learning environment. The study reveals that the impact of artificial intelligence in enhancing student performance and instructional design has received wide attention from the academic research. At the same time, the learning theories like activity theory, self- determination theory, and connectivism learning theory, collaborative learning theory, and situated learning theory are still explored by academic community within the context of artificial intelligence and smart learning environment.

Keywords: Smart Learning Environment, Artificial Intelligence, Learning Theory, IoT.

INTRODUCTION

"Studying smarter, not harder" (Paul, 2014). This saying has always rung true in our minds,expressing the changes that take place in our day-to-day life, but has technology truly made life better these days? It's easy because all we must do is create an intelligent environment around us, such as an educational environment. The goal is to create a specific, measurable, achievable, relevant, and time-bound learning environment that allows learners to use knowledge and skills more effectively (Boogaard, 2023).

The fourth industrial revolution (Industry 4.0) revolutionized all aspects of our lives, including education. Technologies such as artificial intelligence (AI), the Internet of Things (IoT) and big data provide new opportunities to improve learning, customize it and make it more effective. Here are some of the ways in which the Fourth Industrial Revolution is transforming the smart educational environment: custom learning using artificial intelligence, can analyze students' data and understand their individual needs and ways of learning. Based on this data, tailored learning plans can be created for each student, considering strengths, weaknesses, and interests. This can include interactive educational tasks, modified educational content and ad hoc evaluations. Smart Learning AI systems allow students to receive immediate feedback and feedback on their work. This can helpstudents identify their strengths and weaknesses and improve their performance faster. AI systems can also provide tailored educational support to students with certain concepts (University of San Diego, 2021). Enhanced virtual and realistic learning environments technologies provide immersive learning experiences that attract students and make them more engaged. These techniques can be used to create realistic

simulations of historical events or distant places, or to conceive complex scientific concepts. This can help students better understand and remember information for longer (Das, 2024). Breaking down geographical barriers allows telecommunications technologies forstudents from around the world to attend classes and interact with teachers and other students. This removes geographical barriers and makes access to education more accessible than ever. Students from developing countries have access to quality education from the world's best universities due to the development of technology (Matellio, 2024).

In this research, a literature review has been conducted to explore the theoretical frameworks and dimensions of artificial intelligence within the context of smart learning environment. The paper is structured as follows: Section2 presents the background, section 3 presents the dimensions of AI in smart learning, section 4 presents the theoretical frameworks for smart learning environment,section 5 presents discussion, and finally section 6 concludes with future research directions.

BACKGROUND

Smart learning environments (SLEs) represent a new direction in education, and use technology to improve, enhance and significantly customize the learning process. There is no agreed definition of smart learning environments, but many theoretical frameworks offer insights into their fundamental characteristics. Among them, intelligent learning environments have an enormous ability to adapt toeach student's needs and different learning contexts, by adjusting the sequence of tasks, difficulty, time, type of feedback and speed of learning. Customization Smart learning environments offer tailored education for each learner, considering their goals, needs and interests. Smart Support Smart learning environments provide advanced learning support by understanding the context of thelearner's situation and the real-world environment and providing timely and appropriate assistance. Researchers are interested in multiple research areas related to smart learning environments, such as their theoretical foundations, so that theories that form the basis of smart learning environments are studied and how they function effectively. Its technological applications by developing new technologies to make smart learning environments more effective and user-friendly. It also considers potential obstacles so that challenges to the application of smart learning environments such as privacy, ethics and cost issues can be addressed (Giemza, 2024). Smart learning environments have several benefits, including improved learning environments that help smart learning environments improve learning outcomes by providing a tailored learning experience for each long. Increased motivation stimulates students' smart learning environments to learn andenhances their participation in the educational process. Time saving enables smart learning environments to focus on students' individual needs rather than routine tasks (Cheung et al., 2021). Smart learning environments are a revolution in education and offer tremendous potential to improve and significantly personalize the learning process.

Dimensions of Artificial Intelligence in Smart Learning

A comprehensive literature review has been conducted to explore the recent progress in smart learning environment in regard to artificial intelligence. Table 1 lists the most relevant studies basedon keyword-based search using "Smart Learning" and "Artificial Intelligence". Most of these studies focused on different parameters that artificial intelligence influences in smart learningenvironment. Mostly, student performance (Cheung et al., 2021; Yu, 2021), and instructional design(Balaquiao, 2024; Nasar et al., 2023) are considered within the context of artificial intelligence.

Table 1: Dimensions of AI in Smart Learning

Reference	Dimensions of AI
(Yu, 2021)	Student performanceStudent efficiency Student engagement Student task analysis
(Cheung et al., 2021)	Evaluation on learning performance Feedback and interventionInstructional design

(Hassan, 2022)	Personalized learning Automated grading Feedback for Lectures Adaptive learning Campus Conversations
(Behera et al., 2022)	Feedback for Lectures Student monitoring
(Nasar et al., 2023)	Productivity Interesting Learning Environment
(Takami et al., 2023)	Personality-based tailored explanation Student engagement with explainable recommender systems
(Labadze et al., 2023)	Sensible Tutoring ProgramsAdaptive Education
(Owan et al., 2023)	Better Learning Outcomes Enhanced Engagement and MotivationEquity and Accessibility
(Shahzad et al., 2024)	Academic performance Student Mental Wellbeing
(Balaquiao, 2024)	Student performance Instructional effectiveness

AI is an effective tool that can greatly improve student performance in SLEs and learning experiences. Teachers can design individualized, captivating, and productive learning environments that enable every student to realize their full potential by judiciously and morally utilizing AI. By improving student performance and tailoring learning experiences, the combination of artificial intelligence (AI) and smart learning environments (SLEs) has the potential to completely transform the educational landscape (Saad, 2024).

Chatbots with AI capabilities or online tutors can offer students individualized advice and assistance. In real time, these systems can mimic the functions of a human tutor by responding to inquiries, elaborating on ideas, and providing focused feedback. This can be especially helpful for students who want a more hands-on learning environment or who require more support (Labadze et al., 2023).

AI influences the academic achievement of students. More comprehension and better test scores canresult from tailored learning experiences and focused support. Also, gamified learning and interactive AI features can keep students engaged and learning more fun. By personalizing instruction for students with varying needs and learning preferences, artificial intelligence (AI) can increase educational equity (Owan et al., 2023).

Theoretical Frameworks in Smart Learning

In the following section we present few learning theories which are relevant in the context of smart learning.

Activity Theory (AT)

Leontiev Activity Theory (AT) explains how Smart Learning Environments (SLEs) facilitate learning. It identifies key concepts such as subjects, objects, mediating tools, outcomes, and community. Subjects are active agents, objects represent goals, mediating tools are technological components, outcomes are transformations, and community refers to the social context where the activity takes place.AT emphasizes the dynamic interplay between AT and SLEs, which can be supported by meaningful objects, technology mediating, learners' transformation through activity, and community involvement. SLEs can provide interactive tools, simulations, and feedback, enhance understanding and skill development, and foster collaboration through online forums and discussion boards.AT, a valuable framework for Social Learning Environments (SLEs), has limitations, such as focusing on individual activity and not explicitly addressing the role of teachers.However, it offers a powerful lens for designing technologically advanced SLEs that promote meaningful learning experiences (Kaptelinin, 2014)

For example, the "Discover" platform offers interactive learning tools like simulations and gaming, enhancing

student engagement. It provides real-time feedback, online forums, and discussion panelsfor group projects. The platform mimics dynamic interactions between subjects, objects, and mediation tools, enhancing understanding of concepts. It also provides practical application opportunities and encourages collaboration through collaborative tools and activities.

Self-Determination Theory (SDT)

Deci & Ryan's (1985) Self-Determination Theory (SDT) explains how Smart Learning Environments (SLEs) can boost intrinsic motivation, enhancing engagement and learning outcomes.SDT identifies three psychological needs: autonomy, competence, and relatedness, which fuel motivations can foster intrinsic motivation by offering learners choices, mastery-oriented feedback, collaborative learning, and gamification elements. These elements promote autonomy and competence, but should complement intrinsic motivation, not replace it with extrinsic rewards. They should also facilitate interaction and collaboration within the learning community. Intrinsic motivation in learning leads to deep engagement, improved persistence, and transfer of knowledge. However, implementing it in Student Learning Environments (SLEs) requires careful consideration of overstructured environments, focus on extrinsic rewards, and individual needs. A balance between guidance and student choice is crucial to avoid undermining autonomy. SDT offers a robust framework for understanding intrinsic motivation in learning, enabling educators to create learning environments that promote love, engagement, and improved learning outcomes (Ackerman, 2018). For example, the "Creativity" platform enhances students' autonomy and motivation by offering multiple content and learning methods. It provides mastery-oriented feedback, encourages group projects, and incorporates gaming elements. This educational environment promotes independence, competence, and connection, fostering core motivation and improved learning outcomes. Students with a strong motivation are more persistent and able to transfer knowledge effectively.

Connectivism Learning Theory

Connectivism, a learning theory by George Siemens, provides a unique perspective on knowledge acquisition and utilization in the digital age, particularly useful in designing Smart Learning Environments. Connectivism emphasizes learning as a network creation process, with technology and communication being key principles. Knowledge is not limited to individuals but resides within connections, and SLEs can facilitate this by offering diverse resources, online communities, and collaborative platforms. They also encourage continuous knowledge updating and real-world application of knowledge, promoting continuous learnings can align with Connectivism principles by incorporating social learning features, curation tools, adaptive learning systems, and real-world simulations. These features allow learners to connect, share knowledge, curate information, and build personal learning networks. SLEs also foster decision-making skills and the ability to learn from experience. Integrating Connectivism principles in Social Learning Environments (SLEs) empowers learners, promotes lifelong learning, and develops critical thinking skills.

However, it requires careful planning to manage information overload, address the digital divide, and assess learning within a network-based framework, which requires innovative approachesbeyond traditional methods. Connectivism enhances digital learning by fostering strong knowledge networks, critical thinking skills, and lifelong learning by incorporating its principles into SLE design (Western Governors University, 2021).

In a smart learning environment (SLE), the following is an illustration of how connectivism principles are applied.

The "Knowledge" platform offers a variety of educational resources, online communities, andcollaborative tools for students to share ideas and build personal learning networks. It integrates social learning features, organizational tools, adaptive learning systems, and real-world simulations to promote lifelong learning. The platform encourages critical thinking, encourages interaction, and provides an interactive learning experience, fostering personal learning networks and fostering critical thinking skills. It also provides organizational tools

and real-world simulations.

The uniform appearance will assist the reader to read paper of the proceedings. It is therefore suggested to authors to use the example of this file to construct their papers. This particular exampleuses an American letter format with 25 mm margins left, right, top and bottom.

All text paragraphs should be single spaced, with first line intended by 10 mm. Double spacing should only be used before and after headings and subheadings as shown in this example. Position and style of headings and subheadings should follow this example. No spaces should be placed between paragraphs.

Collaborative Learning Theory

Collaborative learning theory involves peer-to-peer learning that fosters deeper thinking in the classroom. Collaborative learning theory suggests that group learning helps students develop their higher-level thinking, oral communication, self-management and leadership skills. Students also have the opportunity to build upon their leadership and organizational skills. Collaborative learning theory emphasizes the power of interaction and teamwork in fostering deeper understanding and knowledge retention. It posits that learners benefit from working together on tasks, sharing ideas, and explaining concepts to one another (O'Rourke, 2020) .

Fundamental Principles of Collective Learning are social interaction, active learning, many view points, and enhanced motivation. Through cooperative learning exercises, students are encouragedto talk, argue, and clarify ideas to one another. Critical thinking and a deeper understanding are fostered by this social interaction. Rather than just absorbing knowledge passively, learners actively participate in the learning process. A higher retention of knowledge results from this engagement. Working together exposes students to a range of perspectives and methods for solving problems, which deepens their understanding. Collaborative learning supports the development of competencies that are essential for success in the future, including leadership, teamwork, communication, and negotiation. Collaborating with others to achieve a common objective can be more stimulating than working independently, resulting in greater commitment and tenacity (Padayichie & Main, 2023).

Collaborative learning activities can be implemented on a rich platform provided by Smart Learning Environments (SLEs). Here are a few instances such as (i) jigsaw strategy, after conducting separate studies on various facets of a subject, students gather to share their discoveries with one another. This encourages communication, knowledge exchange, and active learning, (ii) problem-based learning (PBL), students collaborate to find solutions to real-world issues. This method promotes cooperation, critical thinking, and applying knowledge to practical situations, (iii) Online forums and discussions, SLEs can help students debate concepts, provide answers to queries,and expand on each other's knowledge in online forums and discussions, (iv) Group Projects, students can hone their communication, problem-solving, and cooperation skills by collaborating onprojects. SLEs can offer resources sharing, virtual collaboration, and project management tools, and (v) peer Review and Feedback, in SLEs, students have the ability to evaluate and comment on each other's work. This encourages introspection, critical thinking, and the capacity for both giving and receiving constructive criticism.

Situated Learning Theory

According to the theory of situated learning, learning happens most of the time unintentionally and takes place in real-world contexts, cultures, and activities. It supports the notion that learning occurs most effectively in cooperative group environments and when the activities are grounded in real-world situations. According to the theory of situated learning, knowledge is most effectively acquired and retained when it is learned in the context of its intended application.

This theory places a strong emphasis on the value of social interaction, real-world experiences, and active

learning. In-depth examination of this theory and its application to real-world instances in Smart Learning Environments (SLEs) will be provided (Dyack, 2020).

The basic ideas of contextual learning (Herrera, 2020), social interaction, legitimate peripheral participation, authentic activities can be considered within situated learning. In contextual learning, information is best absorbed and retained when it is acquired in the setting in which it will be applied. in project-based learning, students are encouraged to apply their knowledge and skills in a practical setting by working on projects that deal with real-world problems. With the use of virtual reality (VR) and augmented reality (AR), educators can design immersive learning environments that mimic real-world situations and let students hone their skills in a secure setting.

DISCUSSION

Smart Learning Environments (SLEs) are transforming education by utilizing technology to create personalized, dynamic, and engaging learning experiences, with key points connected to existing research. SLEs prioritize learner-centered design, utilizing technology for adaptive learning and personalized instruction. They align with research on student-centered approaches and the positive impact of technology on engagement and knowledge retention when strategically implemented.

Artificial Intelligence, or AI, has quickly infused every aspect of our lives. Researchers were experimenting with ideas like logic machines and game-playing algorithms in the early days of computing, which is when artificial intelligence (AI) was first used. The foundation for today's more advanced AI applications was built by these early efforts. Since then, AI has spread widely.It's found in everything from streaming service recommendation algorithms to your phone's face recognition software. Artificial intelligence (AI) is a dynamic field that is always expanding, changing how we interact with the world and pushing the envelope of what is possible. The introduction of Smart Learning Environments (SLEs) has greatly changed the educational landscape. These technologically advanced ecosystems provide dynamic, individually tailored learning experiences for every student, going beyond traditional classroom settings.

SLEs use a potent array of instruments (Singh & Hassan, 2017), such as (i) learning platforms that are adaptive, these platforms adjust the content and level of difficulty to each student's requirements, making sure that everyone is properly challenged, (ii) interactive simulations, by participating in realistic simulations, students can apply their knowledge in a fun and safe setting, (iii) Real-time feedback mechanisms, SLEs give students immediate performance feedback, enabling them to make necessary corrections and improve their method of instruction.

Through the use of these resources, SLEs tailor the learning process to each student's unique strengths and shortcomings. This encourages a greater comprehension of ideas and kindles a desire to learn new things.

Broader Implications

SLEs promote student engagement and motivation by making learning interactive, improving learning outcomes through in-person instruction, and promoting educational equality by offering a wide range of educational materials. Promoting digital education is an excellent example of how different actors can collaborate to meet technological challenges and leverage their potential. For example, the role of Governments is to provide the necessary digital infrastructure, such as high- speed Internet networks, tablets, and students' smartphones. as well as the development of digital curricula and the training of teachers in the use of technology in education. Funding digital education programs and support for students in need. The role of institutions comes through sharing their technology expertise to develop innovative educational solutions and offer scholarships and training programs to students and teachers. It also supports research into digital education. In this case, the role of the private sector is to develop innovative digital learning tools and platforms, providing Internet services and technology at appropriate prices. Collaborate with educational institutions to provide digital educational

opportunities for students.

Challenges and Strategies

The digital divide and data privacy issues in SLEs require strategies like providing hardware, reliable internet connectivity, comprehensive teacher training, and robust protocols to address these inequalities and ensure transparency with parents and students. SLEs have the potential to revolutionize education, but challenges like the digital divide and teacher training need to beaddressed for equitable implementation.

CONCLUSION

Smart Learning Environments (SLEs) are revolutionizing education by personalizing learning, catering to individual student needs, and enhancing engagement through interactive elements, potentially improving learning outcomes. Responsible development, equitable access to technology, proper education support, and robust data privacy and security protocols are crucial for unlockingthe full potential of SLEs. SLEs offer personalized, engaging, and effective learning experiences forstudents, with responsible implementation and potential challenges addressing to create a brighter future for education. AI is set to revolutionize education by enhancing personalized instruction, tracking student progress, providing valuable insights into student performance, and enhancing resource efficiency. It will also help schools become smarter, leading to more efficient decision- making and a more equitable learning environment. AI technology, such as ChatGPT, could provide quality educational access to more people, allowing them to tackle global challenges more collaboratively. Despite skepticism, the promise of AI in education is becoming increasingly attractive, as it can solve universal issues and increase engagement with learning activities.

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