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Harnessing Artificial Intelligence Tools to Enhance Smart Learning

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Abstract. The emergence of smart learning applications has significantly impacted the educational process, transforming student interaction and shaping the future of learning. Integrating artificial intelligence into smart learning applications has become a powerful tool, enriching student interaction and shaping the future of learning. This paper explores the transformative impact of artificial intelligence on smart learning applications, focusing on the characteristics, applications, and benefits of artificial intelligence -integrated smart learning. It uses a literature review method to analyze existing studies on smart learning and artificial intelligence integration in education. This study identifies key characteristics of practical smart learning applications, their impact on student outcomes, and the challenges and benefits of artificial intelligence integration. Empirical data from various educational institutions has been examined to provide real-world examples and case studies of successful smart learning implementations. The findings reveal that artificial intelligence significantly enhances learning experiences and improves student engagement and outcomes but it also necessitates careful consideration of data privacy, digital equity, teacher training, and ethical considerations. The research concludes that ongoing collaboration between educators, developers, and policymakers is crucial for maximizing artificial intelligence benefits in education while mitigating potential risks and ensuring equitable access to quality learning for all students.

Keywords: e-learning; smart learning; education; technology; artificial intelligence

1. Introduction

Learning is radically transforming as technology is increasingly integrated into the learning process (Liu & Yu, 2023). This shift is primarily driven by the emergence of smart learning (SL) applications (apps) that leverage the capabilities of artificial intelligence (AI), machine learning, and cloud computing (Occhipinti et al., 2025). These apps enhance the educational experience and promote

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interaction and engagement between students and their educational environments to meet learners' diverse needs through an advanced educational framework that integrates various technologies (Chatterjee et al., 2023). As teachers and institutions seek to adopt new methodologies, understanding the different components, benefits, and challenges of SL becomes key to maximizing the educational potential of these technologies. AI apps are used in data analysis and user-centered education design to create dynamic learning environments, while SL is transforming how students learn, interact, and achieve their full potential through the use of AI, data analytics, and interactive tools (Khamis, 2024). It is necessary to identify the best learning tools that exist, while overcoming challenges to achieve the requirements of creative thinking in the learning process, and to link educational content with the context currently directed by students. A teacher who performs SL work in line with SL objectives must be prepared (Yeung et al., 2024).

In this paper, we review the concept of SL with available apps and summarize the results from recent studies to provide insights into the current state of SL apps in education. This research also explores using AI tools to enhance SL in education. It focuses on understanding SL, its characteristics, and the challenges in implementation. The research also explores the role of AI in SL, its benefits, limitations, and impact on student performance and engagement. It also addresses practical and ethical issues, such as data privacy, digital equity, teacher training, and potential negative impacts. The research also examines global perspectives and future directions for AI-powered SL. It uses a literature review and analysis of existing studies to provide empirical evidence.

2. Methods

This study utilized a systematic literature review approach and quantitative research design to analyze existing scholarly literature on SL and AI integration within SL apps. The research was conducted across multiple academic databases, using keywords related to SL, AI in education, and educational technology. Inclusion and exclusion criteria were established to select relevant and high-quality studies. Data analysis involved a qualitative and quantitative approach.
To understand AI-integrated SL, the literature categorized its apps, benefits, challenges, future directions, themes, and trends. Quantitative data, such as student performance metrics and engagement scores, were extracted and analyzed to assess the impact of AI on SL. Statistical methods, such as descriptive and potentially inferential statistics, were used to summarize and interpret the quantitative data. The reliability of data sources was assessed based on factors such as the reputation and impact factor of the journals, the rigor of research methodologies, and the consistency of findings across multiple studies. The selection criteria and inclusion/exclusion process aimed to minimize bias and prioritize high-quality, peer-reviewed research, ensuring the credibility and trustworthiness of the included data.

3. Literature Review

The literature review highlighted the importance of SL apps in delivering personalized learning experiences (Kerimbayev et al., 2024). By tailoring content

to individual learner needs, student engagement and achievement were improved (Tagdimi et al., 2023). Gamification in education through SL apps has been found to positively impact student motivation and engagement (Deep et al., 2024). Collaborative learning is also highlighted as a positive correlation between SL apps and student performance (Dewi et al., 2023). Learning analytics (LA) in SL apps can help educators identify learning trends and adjust instructional strategies, ultimately improving student success rates (Kapur, 2024). Accessibility and equity are other important factors, with studies showing that SL apps can help bridge learning gaps in underserved communities (Yusup et al., 2024). Social presence and communication are other crucial aspects of SL apps, as they foster a sense of community and support among learners, enhancing motivation and learning outcomes (None, 2025).

Cognitive load theory and app design can help manage cognitive load effectively, leading to the improved retention and comprehension of material (Sweller, 1988). The long-term effects on learning habits are also examined, with studies showing that consistent use of SL apps positively influences students' self-regulated learning skills, leading to better academic outcomes over time (Siantuba et al., 2023). Teachers' roles and professional development are also highlighted; teachers who receive adequate professional development and support are more likely to adopt these technologies successfully (Li, 2024). The SL apps function within various learning environments, including formal and informal settings, and they are versatile tools that can enhance learning across contexts (Jurczyszyn, 2024). Overall, the literature review highlighted the potential benefits of SL apps in various learning environments.

Research has demonstrated the profound impact of technology on educational practices. Studies exploring the effectiveness of SL methods have shown increased academic performance, greater student engagement, and improved retention rates. For instance, a meta-analysis of various studies indicated that students utilizing adaptive learning platforms exhibited significantly higher learning outcomes than those in traditional learning settings. Moreover, these studies illustrate that integrating social media apps and AI tools in SL requires tailored approaches, gamification, collaboration tools, data analytics, addressing the digital divide, personalized learning, engagement, collaboration, assessment, accessibility, and instructor support. Some studies are highlighted as follows:
Personalized and adaptive learning studies:

- Ambele et al.'s (2022) study explored how personalized learning in e-learning helps educational institutions adapt to the fast pace of information technology and improve study efficiency, focusing on self-adaptive learning and relevant information, which is central to leading online education platforms. Literature from 2010 to 2021 was examined to close the gap and promote the developing trend of personalized learning technologies and apps in higher education. The authors reviewed current trends and discussed future research directions in the field (Ambele et al., 2022).
- Pratama et al.'s (2023) study explored the impact of AI on education, highlighting its potential to revolutionize traditional teaching methods.

Using qualitative descriptive methods, including questionnaires, interviews, and observations, the researchers found overwhelming student support for AI-enhanced learning experiences. The results showed that 88% of students valued AI's importance in learning; 74% saw AI as a viable alternative for self-learning; and 88% believed AI could effectively serve as virtual tutors. However, 57% disagreed that AI could replace human teachers (Pratama et al., 2023).

- Lokare and Jadhav's (2024) study presented an AI-based learning prediction model that predicts learning styles based on input attributes such as attention, meditation, cognitive workload, facial expressions, and emotional state. The model uses three machine learning classifiers, with the random forest classifier achieving the highest accuracy (87.5%). This model offers advantages such as personalized learning experiences, understanding individual learning styles, and enabling institutions to tailor teaching methods and resources (Lokare & Jadhav, 2024).

Data and Learning Analytics in Education:

- Wong's (2017) paper reviewed the growing research on LA in higher education, focusing on its use in pedagogies, instructional design, and student performance. The author identified benefits such as effective decision-making, monitoring student learning, and identifying students at risk. The study also highlights the importance of LA in open and distance education, because the existing literature mainly focuses on conventional face-to-face institutions. The findings provide a foundation for further exploration and understanding of this emerging field (Khamis, 2024; Wong, 2017).
- Banihashem et al.'s (2022) systematic literature review examined the implementation of LA in technology-mediated higher education environments. The authors identified four key dimensions of LA systems: data types, analytical methods, objectives, and stakeholders. The authors proposed a conceptual framework for implementing LA for feedback systems and suggested future empirical research (Banihashem et al., 2022).
- Alfredo et al.'s 2024) study reviewed how the rapid expansion of LA and AI in education raises concerns about data privacy and agency. A systematic literature review reveals gaps in understanding the importance of human control, safety, reliability, and trustworthiness in designing and implementing these systems. Results show some consideration of human control but limited end-user involvement. The study recommends balancing stakeholders' involvement, actively involving end-users, and exploring safety, reliability, and trustworthiness as principles in future human-centered LA AI in education systems (Alfredo et al., 2024).

Artificial Intelligence in Education:

- Wang et al.'s (2024) review explored the various categories of AI apps in education, research topics, and research design elements. The literature covers adaptive learning, personalized tutoring, intelligent assessment, profiling, prediction, and emerging products, with topics ranging from technical design of education systems to adoption, impacts, and

challenges. The review highlights diverse theories, multidisciplinary publication venues, and underexplored research areas. It provides valuable insights for scholars to understand AI in education research and identify future opportunities (Wang et al., 2024).

- Labrague and Sabei's (2024) review analyzed 14 studies on AI-powered chatbots in nursing education, focusing on their effectiveness. The primary apps were identified as enhancing learning, skill development, simulation support, educational assistance, and assessment facilitation. The review found that chatbots increased knowledge retention, engagement, and skill development among students. However, the authors stressed the need for continued research and refinement of the technology, along with comprehensive educator training to address existing limitations and challenges in nursing education effectively (Labrague & Sabei, 2024).
- Farrelly and Baker's (2023) study explored the impact of generative AI impact on student life, particularly international students. While generative AI tools, such as ChatGPT, have revolutionized education, there are concerns regarding academic integrity, detection, biases, and equity. The paper emphasized addressing these challenges, promoting AI literacy, ethical considerations, and cultural competence to ensure equitable access and positive outcomes for all students (Farrelly & Baker, 2023).

Augmented and Virtual Reality in Education:

- Deng et al.'s (2024) study explored the use of augmented reality in education, addressing technical issues and enhancing learning efficiency. The authors identified gaps in existing research methodologies, namely inadequate control over node consistency and inadequate design of collaborative visualization components. A novel predictive algorithm was proposed to improve real-time interaction and coherence among multiple learners. The authors also proposed personalized collaborative visualization components for effective team-based learning (Deng et al., 2024).
- Cowan and Farrell's (2023) study investigated tutors' attitudes toward integrating virtual reality into their teaching practices. The study, conducted among 50 tutors across four institutions in Ireland and Northern Ireland, revealed that, while tutors are open to adopting VR, systemic barriers hinder its implementation. These obstacles include technological deficiencies in classrooms, tutors' lack of preparedness to effectively integrate VR, and limited curriculum-focused VR resources. To address these challenges, the authors proposed a collaborative approach among education stakeholders to develop VR pedagogy and promote its seamless integration into teacher education programs (Cowan & Farrell, 2023).

Innovative Teaching Approaches:

- Shu & Gu's (2023) research showed that a smart education model incorporating advanced technologies, such as the Edu-Metaverse, significantly improves students' learning outcomes compared to

traditional methods. The smart education model emphasizes creating an ecological teaching environment with multimodal resources, enhancing engagement and critical thinking skills. The model can be applied across various educational settings, including vocational, open, and general education. The study called for educational authorities to organize workshops for instructors and instructional designers to understand Edu-Metaverse's technical aspects and address data privacy issues.

- Asoodeh et al.'s (2012) research examined the impact of student-centered learning on academic achievement and social skills in elementary schools. A sample of students was trained using a cooperative approach; the results showed that this approach was effective in improving academic performance, social acceptance, self-confidence, and mental abilities (Asoodeh et al., 2012).

3.1. SL Apps Analysis

A SL app can be analyzed based on several key criteria to assess its effectiveness, usability, and impact on learning outcomes. These criteria include:

- User experience: Evaluate the app's interface, navigation, engagement, and accessibility features (Tatnall & Fluck, 2022).
- Educational efficacy: Review learning outcomes, content quality, and personalization for different learning styles (Rafiq et al., 2024).
- Technology integration: Assess platform compatibility and integration with learning management systems (Sabiroh et al., 2024).
- Data usage and privacy: Analyze policies on data collection and protection (Vorecol, 2024).
- Engagement techniques: Consider motivation systems and social learning elements (Bandura 2024).
- Support and resources: Evaluate technical support and the availability of supplementary materials (Dimitriadou & Lanitis, 2023).
- Learning analytics: Examine how the app collects and presents user performance data (Khamis, 2024).
- Scalability and flexibility: Determine adaptability for updates and different educational contexts (Hashim et al., 2022).
- Cost and accessibility: Analyze pricing models and availability across various demographics (GMI, 2023).

A pedagogical design should align with educational standards, cater to diverse learning preferences, and provide meaningful feedback. Continuous improvement based on learner feedback and educational research is essential. By using these criteria, researchers and educators can gain a comprehensive understanding of an app's strengths and weaknesses, guiding decisions about its suitability in different learning environments.

3.2. Characteristics of SL Apps

Smart learning is a new approach to education that uses AI algorithms to personalize and enhance learning experiences. These apps use algorithms to tailor content to individual students' needs and learning styles, ensuring they remain engaged and motivated. The interactivity provided by these apps fosters a

collaborative learning environment, allowing students to engage with peers and educators in real time while fostering critical thinking and problem-solving skills. SL apps offer a range of features to enhance educational experiences, including adaptive learning, gamification, collaborative tools, integrated assessment, and multimodal content delivery. These apps use algorithms to assess students' knowledge and adapt content accordingly, promoting active participation and retention. They also provide real-time feedback, allowing learners to understand their strengths and weaknesses and facilitating continuous improvement.

These apps are accessible on multiple platforms, with learners accessing educational resources at any time and location. They also offer analytics and reporting, allowing educators to track student progress and make data-driven decisions. This approach helps identify trends and tailor instruction better to support student success. SL apps typically offer a range of features designed to enhance the learning experience (Abbas Shah et al., 2023; De Mattei et al., 2024; Mhlongo et al., 2023; Shahzad et al., 2024) including:

- Adaptive learning: Algorithms assess student knowledge and adapt instructional content.
- Gamification: Game design elements, such as rewards and challenges, promote engagement.
- Collaborative tools: Discussion forums and group projects encourage social interaction and peer learning.
- Ambient intelligent classrooms: Sensors and smart devices are used to create an adaptive learning environment, enhancing student engagement and fostering a personalized, responsive educational experience.
- Smart classrooms: Traditional teaching methods are combined with advanced technologies, such as interactive whiteboards, projectors, and digital tools, creating an engaging learning atmosphere for students.
- Virtual classrooms: Remote learning is enabled via digital platforms, utilizing video conferencing, online resources, and collaborative software for flexible and distance education.
- Integrated assessment: Continuous assessment features monitor progress.
- Multimodal content delivery: Videos, podcasts, interactive simulations, and text are used to create a rich learning experience.
- Personalization: AI algorithms tailor content and learning paths based on individual learner profiles.
- Interactivity: Multimedia elements, such as videos, quizzes, and gamified interfaces, encourage active participation and retention.
- Real-time feedback: Immediate feedback mechanisms enable learners to understand their strengths and weaknesses.
- Accessibility: Apps are available on multiple platforms for access at any time and location.
- Learning analytics: Data are used to track student performance and engagement, enabling educators to customize teaching strategies to meet individual student needs and enhance the overall learning experience.

3.3. Benefits of SL Apps

Using SL apps in education offers numerous benefits, including personalized learning experiences, increased motivation, flexibility, convenience, and scalability (Hashim et al., 2022). These apps cater to different learning styles and abilities, fostering interest and motivation (Liang et al., 2023). They also provide accessibility and inclusivity, enabling students in remote or underserved areas to access quality education; this makes it easier for learners to study at their convenience (Dogan et al., 2023). Additionally, SL apps encourage self-directed learning, and promote lifelong learning habits and critical thinking skills (Morris et al., 2023). Furthermore, data-driven insights can be accessed through analytics, which enhance instructional strategies and outcomes. Self-paced learning allows students to progress at their own pace, reducing the limitations of traditional classrooms. Fortunately, SL apps are cost-effective. Often available at low or no cost, SL apps provide quality educational resources without significant financial investment (Dimitriadou & Lanitis, 2023).

3.4. Limitations of SL Apps

SL apps offer numerous advantages in enhancing educational experiences but they also present challenges which can hinder their effectiveness (Nguyen et al., 2022; Praharaj et al., 2024; Tabuenca et al., 2024; Thomas et al., 2019; Xu et al., 2024). These limitations are categorized as follows:

- Digital divide: Uneven technology access can exacerbate educational disparities and greater reliance on technology can reduce critical thinking and interpersonal communication skills.
- Data privacy concerns: The collection and analysis of learner data can lead to privacy and security issues.
- Quality control: An overwhelming amount of resources can lead to inadequate content evaluation, with dependence on technology potentially affecting traditional learning methods and interpersonal skills.
- Teacher training: Adequate training is needed to effectively integrate SL apps into teaching practices.
- Cognitive overload: Overreliance on SL apps can forego traditional learning methods.
- Motivational challenges: Designing apps that foster sustained interest and motivation among all learners is crucial.
- Integration into existing curriculum: Aligning SL apps with educational goals is crucial.

3.5. Use of AI in SL

Since the early 2000s, many innovative SL apps have emerged, incorporating advanced technologies and educational methodologies to enhance the learning experience. These include AI-powered teaching apps, such as Socratic, Khan Academy Kids, and others (Khan, 2022).

Table 1 shows many apps and websites that support the integration of AI into the educational process; these apps can analyze learners' performance and adapt content to address individual learning gaps. The integration of learning environment and AI apps has helped to enhance SL apps that include augmented

reality learning apps, such as Merge Cube and Google Expeditions, that provide immersive learning environments (Silva et al., 2024). Engaging learning platforms, such as Classcraft and Kahoot!, make learning more enjoyable and interactive. Collaborative learning networks, such as Edmodo and Flipgrid, have also facilitated convergence with AI apps. In contrast, partial learning apps, such as Quizlet and Duolingo, promote skills acquisition through short lessons and tests. Blockchain-based accreditation platforms, such as Blockcerts, have used blockchain technology to issue and verify educational credentials securely, adding a new dimension to the teaching process. Virtual reality learning apps, such as VR Classroom and Engage, have provided distinctive experiences and an immersive learning environment.

In contrast, skills development apps, such as LinkedIn Learning and Coursera, offer practical courses (Das, 2024). AI-powered content creation and assessment tools, such as OpenAI's ChatGPT, help teachers create customized learning materials. Furthermore, important apps help learners organize their tasks and facilitate their management. For example, task management tools, such as Todoist or Microsoft To-Do Help, prioritize and track task accomplishment. Time management apps, such as Pomodoro, Focus Booster, or Forest, are limited to specific and tuned times with idle periods and rest allocated. It also includes memoir organization tools and techniques, material ranking, group classification, and Evernote or Notion learning course management.

Table 1. Smart learning apps, along with their respective companies, dates of issue, number of users, prices, and reference links

App Name	Company	Issue Date	Users	Price	AI Tool	Content
Klickpath	Klickpath Inc.	2022	250,000+	Free / $15/mo	Personalized Learning AI	Educational Pathway Tracking
Brighterly	Brighterly	2021	200,000+	Free / varies	Personalized Learning AI	Math Learning for Kids
Elevate	Elevate Labs, Inc.	2021	3 million+	Free / $5/mo	Personalized Learning AI	Brain Training and Skill Development
Filo	Filo, Inc.	2021	500,000+	Free / $7.49/mo	Live Tutoring AI	On-Demand Tutoring
Kodable	Kodable, Inc.	2021	200,000+	Free / $10/mo	Adaptive Learning AI	Coding and Computer Science for Kids
Schooled	Schooled, Inc.	2021	500,000+	Free / $99/yr	Smart Tutoring AI	Online Tutoring
Tandem	Tandem Language Learning	2021	1 million+	Free / $6.99/mo	Language Matching AI	Language Exchange Platform
Beelinguapp	Beelinguapp	2020	5 million+	Free / $1.99/mo	Dual Language AI	Bilingual Reading Resources
Brilliant	Brilliant.org	2020	10 million+	Free / $24.99/mo	Problem-solving AI	Interactive Math and Science Courses
ClassDojo	ClassDojo, Inc.	2020	40 million+	Free	Behavior Tracking AI	Classroom Management
Clever	Clever, Inc.	2020	15 million+	Free	Smart Data Integration AI	School Management and Learning Tools
Gimkit	Gimkit, Inc.	2020	1 million+	Free / $4.99/mo	Gamification AI	Educational Games and Quizzes
Kahoot!	Kahoot! AS	2020	50 million+	Free / varies	Gamification AI	Educational Games and Quizzes

App Name	Company	Issue Date	Users	Price	AI Tool	Content
QuillBot	QuillBot, Inc.	2020	2 million+	Free / $14.95/mo	Paraphrasing AI	Writing Assistant and Grammar Check
Unacademy	Unacademy, Inc.	2020	30 million+	Free / $4.99/mo	AI Learning Paths	Online Courses and Competitive Exam Prep
LinkedIn Learning	LinkedIn, Inc.	2015	27 million+	Free / $29.99/mo	Course Recommendation AI	Professional Development Courses
Photomath	Photomath, Inc.	2014	220 million+	Free / $79.99/yr	Optical Character Recognition (OCR) AI	Math Problem Solving
Lingvist	Lingvist	2013	1 million+	Free / $14.99/mo	Adaptive Learning AI	Language Learning
Memrise	Memrise Ltd.	2013	40 million+	Free / $9/mo	Spaced Repetition AI	Language Learning and Memory
Coursera	Coursera, Inc.	2012	92 million+	Free / varies	AI course recommendations	Online Courses and Specializations
edX	edX Inc.	2012	35 million+	Free / varies	Adaptive Learning AI	Online Courses and MicroMasters
Duolingo	Duolingo, Inc.	2011	500 million+	Free / $6.99/mo	Personalized Learning AI	Language Learning
Skillshare	Skillshare, Inc.	2010	12 million+	$32/mo	AI Recommendations	Video Courses on Creative Skills
Brainly	Brainly, Inc.	2009	150 million+	Free / $18/yr	AI Moderation	Q&A and Homework Help
Khan Academy	Khan Academy	2008	18 million+	Free	Adaptive Learning AI	Video Lessons and Exercises
Quizlet	Quizlet, Inc.	2007	50 million+	Free / $35.99/yr	AI-powered Study Tools	Flashcards and Study Sets

3.5. Acceptance of AI Tools in SL

Teachers' and students' acceptance of AI apps and emerging AI tools is essential to achieving the goals of the educational process. From the aforementioned obstacles and limitations to using these apps and tools, which directly affect the acceptance of AI apps in SL, we must first understand what acceptance is and its implications through educational practice. Acceptance is achieved by demonstrating users' readiness to adopt and use a new tool or app in the educational environment. This readiness is affected by several factors, including perceived usefulness, ease of use, trust, and social influences. This is measured through specialized models for measuring satisfaction and acceptance, such as the technology acceptance model and the unified acceptance and use theory of technology (Neves et al., 2025; Sheikhtaheri et al., 2023). From the previous studies mentioned, the evidence indicates that teachers and students have perceptions of the usefulness of AI apps and their enrichment of the educational process, and studies confirm that they are willing to accept this style of education (Cortez et al., 2024). AI-powered tutoring systems that provide personalized feedback can also motivate students and increase satisfaction with the learning experience (Mnguni et al., 2024).

Studies have focused on the ease of use of AI apps as a critical factor in acceptance (Neves et al., 2025). Increased trust in AI and its ethical implications through transparency in AI algorithms and interactions can foster a more positive attitude toward acceptance (Sheikhtaheri et al., 2023). Acceptance is also supported by the availability of training and support for teachers to familiarize themselves with

and effectively use AI apps (Lünich et al., 2024). Cultural inclinations and social influences to adopt new perceptions and behaviors in the learning process have encouraged teachers to explore and experiment with AI tools in the educational process (Mnguni et al., 2024).

Studies have concluded that there is a clear understanding and acceptance of these apps with the adoption of several approaches to engage in implementation supported by the guidance of stakeholders and curriculum and education development agencies. This is followed by enhancing the professional development of teachers with the skills necessary to use AI tools confidently and effectively. Enhancing cooperation between individuals and institutions regarding their experiences with AI tools in disseminating knowledge and best practices leads to increased acceptance.

3.6. Tracking SL Worldwide

Fueled by technological advancement and innovative teaching assets, SL, especially AI tools, has changed the world's learning landscape. Table 2 shows an overview of the current state of SL in some countries, highlighting the methods used, its tools, and the type of targeted education, with an indication of the initiation of SL usage in that country. South Korea's Smart Nation initiative and Singapore's Smart Nation (2024) program are pioneering models. Finland's education system includes AI-enabled adaptive learning, while the United States focuses on virtual learning environments and online courses. Brazil's national education plan emphasizes digital literacy. The European Union's Digital Education Action Plan promotes digital literacy and educational innovation. Australia and Canada have implemented national learning management systems. China's innovative learning platform also uses AI-based adaptive learning. India's National Digital Learning Resource Centre offers virtual learning platforms and mobile apps.

Table 2. An overview of the current state of SL worldwide, highlighting methodology, SL tools, targeted sectors, type of student, and starting year

Country	Methodology	Smart Apps/Tools/LMS/AI/VR	Targeted Sectors	Type of Student	Starting Year	Ref.
Singapore	Blended learning, flipped classrooms	Singapore Learning Management System, Google AI, zSpace	Primary, Secondary, Tertiary	Public, Private	2010	A
United States	Virtual learning environments, online courses	Canvas, Blackboard, Google AI Classroom, IBM Watson, zSpace, Oculus	K-12, Higher Education	Public, Private	2010	B
South Korea	Integrated technology, AI-powered adaptive learning	SMART Board, Dream Class AI, VR First	K-12, Higher Education	Public, Private	2011	C
Australia	Blended learning, online courses	Australian Learning Management System, Google AI, zSpace	K-12, Higher Education	Public, Private	2008	D
Türkiye	Blended learning, online courses	Turkish Education Platform (TEP), Anadolu University Learning Platform	K-12, Higher Education	Public, Private	2010	E

Brazil	Digital literacy, online resources	Brazil Digital Agenda, Google AI, Google Expeditions	Primary, Secondary	Public	2013	F
India	Virtual learning platforms, mobile apps	National Digital Learning Resource Centre (NDLRC), BYJU'S AI, Google Expeditions	K-12, Higher Education	Public, Private	2013	G
China	AI-driven adaptive learning, intelligent tutoring	Intelligent Learning Platform (ILP), Zhihu AI, HTC Vive	K-12, Higher Education	Public, Private	2015	H
Finland	Personalized learning, gamification	Finnish Education Platform (FEP), Koodi AI, Oculus	Primary, Secondary	Public	2015	I
Russia	Virtual learning platforms, AI-powered assessment	Russian Education Platform (REP), Yandex practicum, Yandex Education	Primary, Secondary	Public	2015	J
Japan	AI-powered adaptive learning, robotics	Japanese Education Platform (JEP), Sony Global Education	Primary, Secondary	Public	2016	K
Canada	Personalized learning, AI-powered assessment	Canadian Digital Learning Platform (CDLP), Google AI, Oculus	Primary, Secondary	Public	2017	L
United Arab Emirates	AI-powered adaptive learning, virtual reality	UAE Education Platform (UAEPP), Dubai Future Accelerators	Primary, Secondary	Public	2018	M
South Africa	Virtual learning platforms, mobile apps	South African Education Platform (SAEP), MTN Education Platform	K-12, Higher Education	Public, Private	2020	N

A:(Smart, 2019); B:(Artificial, 2024); C:(Kim et al., 2013); D:(Clarke, 2023); E:(Yavuzalp et al., 2016); F:(Giacon & Giselle, 2024); G:(Ministry, 2020); H:(Zong, 2024); I:(Finnish, 2019); J:(Yandex, 2025); K:(MEXT, 2025); L:(Digital, 2020); M:(Prime, 2024); N:(Tope & Kalema, 2019).

3.7. Insights from Statistical Readings

Recent studies and statistics from various educational institutions revealed the positive impact of SL apps. Institutions that have successfully integrated AI-driven platforms report higher student engagement scores, improved academic outcomes, and greater satisfaction among both students and educators. These insights underscored the transformative potential of SL and its role in shaping a modern educational landscape. Figure 1, Figure 2, Figure 3, and Figure 4 represent the harnessing of AI in SL.

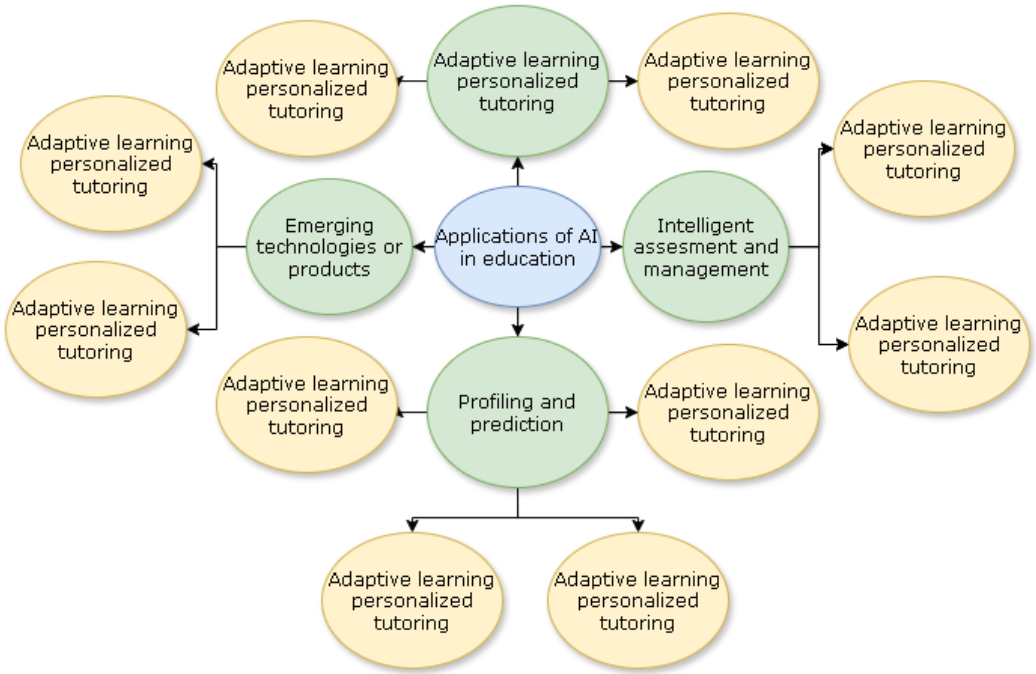

Figure 1. AI applications in education (Wang, 2024)
[Download: high-res original image (185KB)]

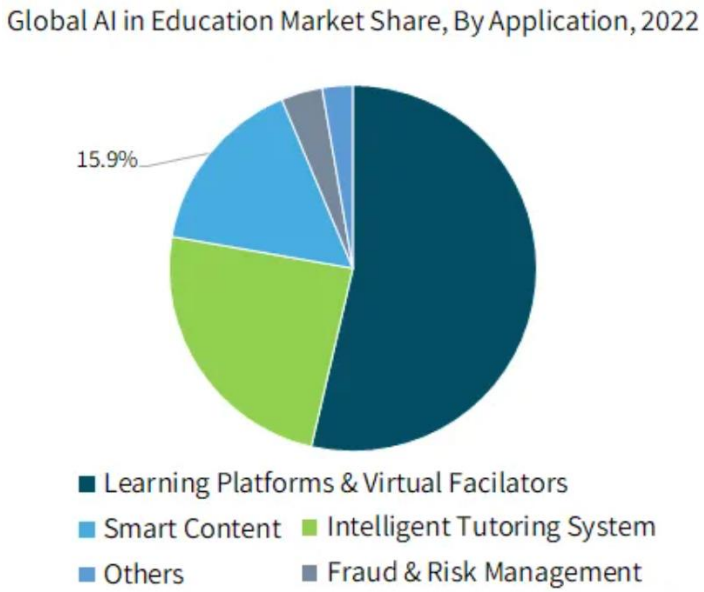

Figure 2. market size of AI in education (GMI, 2023)

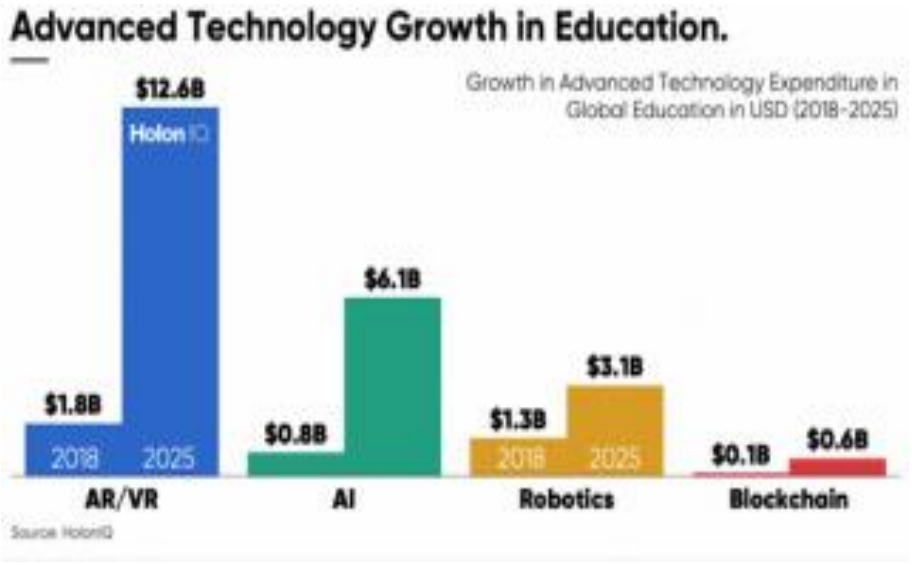

Figure 3. Global spending on artificial and virtual reality in education (Bradley, 2021)

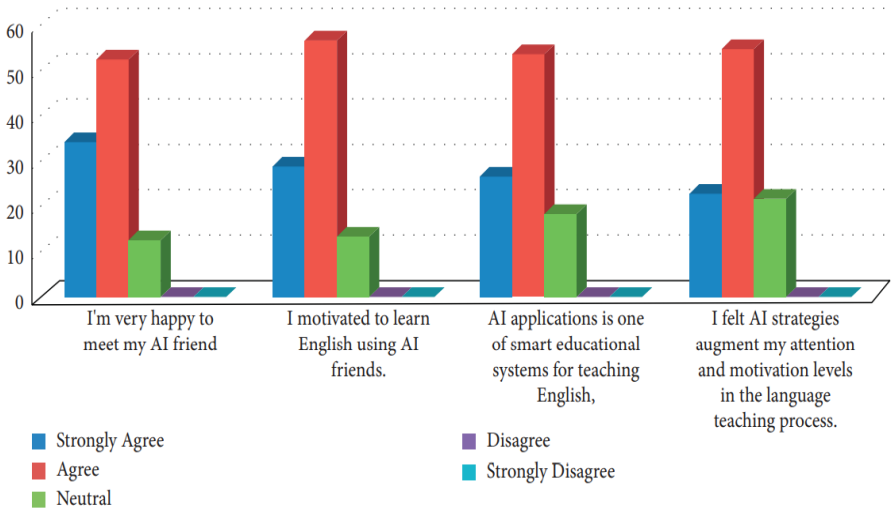

Figure 4. Students' perceptions of learning English through AI (Muthmainnah et al., 2022)

3.8 SL Planning Charts

Figure 5 shows a SL planning mind map of the key components of SL planning, including objectives, resources, stakeholders, timeline, and assessment and evaluation methods. A clear visual roadmap was provided for integrating AI tools into SL initiatives, simplifying complex planning processes.

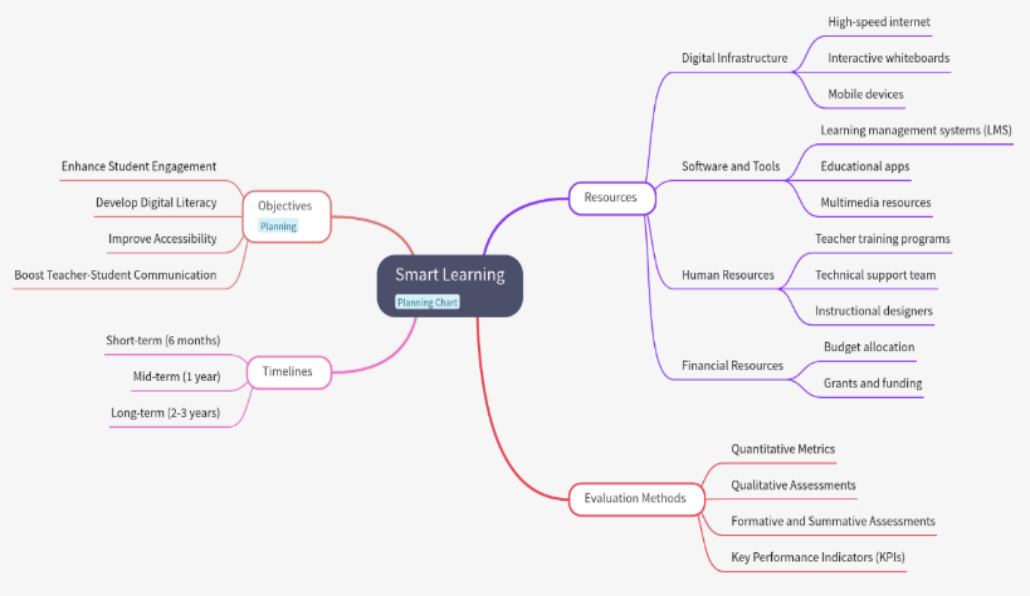

Figure 5. Mind map of the key components of planning smart learning

4. Discussion

The literature underscores the transformative potential of SL apps in modern educational environments. SL apps provide personalized learning experiences that cater to individual student needs, leading to improved engagement and academic achievement, with gamification playing a crucial role in boosting motivation. Collaborative learning practices, supported by SL apps, also improve educational outcomes, promoting social interaction and critical thinking. SL apps offer diverse functionalities, such as adaptive learning, integrated assessment, and real-time feedback mechanisms, which empower educators to customize instruction and monitor progress effectively.

Accessibility and equity are also critical dimensions of SL apps. They can bridge educational gaps in underserved communities, promoting inclusivity and self-directed learning. However, concerns about the potential replacement of human teachers persist; professional development and supportive structures for educators are essential for successful adoption.

Long-term implications of SL app usage on students' learning habits are also important. Consistent engagement with SL apps correlates with enhanced academic outcomes over time, fostering critical thinking and lifelong learning habits. However, challenges such as cognitive overload, privacy concerns, and the digital divide must be addressed to ensure equitable implementation.
In comparing the current study with previous research in SL apps, several notable distinctions and contributions emerge that highlight the gap and novelty of this work:

- The study extends the focus of previous research by examining the interplay between various components of SL ecosystems.
- It explores how these elements can enhance educational outcomes beyond personalization.

- The research integrates multiple innovative technologies, including AI, augmented reality and virtual reality, to create immersive and engaging learning experiences.
- The study takes a longitudinal perspective, examining the sustained impact of SL apps on students' self-regulated learning skills and academic habits over time.
- The research adopts an interdisciplinary lens, incorporating insights from cognitive load theory, educational psychology, and technology adoption frameworks.
- The study identifies and proposes strategies for mitigating data privacy, security, and equitable access concerns in SL app deployment.
- The study emphasizes the continuous feedback 'loop' between teacher training, the integration of SL technologies, and educational outcomes.
- The research aims to contribute novel perspectives to the discourse surrounding SL apps.

While SL apps have significant benefits, it is crucial to navigate any associated limitations, such as digital equity, quality content control, and adequate instructor training, to maximize their effectiveness. Future research should explore these interfacing areas to better understand how to leverage SL apps for the benefit of all learners.

5. Conclusion

Integrating SL and AI in education significantly enhances student interaction, personalizes learning experiences, and prepares students and educators for future demands. However, challenges such as data privacy, equitable access, and acceptance among educators must be addressed to ensure that the transition toward SL is effective and inclusive. SL apps offer unique opportunities for personalized and accessible learning experiences; however, challenges such as digital equity and data privacy persist. It is also clear that realizing SL apps' full potential depends on enhancing additional research and collaboration among teachers, developers, and policymakers. SL apps offer enhanced engagement, personalized learning and accessibility, yet access, quality and effectiveness challenges remain.

Previous studies provide a solid foundation for understanding how to best integrate these technologies into educational settings. SL apps are motivating a revolution in education and provide diverse opportunities for personalized and collaborative learning experiences. However, challenges remain in addressing access and ensuring quality content. Ongoing research, collaboration among stakeholders, and attention to educational access are essential to unlock the full potential of SL apps and ensure equitable and effective learning environments for all students.

6. Future Directions

The integration of AI in SL is promising. AI tools should be designed to meet the needs of teachers and learners, enhancing learning outcomes and streamlining administrative tasks. Longitudinal studies should be conducted to assess the long-term impact of AI on educational outcomes. Interdisciplinary collaboration

among educators, technologists, and policymakers is crucial for creating robust AI-driven learning environments. Establishing best practices and standards for AI integration can further enhance the effectiveness of SL apps. Future research should focus on longitudinal studies, user experience exploration, impact of cultural context, analysis of efficacy across subjects, and teacher-led research. These areas will help shape a future where technology enriches the learning experience while ensuring equitable access for all learners.

8. References

Abbas Shah, S. F., Mazhar, T., Shahzad, T., Khan, M. A., Ghadi, Y. Y., & Hamam, H. (2023). Integrating educational theories with virtual reality: Enhancing engineering education and VR laboratories. *Social Sciences & Humanities Open*, *10*, 101207. https://doi.org/10.1016/j.ssaho.2024.101207

Alfredo, R., Echeverria, V., Jin, Y., Yan, L., Swiecki, Z., Gašević, D., & Martinez-Maldonado, R. (2024). Human-centred learning analytics and AI in education: A systematic literature review. *Computers and Education: Artificial Intelligence*, *6*, 100215. https://doi.org/10.1016/j.caeai.2024.100215

Ambele, R. M., Kaijage, S. F., Dida, M. A., Trojer, L., & Kyando, N. M. (2022). A review of the development trend of personalized learning technologies and its applications. *International Journal of Advances in Scientific Research and Engineering*, *8*(11), 75–91. https://doi.org/10.31695/ijasre.2022.8.11.9

Artificial Intelligence (AI) Guidance. (2024). *U.S. Department of Education*. https://www.ed.gov/about/ed-overview/artificial-intelligence-ai-guidance

Asoodeh, M., Asoodeh, M., & Zarepour, M. (2012). The impact of student-centered learning on academic achievement and social skills. *Procedia – Social and Behavioral Sciences, 46*, 560–564. https://doi.org/10.1016/j.sbspro.2012.05.160

Bandura, A. (2024). *Social Learning Analysis of Aggression*. Routledge EBooks. https://doi.org/10.4324/9781003487630-10

Banihashem, S. K., Noroozi, O., Van Ginkel, S., Macfadyen, L. P., & Biemans, H. J. (2022). A systematic review of the role of learning analytics in enhancing feedback practices in higher education. *Educational Research Review, 37*, 100489. https://doi.org/10.1016/j.edurev.2022.100489

Bradley, B. (2021). Global spending on virtual reality, AI in education poised to skyrocket, report says. *Marketbrief*. https://marketbrief.edweek.org/education-market/global-spending-on-virtual-reality-ai-in-education-poised-to-skyrocket-report-says/2021/02

Chatterjee, P., Gantait, A., Swamy, G.A., George, B. (2023). Information and Communication Technologies in Education: A Framework for Transforming the Indian Education System through Smart Learning. In A. Omrane, G. Patra, & S. Datta (Eds.), *Digital Technologies for Smart Business, Economics and Education. Arts, Research, Innovation and Society*. Springer. https://doi.org/10.1007/978-3-031-24101-7_16

Clarke, M. (2023). The Australian Framework for Generative Artificial Intelligence (AI) in Schools - Department of Education, Australian Government. *Department of Education.* https://www.education.gov.au/schooling/announcements/australian-framework-generative-artificial-intelligence-ai-schools

Cortez, P. M., Ong, A. K. S., Diaz, J. F. T., German, J. D., & Singh Jagdeep, S. J. S. (2024). Analyzing preceding factors affecting behavioral intention on communicational artificial intelligence as an educational tool. *Heliyon*, *10*(3), e25896. https://doi.org/10.1016/j.heliyon.2024.e25896

Cowan, P., & Farrell, R. (2023). Virtual reality as the catalyst for a novel partnership model in initial teacher education: ITE subject methods tutors' perspectives on the island of Ireland. *Education Sciences*, *13*(3), 228. https://doi.org/10.3390/educsci13030228

Das, S. (2024, May 28). *Beyond The Screen: Exploring Augmented Reality In Education. ELearning Industry.* https://elearningindustry.com/beyond-the-screen-exploring-augmented-reality-in-education

De Mattei, L., Morato, M. Q., Sidhu, V., Gautam, N., Mendonca, C. T., Tsai, A., Hammer, M., Creighton-Wong, L., & Azzam, A. (2024). Are artificial intelligence virtual simulated patients (AI-VSP) a valid teaching modality for health professional students? *Clinical Simulation in Nursing*, *92*, 101536. https://doi.org/10.1016/j.ecns.2024.101536

Deep, P. D., Ghosh, N., Gaither, C., & Koptelov, A. (2024). Gamification Techniques and the Impact on Motivation, Engagement, and Learning Outcomes in ESL Students. *RAIS Journal for Social Sciences*, *8*, 32–42. https://journal.rais.education/index.php/raiss/article/view/233/188

Deng, W., Wang, L., & Deng, X. (2024). Exploring interactive learning environments based on augmented reality technology. *International Journal of Interactive Mobile Technologies (iJIM)*, *18*, 15–29. https://doi.org/10.3991/ijim.v18i12.49911

Dewi O. M., & Elysia, N. (2023). The effects of the smart apps creator-based jire collaborative learning model on students' physics learning output in Gorontalo city. *International Journal of Science and Research Archive*, *9*(1), 194–202. https://doi.org/10.30574/ijsra.2023.9.1.0387

Digital Learning Canada – Canadian Digital Learning Research Association. (2020, September 25). *CDLRA/ACRFL*. Canadian Digital Learning Research Association. https://cdlra-acrfl.ca/about/

Dimitriadou, E., & Lanitis, A. (2023). A critical evaluation, challenges, and future perspectives of using artificial intelligence and emerging technologies in smart classrooms. *Smart Learning Environments*, *10*(1), 12. http://dx.doi.org/10.1186/s40561-023-00231-3

Dogan, M. E., Goru Dogan, T., & Bozkurt, A. (2023). The Use of Artificial Intelligence (AI) in Online Learning and Distance Education Processes: A Systematic Review of Empirical Studies. *Applied Sciences*, *13*(5), 3056. https://doi.org/10.3390/app13053056

Farrelly, T., & Baker, N. (2023). Generative artificial intelligence: Implications and considerations for higher education practice. *Education Sciences*, *13*(11), 1109. https://doi.org/10.3390/educsci13111109

Finnish National Agency for Education. (2019). Front page. Fi*nnish National Agency for Education.* https://www.oph.fi/en

Giacon, M. N., & Giselle, T. (2024, January 4). PNE (*National Education System*) 2014-2024 *Goal 20: the challenges for its monitoring and evaluation*. https://doi.org/10.13140/RG.2.2.22953.98404

GMI. (2023). AI in education market size, global industry forecast 2027. *Global Market Insights*, *Inc*. https://www.gminsights.com/industry-analysis/artificial-intelligence-ai-in-education-market

Hashim, S., Omar, M. K., Jalil, H. A., & Nurfadhlina Mohd Sharef. (2022). Trends on Technologies and Artificial Intelligence in Education for Personalized Learning: Systematic Literature Review. *International Journal of Academic Research in Progressive Education and Development*, *11*(1), 884–903. http://dx.doi.org/10.6007/IJARPED/v11-i1/12230

Jadhav, A. (2024). *Smart learning solutions: Harnessing the power of educational software*. Market Research Intellect® | Market Analysis and Research Reports, Jul. 15, 2024.

https://www.marketresearchintellect.com/blog/smart-learning-solutions-harnessing-the-power-of-educational-software/

Jurczyszyn, E. (2024). Exploring the dynamic landscape of formal, informal and non-formal learning. *International Journal of Pedagogy, Innovation and New Technologies*, *11*(1), 53–59. https://doi.org/10.5604/01.3001.0054.7069

Kapur, R. (2024). Factors necessary in leading to development of the education system in India. *International Journal of Information, Business and Management*, *16*(4), 150–159. https://search.proquest.com/openview/b75fb342452fae5c4b54a3b004384564/1?pq-origsite=gscholar&cbl=2032142

Kerimbayev, N., Umirzakova, Z., & Shadiev, R. (2023). A student-centered approach using modern technologies in distance learning: a systematic review of the literature. *Smart Learn. Environ.*, *10*, 61. https://doi.org/10.1186/s40561-023-00280-8

Khan Academy Kids. (2022). *Free, Fun Educational App for Young Kids | Khan Academy Kids*. Learn.khanacademy.org. https://learn.khanacademy.org/khan-academy-kids/

Kim, T., Cho, J.Y., Lee, B.G. (2013). Evolution to Smart Learning in Public Education: A Case Study of Korean Public Education. In T.Ley, M.Ruohonen, M.Laanpere, A.Tatnall (Eds.), *Open and Social Technologies for Networked Learning*. Springer. https://doi.org/10.1007/978-3-642-37285-8_18

Kurniawati, Sri. (2025). Social emotional learning on students' learning motivation to young learners. *Jurnal Pendidikan Generasi Nusantara*. 3. 1-8. https://doi.org/10.61787/gyzbhw61

Labrague, L. J., & Sabei, S. A. (2024). Integration of AI-powered chatbots in nursing education: A scoping review of their utilization, outcomes, and challenges. *Teaching and Learning in Nursing*. https://doi.org/10.1016/j.teln.2024.11.010

Li, L. (2024). Editor's Message for the series of Educational Technology in China. *Journal of Educational Technology Development and Exchange*, *17*(1), I–I. https://doi.org/10.18785/jetde.1701.01

Liang, M., Lim, C. P., Park, J., & Mendoza, N. B. (2023). A review of ICT-enabled learning for schoolgirls in Asia and its impacts on education equity. *Educational Technology Research and Development*. https://doi.org/10.1007/s11423-022-10178-w

Liu, M., Yu, D. Towards intelligent e-learning systems. *Educ Inf Technol.*, *28*, 7845–7876 (2023). https://doi.org/10.1007/s10639-022-11479-6

Lokare, V. T., & Jadhav, P. M. (2024). An AI-based learning style prediction model for personalized and effective learning. *Thinking Skills and Creativity*, *51*, 101421. https://doi.org/10.1016/j.tsc.2023.101421

Lünich, M., Keller, B., & Marcinkowski, F. (2024). Diverging perceptions of artificial intelligence in higher education: A comparison of student and public assessments on risks and damages of academic performance prediction in Germany. *Computers and Education: Artificial Intelligence*, 7, 100305. https://doi.org/10.1016/j.caeai.2024.100305

MEXT (Ministry of Education, Culture, Sports, Science and Technology). *Education system in Japan*. Retrieved February 28, 2025, from https://www.mext.go.jp/en/policy/education/index.htm

Mhlongo, S., Mbatha, K., Ramatsetse, B., & Dlamini, R. (2023). Challenges, opportunities, and prospects of adopting and using smart digital technologies in learning environments: An iterative review. *Heliyon*, *9*(6), e16348. https://doi.org/10.1016/j.heliyon.2023.e16348

Ministry of Human Resource Development. (2020). *National Education Policy 2020*. Government of India. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf

Mnguni, L., Nuangchalerm, P., Zaky El Islami, R. A., Sibanda, D., Sari, I. J., & Ramulumo, M. (2024). The behavioural intentions for integrating artificial intelligence in

science teaching among pre-service science teachers in South Africa and Thailand. Computers and Education: *Artificial Intelligence*, 7, 100334. https://doi.org/10.1016/j.caeai.2024.100334

Morris, T. H., & Rohs, M. (2023). The potential for digital technology to support self-directed learning in formal education of children: A scoping review. *Interactive learning environments*, *31*(4), 1974–1987. https://doi.org/10.1080/10494820.2020.1870501

Muthmainnah, P. M. I. S., & Oteir, I. (2022). Playing with AI to investigate human-computer interaction technology and improving critical thinking skills to pursue 21st century age. *Education Research International*, 2022. https://doi.org/10.1155/2022/6468995

Neves, C., Oliveira, T., Cruz-Jesus, F., & Venkatesh, V. (2025). Extending the unified theory of acceptance and use of technology for sustainable technologies context. *International Journal of Information Management*, *80*, 102838. https://doi.org/10.1016/j.ijinfomgt.2024.102838

Nguyen, L. T., Kanjug, I., Lowatcharin, G., Manakul, T., Poonpon, K., Sarakorn, W., Somabut, A., Srisawasdi, N., Traiyarach, S., & Tuamsuk, K. (2022). How teachers manage their classroom in the digital learning environment – experiences from the University Smart Learning Project. *Heliyon*, *8*(10), e10817. https://doi.org/10.1016/j.heliyon.2022.e10817

Occhipinti, J. A., Prodan, A., Hynes, W., Buchanan, J., Green, R., Burrow, S., Eyre, H. A., Skinner, A., Ujdur, G., Buchanan, J., Hickie, I. B., Heffernan, M., Song, C., & Tanner, M. (2025). Artificial intelligence, recessionary pressures and population health. *Bulletin of the World Health Organization*, *103*(2), 155. https://doi.org/10.48550/arXiv.2403.17405

Praharaj, L., Gupta, D., & Gupta, M. (2024). Efficient federated transfer learning-based network anomaly detection for cooperative smart farming infrastructure. *Smart Agricultural Technology*, 100727. https://doi.org/10.1016/j.atech.2024.100727

Pratama, M. P., Sampelolo, R., & Lura, H. (2023). Revolutionizing education: Harnessing the power of artificial intelligence for personalized learning. Klasikal: *Journal of Education, Language Teaching and Science*, *5*(2), 350–57. https://doi.org/10.52208/klasikal.v5i2.877

Prime Minister's Initiatives. (2024). *Uaecabinet*.ae. https://uaecabinet.ae/en/prime-ministers-initiatives/mohammed-bin-rashid-smart-learning-programme

Rafiq, S., Iqbal, S., & Afzal, A. (2024). The Impact of Digital Tools and Online Learning Platforms on Higher Education Learning Outcomes. *Al-Mahdi Research Journal*, *5*(4), 359–369. https://ojs.mrj.com.pk/index.php/MRJ/article/view/342

Sabiroh, Md S. S., Ismail, I., Annuar, N., Abdul Rahman, N. R., Abd Hamid, N. Z., & Abd Mutalib, H. (2024). A conceptual analysis of technology integration in classroom instruction towards enhancing student engagement and learning outcomes. *International Journal of Education, Psychology and Counseling*, *9*(55), 750–769. https://doi.org/10.35631/ijepc.955051

Shahzad, M. F., Xu, S., Lim, W. M., Yang, X., & Khan, Q. R. (2024). Artificial intelligence and social media on academic performance and mental well-being: Student perceptions of positive impact in the age of smart learning. *Heliyon*, *10*(8), e29523. https://doi.org/10.1016/j.heliyon.2024.e29523

Sheikhtaheri, A., Taheri Moghadam, S., Dehnad, A., & Tatarpoor, P. (2023). Factors influencing nurses' acceptance of patient safety reporting systems based on the unified theory of acceptance and use of technology (UTAUT). *Informatics in Medicine Unlocked*, *49*, 101554. https://doi.org/10.1016/j.imu.2024.101554

Shu, X., & Gu, X. (2023). An empirical study of A smart education model enabled by the edu-metaverse to enhance better learning outcomes for students. *Systems*, *11*(2), 75. https://doi.org/10.3390/systems11020075

Siantuba, J., Nkhata, L., & de Jong, T. (2023). The impact of an online inquiry-based learning environment addressing misconceptions on students' performance. *Smart Learning Environments*, *10*(1). https://doi.org/10.1186/s40561-023-00236-y

Silva, G., Godwin, G., & Jayanagara, O. (2024). The Impact of AI on Personalized Learning and Educational Analytics. *International Transactions on Education Technology (ITEE), 3*(1), 36–46. https://doi.org/10.33050/itee.v3i1.669

Smart Nation Singapore. (2019). Singapore National AI Strategy 2.0 (NAIS 2.0). *Smartnation.gov.sg*. https://www.smartnation.gov.sg/nais/

Sweller, J. (1988). Cognitive Load during Problem Solving: Effects on Learning. *Cognitive Science*, *12*(2), 257–285. https://doi.org/10.1207/s15516709cog1202_4

Tabuenca, B., Uche-Soria, M., Greller, W., Hernández-Leo, D., Balcells-Falgueras, P., Gloor, P., & Garbajosa, J. (2024). Greening smart learning environments with artificial intelligence of things. *Internet of Things*, *25*, 101051. https://doi.org/10.1016/j.iot.2023.101051

Tagdimi, Zakaria & Souhaib, Aammou & Amzil, Ikram. (2023). Resource reappropriation approach: enhancing student engagement and learning outcomes through personalized content. *Conhecimento & Diversidade*, *15*, 213-225. https://doi.org/10.18316/rcd.v15i39.11132

Tatnall, A., & Fluck, A. (2022). Twenty-five years of the education and the information technologies journal: Past and future. *Education and Information Technologies*, *27*(2), 1359–1378. https://doi.org/10.1007/s10639-022-10917-9

Thomas, L. J., Parsons, M., & Whitcombe, D. (2019). Assessment in smart learning environments: Psychological factors affecting perceived learning. *Computers in Human Behavior*, *95*, 197–207. https://doi.org/10.1016/j.chb.2018.11.037

Tope, S. A., & Kalema, B. M. (2019, August 1). *A Pedagogical Smart Learning Environment in South African Tertiary Institutions*. https://www.researchgate.net/publication/335757216_A_Pedagogical_Smart_Learning_Environment_in_South_African_Tertiary_Institutions

Vorecol.com. (2024). *Data Security and Privacy Concerns in Learning Management System Implementation*. Vorecol.com. https://vorecol.com/blogs/blog-data-security-and-privacy-concerns-in-learning-management-system-implementation-185048

Wang, S., Wang, F., Zhu, Z., Wang, J., Tran, T., & Du, Z. (2024). Artificial intelligence in education: A systematic literature review. *Expert Systems With Applications, 252*,124167. https://doi.org/10.1016/j.eswa.2024.124167

Wong, B. (2017). Learning analytics in higher education: An analysis of case studies. *Asian Association of Open Universities Journal*, *12*, 21–40. http://dx.doi.org/10.1108/AAOUJ-01-2017-0009

Xu, J., Li, J., & Yang, J. (2024). Self-regulated learning strategies, self-efficacy, and learning engagement of EFL students in smart classrooms: A structural equation modeling analysis. *System*, *125*, 103451. https://doi.org/10.1016/j.system.2024.103451

Yandex. (2025). *Yandex.rs*. https://education.yandex.rs/main/index_en

Yavuzalp, N., Derya Gürer, Melih, Curaoğlu, O., Durmuş, S., Akayoğlu, S., Bahar, M., Kiliç, F., & Tekinarslan, E. (2016). FATIH Project in Turkey: A Case Analysis. Icm.edu.pl; Wydawnictwo Uniwersytetu Śląskiego. *Katowice 2015*. https://open.icm.edu.pl/items/79e2acf5-ec60-4def-861a-e69fb8c58dbe

Yeung, R. C. Y., Yeung, C. H., Sun, D., & Looi, C. K. (2024). A systematic review of drone integrated STEM education at secondary schools (2005–2023): Trends, pedagogies, and learning outcomes. *Computers & Education*, 104999. https://doi.org/10.1016/j.compedu.2024.104999

Yusup, Y., Subiyakto, B., Sari, R., Ilhami, M. R., & Syarifuddin, S. (2024). Application of Smart Apps Creator as Social Studies Learning Media in Class VII Market Materials. *The Kalimantan Social Studies Journal*, *6*(1), 97. https://doi.org/10.20527/kss.v6i1.12123

Zeng, H., Liu, J., Wu, D., & Yue, L. (2023). *Smart education best practices in Chinese schools*. Springer. https://doi.org/10.1007/978-981-99-6097-2

Zong Zheng (宗政), 2024). National Smart Education Platform launches special education section - Ministry of Education of the People's Republic of China. *Moe.gov.cn*. http://en.moe.gov.cn/news/press_releases/202412/t20241210_1166463.html