

## PAPER

# LXA v1.0: A Framework to Embrace Agentic AI in Mobile Learning for Industry 5.0 Readiness

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Mobile learning is shifting from static content delivery to intelligent, human-centered ecosystems aligned with Industry 5.0. Yet many platforms remain fragmented, offering only limited personalization, weak ethical safeguards, and low adaptability. This study introduces the Learning eXperience with Agency (LXA v1.0) framework, developed to guide mobile learning toward 2030 through agentic AI. LXA v1.0 was created using a mixed-method approach. The process combined a scoping review of research published between 2015 and 2025, conceptual modeling, and a two-round Delphi study with 14 international experts. The review examined how learning management systems (LMS) have developed into AI-enabled platforms while also pointing out persistent gaps in autonomy, transparency, and resilience. Feedback from experts stressed the need to design systems that are inclusive and firmly rooted in ethical values. The framework is built around four connected pillars. The agency focuses on learner control supported by AI. Ambient learning relates to context-aware experiences. Inclusion & ethics point to fair and transparent design. Resilience refers to the ability to adapt during periods of disruption. The Delphi validation produced strong agreement on clarity, feasibility, measurability, and relevance. Taken together, LXA v1.0 provides a tested roadmap for building mobile-first learning ecosystems that are advanced in technology, grounded in ethics, and prepared for the future.

**KEYWORDS**

mobile learning, agentic AI, Industry 5.0, human-AI collaboration, AI ethics

## 1 INTRODUCTION

With the growth of digital technology, the way people learn has changed. In earlier times, learning was led mainly by teachers, and students were passive listeners. Nowadays, much learning takes place on mobile devices, and this gives learners the chance to decide when, where, and at what speed they want to study. Such flexibility reflects a wider social change, as phones and tablets have become the main tools people use to find information, gain new skills, and build their careers [1]. Initially, learning management systems (LMSs) acted as an online tool to upload notes and readings.

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These systems helped teachers assess the progress of the students. Most of the lessons looked the same, since the platform was designed for uniformity delivery. As time went on, these systems no longer met all learning needs. This led to the rise of Learning Experience Platforms (LXPs). LXPs still hold the resources, but they do more. They pull in content from many different sources and help students build their own learning paths. They also adjust the pace of study to match each learner. Because of this, learning has become more flexible, more personal, and far more engaging [2]. Existing mobile learning frameworks still fall short of the vision set out in Industry 5.0, which calls for technology that is human-centered, sustainable, and built around cooperation between people and intelligent systems [3]. Research in this area [4], [5] shows that many of the current platforms limit learner independence. They also face problems with inclusivity, ethics, data protection, and the openness of algorithms.

In contrast, agentic AI is not bound only by fixed rules. It can set its own goals, shape learning routes, and work as a partner with the learner. This allows it to give tailored support in both formal and informal learning settings [6], [7]. Studies on the AI-C2C framework underline the need for designs guided by conscience. They highlight values such as accountability, fairness, and sustainability in addressing the challenges linked to agentic AI [8], [9]. The current study puts forward learning experience with agency (LXA v1.0), a framework that brings agentic AI into mobile learning to meet the goals of Industry 5.0. The framework was shaped through a scoping review and a Delphi validation process. It is built on four key pillars: agency, ambient learning, inclusion and ethics, and resilience. The study makes three main contributions. First, it brings together evidence on the use of agentic AI in adaptive platforms. Second, it points out the ethical and design issues faced in mobile education. Third, it presents a validated model that can guide the creation of mobile learning systems that are inclusive, sustainable, and ready for the future.

## 2 LITERATURE REVIEW

Research on digital learning shows a steady shift from LMSs to LXPs and, more recently, to models that use advanced technologies. Early LMSs mainly handled compliance and content delivery, offering little room for learner choice or personalization [4], [10], [11]. LXPs moved the focus toward learner-driven pathways, mobile access, and social features, but problems with integration and uneven adoption have limited their reach [1], [12], [13]. Newer platforms enhanced by AI bring in adaptive sequencing, predictive personalization, chatbots, and immersive tools, yet they continue to face barriers of scale, ethics, and equity [14], [15], [16]. Table 1 summarizes the progression from LMS to LXP and agentic AI-enabled learning systems.

**Table 1.** Progression of learning systems from LMS to Agentic AI

Stage	Key Features and Capabilities	Adoption Barriers	Status and Future Outlook	Citations
LMS (2010–present)	Course or content management, compliance, basic mobile access	Static pathways, limited personalization	Still widely used; gradually supplemented by LXPs	[4], [10], [11]
LXP (2015–present)	Learner-centric pathways, mobile-first, social features	Integration complexity, uneven adoption	Expanding, but not yet mainstream; often algorithm-driven	[1], [12], [13]

*(Continued)*

**Table 1.** Progression of learning systems from LMS to Agentic AI (Continued)

Stage	Key Features and Capabilities	Adoption Barriers	Status and Future Outlook	Citations
AI-enabled LXP (2022–emerging)	Adaptive learning, predictive personalization, chatbots, AR/VR, analytics	Privacy, ethics, digital divide	Early pilots; penetration limited; transition phase toward agentic models	[14], [15], [16]
Agentic AI Systems (conceptual, 2025+)	Multi-agent orchestration, generative AI, co-agency, reinforcement learning	Trust, transparency, interoperability, equity	Mostly theoretical; proposed frameworks (e.g., LXA v1.0) under validation	[2], [16], [17], [18]

Notes: LMS = Learning management system; LXP = Learning experience platform; AI-LXP = AI-enabled Learning Experience Platform; AI = Artificial Intelligence.

At the same time, recent studies highlight risks linked to opaque algorithms and unequal access to digital tools. These issues often leave underrepresented learners at a disadvantage and weaken the promise of mobile-first education. Current approaches also tend to react to learner actions rather than fostering genuine independence or embedding ethical safeguards in system design. In response, the concept of agentic AI has begun to take shape, aiming to move beyond surface-level personalization toward shared decision-making, openness, and resilience in keeping with the human-centered goals of Industry 5.0 [2], [16], [17], [18]. Taken together, these gaps form the basis for proposing the LXA v1.0 framework.

### 3 MATERIALS AND METHODS

This current study combines a scoping review, the LXA v1.0 framework, and a Digital Delphi validation to bring together research on the role of agentic AI in mobile education. This study also advances the LXA v1.0 framework and confirms its value for developing educational environments that are inclusive, sustainable, and aligned with the aims of Industry 5.0.

#### 3.1 Scoping review

Building on the literature review, a systematic scoping review was carried out to map research trends on the integration of agentic AI within adaptive learning platforms between 2015 and 2025. The review followed the approach outlined by Arksey and O'Malley, with searches conducted across Web of Science, Scopus, IEEE Xplore, and ACM Digital Library. Search terms combined variations of “agentic AI,” “autonomous agents,” and “intelligent agents” with “mobile learning,” “adaptive learning,” and “learning experience platform,” along with “personalization,” “agency,” and “Industry 5.0.” Studies were eligible if they were peer-reviewed, written in English, and examined applications of AI agents in education. Non-empirical work, conference abstracts, and research unrelated to educational technology were excluded. From 847 records initially identified, two researchers independently screened titles and abstracts, reaching 94% agreement (Cohen's  $\kappa = 0.89$ ). In total, 50 studies

were retained, covering applications of agentic AI, mechanisms to enhance learner agency, and ethical concerns in mobile learning environments.

### 3.2 Framework development

Learning experience with agency v1.0 was developed using a design science methodology [10] that combined literature evidence, expert input, and iterative refinement. The scoping review (2015–2025) established the knowledge base, while a two-round Delphi process defined conceptual boundaries and operational criteria. Supplementary interviews with educators and EdTech practitioners added practical insights. Author group workshops and drafting cycles integrated these inputs with theory, drawing on self-determination, situated learning, and human–computer interaction to emphasize autonomy, context-awareness, and usability. Futures thinking and Industry 5.0 priorities guided the value orientation toward human–AI collaboration, resilience, and sustainability. The framework was released as Version 1.0, structured for ongoing revision in response to governance standards, technological advances, and future empirical testing.

### 3.3 Digital Delphi validation

Fourteen international experts took part in two validation rounds aimed at testing and refining the LXA v1.0 framework. In Round 1, participants provided structured qualitative feedback on the four pillars—Agency, Ambient Learning, Inclusion and Ethics, and Resilience—assessing their clarity, feasibility, and practical relevance. Their observations were systematically coded into themes that highlighted key strengths, exposed limitations, and generated recommendations for improvement. Round 2 built on these insights through a quantitative assessment, with experts rating each pillar on a 7-point Likert scale across clarity, feasibility, measurability, and relevance. Consensus was defined as a coefficient of variation (CV) of  $\leq 20\%$  combined with at least 75% agreement among respondents. The quantitative data were examined using descriptive statistics, while the qualitative feedback was analyzed thematically. By triangulating the two strands of evidence, the study confirmed the framework’s conceptual coherence, empirical validity, and practical value for advancing agentic AI in mobile learning.

## 4 RESULTS

### 4.1 Findings from the scoping review (2015–2025)

The scoping review examined how digital learning platforms have developed over the last decade and identified both advances and continuing challenges. While LMSs and LXPs expanded opportunities for learner access and flexibility, most systems still do not meet the expectations of Education 5.0 and Industry 5.0. Personalization in learning systems is still quite restricted. Adjustments usually focus only on pacing or sequencing, without giving learners genuine authority over setting their own goals or making decisions [1], [3], [10], [11]. Context awareness also remains underdeveloped, as most systems fail to incorporate situational or environmental factors into the learning process [19]. At the same time, ethical issues are frequently noted, such as

algorithmic bias and poor accessibility, which tend to further disadvantage already vulnerable learners [15], [20], [21]. Structural barriers—such as weak interoperability, outdated infrastructure, and unequal access to digital tools—still limit the effectiveness of mobile-first ecosystems [22], [23]. Taken together, these challenges reveal a clear gap between what technology can offer, and the human-centered approach highlighted in recent discussions on sustainable and inclusive education [2], [4], [5]. Even so, the review also noted the rise of several promising innovations. AI-enhanced platforms are beginning to incorporate adaptive sequencing, learning content generation, and conversational agents that support engagement in more interactive ways [21], [24], [25]. Yet these developments are still fragmented, often tested as isolated tools rather than integrated into unified systems. The heavy reliance on proprietary algorithms, along with stark differences in regional infrastructure and the absence of widely accepted standards, continues to limit both scalability and inclusivity [17], [18]. At the same time, research on AI-supported content creation [26], the use of design science in education [27], and systematic reviews of agentic AI [28] show that many of the latest innovations remain isolated efforts, with little evidence of coherent integration. The challenges outlined make clear the need for a single, coherent framework—one that weaves together new technical developments while grounding them in ethical safeguards, co-agency, and resilience as essential design values. On this basis, the LXA v1.0 framework has been developed, as presented in Figure 1.

Capability	LMS (2010–2015)	LXP (2015–2022)	AI-LXP (2022–2025)	Agentic AI (2025–2030)
Personalization	No personalization	Reactive personalization	Predictive personalization	Co-agency personalization
Interoperability	Siloed systems	Partial interoperability	Limited interoperability	Cross-platform integration
Context-awareness	Absent context-awareness	Low context-awareness	Medium context-awareness	High ambient context-awareness
Ethics & inclusion	Ethics ignored	Minimal ethics	Emerging ethics	Embedded ethics
Resilience	Fragile resilience	Rigid resilience	Adaptive in parts	Dynamic & scalable resilience

Fig. 1. Evolution of learning platform capabilities from 2010 to 2030

Notes: LMS = Learning Management System; LXP = Learning Experience Platform; AI-LXP = AI-enabled Learning Experience Platform; AI = Artificial Intelligence.

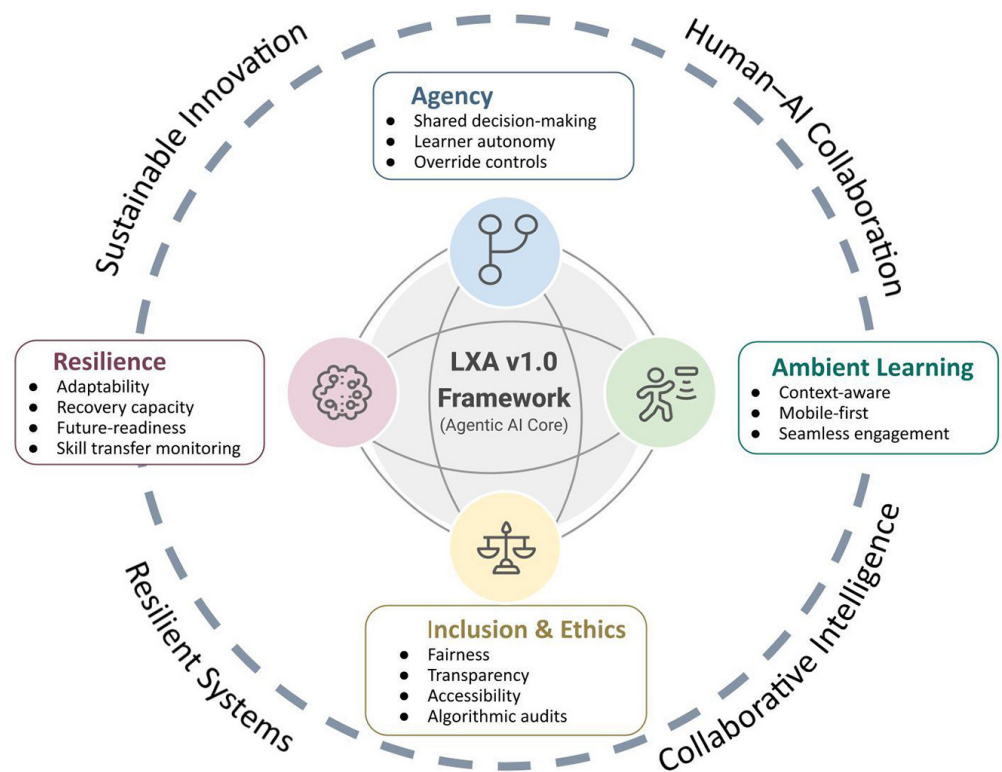
Source: Author-created image.

## 4.2 The learning experience with the agency (LXA v1.0) framework

**Rationale and framework overview.** The scoping review pointed to three main weaknesses in digital learning systems. Many of them lack strong ethical safeguards. The technology they use is often rigid and hard to update. They also give learners limited freedom to direct their own progress. The review further noted that current frameworks provide little defense against issues such as bias, lack of transparency, and the misuse of data [8]. Older LMSs add to these difficulties because they tend to operate in isolation, making it harder to link different tools and to fully support learning on mobile platforms [4], [29]. LXPs have taken learning a bit further by providing more tailored content to users. However, most of them still only respond

to what learners do, rather than helping students take real control of their own learning or ensuring fairness in process design [5], [30]. However, most of them still only respond to what learners do, rather than helping students take real control of their own learning or making sure the process is fair [5]. Because of these shortcomings, they do not fully match the direction set by Industry 5.0, which calls for stronger human–AI partnerships as well as a focus on sustainability and resilience [3]. To fill these gaps, this study puts forward the learning experience with agency (LXA v1.0) framework. It places agentic AI at the center of mobile learning and builds on three principles: ethical design, shared agency, and resilience. The framework is offered as a flexible model that can be updated over time to keep up with new technologies, governance needs, and research evidence.

**Framework architecture: The four pillars.** LXA v1.0 is structured around four interdependent pillars: Agency, Ambient Learning, Inclusion and Ethics, and Resilience, each linked to a functional layer and grounded in Industry 5.0 values (see Figure 2). Agency (Hero Layer) enables co-decision-making between learner and AI through transparent algorithms, override controls, and goal negotiation mechanisms that safeguard autonomy [31], [32]. Ambient Learning (Base Layer) embeds learning in real-world, mobile contexts via seamless delivery, including location-aware micro-learning and push-based nudges for continuous engagement [33], [34]. Inclusion and Ethics (Equity Layer) promotes fairness and accessibility with multilingual design, low-bandwidth optimization, explainability dashboards, and algorithmic audits [35], [36]. Resilience (Outcome Layer) strengthens adaptability by supporting dynamic pacing, feedback-driven recalibration, and monitoring of skill transfer [2], [37]. Together, these pillars address critical gaps in existing systems and position LXA v1.0 as a sustainable, ethically anchored successor to LMS and LXP architectures.



**Fig. 2.** The learning experience with the agency (LXA v1.0) framework with agentic AI at the core and four interdependent pillars aligned to Industry 5.0

Source: Author-created conceptual model.

**Theoretical grounding and novel contributions.** LXA v1.0 rests on three theoretical foundations. First, Industry 5.0 emphasizes human needs, resilience, and sustainability, which in education translate into co-agency, learner well-being, and environmental responsibility measured through override rates, system uptime, and resource efficiency [38–41]. Second, earlier platforms suffered from weak ethical oversight and poor interoperability, underscoring the need for a mobile-first framework designed to address these deficits [35], [42]. Third, recent agentic AI research provides design patterns stressing shared control, transparency, and explainability, which LXA incorporates through features such as co-decision interfaces and explainability dashboards [43], [44]. Collectively, these foundations move LXA from concept to deployable architecture, converting values such as co-agency and resilience into measurable indicators. In doing so, the framework preserves theoretical rigor while ensuring feasibility for both research and practical application.

### 4.3 Validation of LXA v1.0: Agile delphi study

The value of the framework comes from both conceptual rigor and the ability to stand up to expert review. To validate and refine LXA v1.0, the study used an agile, two-round Delphi study that balanced rigorous academic review with practice-based judgment. Fourteen experts participated across both rounds. Five from academia, five from corporate learning and development, and four from EdTech, providing both qualitative insights and quantitative ratings.

**Round 1: Qualitative expert feedback.** In the first round, experts assessed the draft framework for clarity, feasibility, and practical value. Their feedback, coded thematically, highlighted both strengths and areas requiring refinement. Inclusion and Ethics drew the strongest support, while Agency was praised but needed clearer boundaries between personalization and co-agency. Ambient learning was feasible yet insufficiently distinct from existing mobile learning, and resilience was valued but required sharper operational indicators. Table 2 summarizes these findings, outlining consensus areas and practical recommendations that refined definitions and strengthened the implementation pathways of LXA v1.0.

**Table 2.** Delphi round 1: Thematic findings from expert reviews (n = 14 experts, 100% response rate)

Pillar	Expert Feedback Summary	Primary Themes (% mentions)	Consensus Areas	Implementation Recommendations
Agency	Well-articulated but blurred line between personalization and co-agency; risk of cognitive overload and compliance gaps.	Conceptual clarity (71%), implementation (57%), measurement (50%), regulation (29%)	Clearer operational boundaries	Use override/negotiation logs, balance autonomy with compliance, and define learner control indicators
Ambient Learning	Sound and feasible but not clearly distinct from mobile learning.	Technical needs (71%), clarity (57%), differentiation (50%)	Feasibility confirmed	Ensure offline continuity, legacy-device compatibility, and cross-device sync
Inclusion & Ethics	Strongest pillar; feasibility of real-time audits questioned; accessibility standards needed.	Ethical base (79%), implementation (57%), accessibility (50%), trust (29%)	Strong consensus on feasibility	Add explainability dashboards, multilingual support, periodic audits, and trust-building measures
Resilience	Essential but under-specified; indicators lacking.	Measurement (86%), specification (57%), importance (71%)	Conceptual importance clear	Use time-to-competence and skill-transfer metrics, adaptive recovery features, and cognitive load detection

Notes: Percentages = proportion of experts raising each theme; ≥50% = high-priority refinement areas.

**Round 2: Quantitative consensus.** In the second round, experts rated each pillar of LXA v1.0 on clarity, feasibility, measurability, and relevance using a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree). Consensus was defined as a coefficient of variation (CV)  $\leq 20\%$  [45], [46]. Table 3 summarizes the results. Consensus was achieved in 14 of 16 pillar–criterion combinations (87.5%), with full participation. Agency and Resilience reached consensus across all criteria, with Resilience notably shifting from underdefined in Round 1 to fully validate. Ambient Learning and Inclusion and Ethics achieved consensus on most criteria, with only feasibility and relevance narrowly above the CV threshold, indicating minor areas for refinement rather than structural weakness. Overall, the framework earned a median of 6.0/7.0, a mean of 5.64 (SD = 1.13), and 81.3% agreement, reflecting strong alignment across expert perspectives. Together with Round 1, these findings confirm LXA v1.0 as theoretically robust and operationally viable, with Agency and Resilience particularly validated and Ambient Learning and Inclusion & Ethics flagged for refinement.

**Table 3.** Delphi round 2 quantitative validation results: Expert consensus on the LXA v1.0 framework

Pillar	Criterion	Median	IQR	Mean (SD)	CV%	Consensus	Agreement%
Agency	Clarity	6	1.8	6.00 (0.96)	16	✓	92.9
	Feasibility	6	2	5.79 (1.12)	19.4	✓	85.7
	Measurability	6	1.8	5.71 (1.14)	19.9	✓	78.6
	Relevance	6	1.8	5.50 (1.16)	21.1	✓	71.4
Ambient Learning	Clarity	5	2	5.21 (1.12)	21.5	✓	85.7
	Feasibility	5.5	2.5	5.36 (1.20)	22.3	✗	71.4
	Measurability	5	1	4.93 (0.92)	18.8	✓	92.9
	Relevance	6	2	5.79 (1.31)	22.5	✓	78.6
Inclusion & Ethics	Clarity	6	2.8	6.07 (1.35)	22.2	✓	71.4
	Feasibility	5	1	5.07 (0.92)	18.6	✓	92.9
	Measurability	5.5	1	5.50 (1.02)	18.2	✓	85.7
	Relevance	5.5	1.8	5.36 (1.15)	21.3	✗	78.6
Resilience	Clarity	6	1	6.21 (0.89)	15.1	✓	100
	Feasibility	6	2	5.93 (1.14)	18.8	✓	85.7
	Measurability	6	2	5.79 (1.25)	21.6	✓	78.6
	Relevance	6	2.8	5.36 (1.22)	22.6	✓	71.4
Overall Framework	All Criteria	6	2	5.64 (1.13)	20	✓	81.3

Notes: IQR = Interquartile Range; SD = Standard Deviation; CV = Coefficient of Variation. Consensus threshold = CV  $\leq 20\%$ . ✓ = consensus met; ✗ = narrowly missed.

## 5 DISCUSSION

The scoping review shows that despite progress from LMS to LXPs, most digital environments still fail to deliver adaptive, inclusive, and interoperable learning. Personalization remains shallow, offering limited learner control, while accessibility

and multilingual features are inconsistently applied, disadvantaging underrepresented groups [47], [48]. Fragmented infrastructures also restrict data mobility and integration [49]. Emerging AI-enabled ecosystems demonstrate potential through adaptive algorithms, conversational agents, and ambient intelligence that create context-aware, mobile-first experiences [50], [51]. In response, LXA v1.0 consolidates these advances into four pillars: Agency, Ambient Learning, Inclusion and Ethics, and Resilience, providing a structured, measurable model. Expert validation confirmed the need to embed co-agency, inclusion, and resilience as operational features [52]. By translating abstract constructs into indicators such as transparency controls, adaptive pacing, and fairness audits, LXA v1.0 positions itself as a practical framework to bridge persistent gaps in autonomy, equity, and trust [17].

Industry 5.0 reframes digital transformation as human-centered, emphasizing sustainability, resilience, and collaboration between humans and intelligent systems [3], [37], [39]. In education, this calls for frameworks that move beyond automation to support shared decision-making, equitable access, and resilient infrastructures [38], [44]. LXA v1.0 aligns with these priorities by embedding transparency and override controls to safeguard learner autonomy [35], incorporating inclusive design to widen participation [52], and using adaptive feedback loops for real-time recalibration and resilience [47]. It advances the shift from LMS and LXP toward agentic ecosystems by converting abstract constructs, such as transparency, autonomy, and recovery, into operational indicators embedded in system architecture [6]. Practically, it guides EdTech providers, universities, and corporate L&D, with early deployments of AI mentors and mobile microlearning platforms already improving personalization and equity [13], [17]. At the governance level, initiatives like Bring Your Own AI (BYOAI) underscore the urgency of aligning institutional readiness with responsible integration [53]. Collectively, LXA v1.0 emerges as both a conceptual model and a practical blueprint for academia, industry, and policymakers to co-develop scalable, inclusive, and ethically anchored mobile learning ecosystems.

## 6 LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

The development and validation of LXA v1.0 represent an important step, yet several limitations remain. Reliance on peer-reviewed literature excluded grey sources and practitioner insights, while the Delphi study involved only 14 experts, limiting representativeness. The framework is conceptually rather than empirically validated, and its focus on India and the Middle East restricts wider applicability. These gaps highlight clear priorities. Pilot studies in higher education, corporate learning, and EdTech should assess feasibility, inclusivity, and unintended effects, while longitudinal research must distinguish novelty from sustained impact, with emphasis on readiness, equity, and resilience. Future work should also establish enforceable standards for ethical AI governance and extend the framework to non-cognitive dimensions: motivation, collaboration, and well-being, tested across diverse regions and sectors to confirm scalability and long-term value.

## 7 CONCLUSION

This study examined how agentic AI can be operationalized in mobile learning for Industry 5.0 readiness, proposing the learning experience with Agency (LXA v1.0) framework. Built on four pillars: agency, ambient learning, inclusion &

ethics, and resilience, and validated through a two-round Delphi, LXA v1.0 shows both conceptual rigor and practical viability. It advances digital learning by embedding co-agency, inclusion, and resilience into a coherent, human-centered model, while offering educators, technologists, and policymakers a pathway to develop scalable and ethical mobile-first ecosystems. Strong expert consensus, particularly on agency and resilience, supports its adoption across higher education, corporate training, and EdTech. As mobile learning becomes central to lifelong education and workforce development, LXA v1.0 provides principled guidance for building systems that empower human potential and remain adaptive, inclusive, and sustainable.

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## 9 REFERENCES

- [1] A. Ezzaim *et al.*, “AI-based learning style detection in adaptive learning systems: A systematic literature review,” *J. Comput. Educ.*, vol. 12, pp. 731–769, 2025. <https://doi.org/10.1007/s40692-024-00328-9>
- [2] W. Strielkowski, V. Grebennikova, A. Lisovskiy, G. Rakhimova, and T. Vasileva, “AI-driven adaptive learning for sustainable educational transformation,” *Sustainable Development*, vol. 32, no. 2, pp. 1921–1947, 2024. <https://doi.org/10.1002/sd.3221>
- [3] T. Ahmad, F. Aslam, and M. Shafique, “Education 5.0: Requirements, enabling technologies, and future directions,” *Educ. Inf. Technol.*, vol. 28, no. 4, pp. 4993–5013, 2023. <https://doi.org/10.48550/arXiv.2307.15846>
- [4] A. Bozkurt, A. Karadeniz, D. Baneres, A. E. Guerrero-Roldán, and M. E. Rodríguez, “Artificial intelligence and reflections from educational landscape: A review of AI studies in half a century,” *Sustainability*, vol. 13, no. 2, p. 800, 2021. <https://doi.org/10.3390/su13020800>
- [5] H. Wang *et al.*, “Examining the applications of intelligent tutoring systems in real educational contexts: A systematic literature review from the social experiment perspective,” *Educ. Inf. Technol.*, vol. 28, pp. 9113–9148, 2023. <https://doi.org/10.1007/s10639-022-11555-x>
- [6] D. B. Acharya, K. Kuppan, and B. Divya, “Agentic AI: Autonomous intelligence for complex goals—A comprehensive survey,” *IEEE Access*, vol. 13, pp. 18912–18936, 2025. <https://doi.org/10.1109/ACCESS.2025.3532853>
- [7] A. Baillifard *et al.*, “Effective learning with a personal AI tutor: A case study,” *Educ. Inf. Technol.*, vol. 30, pp. 297–312, 2025. <https://doi.org/10.1007/s10639-024-12888-5>
- [8] S. Murugesan, “The rise of agentic AI: Implications, concerns, and the path forward,” *IEEE Intelligent Systems*, vol. 40, no. 2, pp. 8–14, 2025. <https://doi.org/10.1109/MIS.2025.3544940>
- [9] T. Anthuvan and K. Maheshwari, “AI-C2C (conscious to conscience): A governance framework for ethical AI integration,” *AI Ethics*, vol. 5, pp. 4241–4253, 2025. <https://doi.org/10.1007/s43681-025-00736-2>

- [10] X. Zhang, Y. Hai, and C. Li, "Learning management system in education via mobile app: Trends and patterns in mobile learning," *International Journal of Interactive Mobile Technologies (ijIM)*, vol. 18, no. 9, pp. 19–34, 2024. <https://doi.org/10.3991/ijim.v18i09.49027>
- [11] A. Sarnato, W. Sari, S. Rahmawati, R. Hidayat, and H. Patry, "The evolution of e-learning platforms: From U-learning to AI-driven adaptive learning systems," *J. Soc. Sci. Util. Technol.*, vol. 2, no. 2, pp. 289–300, 2024. <https://doi.org/10.70177/jssut.v2i2.1131>
- [12] S. Moya and M. Camacho, "Leveraging AI-powered mobile learning: A pedagogically informed framework," *Computers and Education: Artificial Intelligence*, vol. 7, p. 100276, 2024. <https://doi.org/10.1016/j.caeai.2024.100276>
- [13] A. Das and S. Malaviya, "AI-enabled online adaptive learning platform and learner's performance: A review of literature," *Empirical Economics Letters*, vol. 23, no. 3, pp. 233–266, 2024. <https://doi.org/10.5281/zenodo.14002543>
- [14] K. Baba, N. Faddouli, and N. Cheimanoff, "Mobile-optimized AI-driven personalized learning: A case study at Mohammed VI Polytechnic University," *International Journal of Interactive Mobile Technologies (ijIM)*, vol. 18, no. 4, pp. 81–96, 2024. <https://doi.org/10.3991/ijim.v18i04.46547>
- [15] B. Klimova, M. Pikhart, and J. Kacetl, "Ethical issues of the use of AI-driven mobile apps for education," *Front. Public Health*, vol. 10, p. 1118116, 2023. <https://doi.org/10.3389/fpubh.2022.1118116>
- [16] D. Lynch and M. DeGenarro, "Using a random controlled trial to explore the impact of AI-enabled learning," *International Journal of Advanced Corporate Learning (ijAC)*, vol. 17, no. 4, pp. 58–68, 2024. <https://doi.org/10.3991/ijac.v17i4.48321>
- [17] N. Alotaibi, "The impact of AI and LMS integration on the future of higher education: Opportunities, challenges, and strategies for transformation," *Sustainability*, vol. 16, no. 23, p. 10357, 2024. <https://doi.org/10.3390/su162310357>
- [18] N. Krishnan, "AI agents: Evolution, architecture, and real-world applications," *arXiv preprint arXiv:2503.12687*, 2025. <https://doi.org/10.48550/arXiv.2503.12687>
- [19] B. A. Kumar and B. Sharma, "Context aware mobile learning application development: A systematic literature review," *Educ. Inf. Technol.*, vol. 25, pp. 2221–2239, 2020. <https://doi.org/10.1007/s10639-019-10045-x>
- [20] D. K. Njiru, D. M. Mugo, and F. M. Musyoka, "Ethical considerations in AI-based user profiling for knowledge management: A critical review," *Telematics Information Reports*, vol. 18, p. 100205, 2025. <https://doi.org/10.1016/j.teler.2025.100205>
- [21] O. Boateng and B. Boateng, "Algorithmic bias in educational systems: Examining the impact of AI-driven decision making in modern education," *World Journal of Advanced Research and Reviews*, vol. 25, no. 1, pp. 2012–2017, 2025. <https://doi.org/10.30574/wjarr.2025.25.1.0253>
- [22] T. Naz and M. Khan, "Functionality gaps in the design of learning management systems," *International Journal of Advanced Computer Science and Applications (IJACSA)*, vol. 9, no. 11, 2018. <https://doi.org/10.14569/IJACSA.2018.091152>
- [23] N. U. Rizvi, S. Prabhuram, and C. Kapuria, "Insights into experiences of e-learning as a tool for teaching during the COVID-19 pandemic among university students," in *Technologies, Artificial Intelligence and the Future of Learning Post-COVID-19*, in Studies in Computational Intelligence, A. Hamdan, A. E. Hassaniien, T. Mescon, and B. Alareeni, Eds., Springer, Cham, vol. 1019, 2022, pp. 573–589. [https://doi.org/10.1007/978-3-030-93921-2\\_30](https://doi.org/10.1007/978-3-030-93921-2_30)
- [24] C.-C. Lin, A. Y. Q. Huang, and O. H. T. Lu, "Artificial intelligence in intelligent tutoring systems toward sustainable education: A systematic review," *Smart Learn. Environ.*, vol. 10, p. 41, 2023. <https://doi.org/10.1186/s40561-023-00260-y>

- [25] K. Kiuchi, K. Otsu, and Y. Hayashi, "Psychological insights into the research and practice of embodied conversational agents: A systematic meta-review," *Behaviour and Information Technology*, vol. 43, no. 15, pp. 3696–3736, 2024. <https://doi.org/10.1080/0144929X.2023.2286528>
- [26] C. Diwan, S. Srinivasa, G. Suri, S. Agarwal, and P. Ram, "AI-based learning content generation and learning pathway augmentation to increase learner engagement," *Computets and Education: Artificial Intelligence*, vol. 4, p. 100110, 2023. <https://doi.org/10.1016/j.caeai.2022.100110>
- [27] A. R. Hevner, S. T. March, J. Park, and S. Ram, "Design science in information systems research," *MIS Quarterly*, vol. 28, no. 1, pp. 75–105, 2004. <https://doi.org/10.2307/25148625>
- [28] S. Hosseini and H. Seilani, "The role of agentic AI in shaping a smart future: A systematic review," *Array*, vol. 26, p. 100399, 2025. <https://doi.org/10.1016/j.array.2025.100399>
- [29] A. Agbeyangi and H. Suleman, "Advances and challenges in low-resource–environment software systems," *Informatics*, vol. 11, no. 4, p. 90, 2024. <https://doi.org/10.3390/informatics11040090>
- [30] A. G. Benedek, "MindTheGapp™ between standards and practice of mobile learning experience design: Gaps between mobile learning practice and theory," *Int. J. Adv. Educ. Res. (EduRe J.)*, vol. 2, no. 1, pp. 14–36, 2015. <http://real.mtak.hu/id/eprint/31979>
- [31] P. Brusilovsky, "AI in education, learner control, and human–AI collaboration," *Int. J. Artif. Intell. Educ.*, vol. 34, pp. 122–135, 2024. <https://doi.org/10.1007/s40593-023-00356-z>
- [32] A. Nguyen et al., "Ethical principles for artificial intelligence in education," *Educ. Inf. Technol.*, vol. 28, no. 7, pp. 4221–4241, 2022. <https://doi.org/10.1007/s10639-022-11316-w>
- [33] A. Alam and A. Mohanty, "Educational technology: Exploring the convergence of technology and pedagogy through mobility, interactivity, AI, and learning tools," *Cogent Eng.*, vol. 10, no. 2, 2023. <https://doi.org/10.1080/23311916.2023.2283282>
- [34] S. Ennouamani, Z. Mahani, and L. Akharraz, "A context-aware mobile learning system for adapting learning content and format of presentation: Design, validation, and evaluation," *Educ. Inf. Technol.*, vol. 25, pp. 3919–3955, 2020. <https://doi.org/10.1007/s10639-020-10149-9>
- [35] W. Holmes et al., "Ethics of AI in education: Towards a community-wide framework," *Int. J. Artif. Intell. Educ.*, vol. 32, pp. 504–526, 2021. <https://doi.org/10.1007/s40593-021-00239-1>
- [36] I. Celik, "Towards intelligent-TPACK: An empirical study on teachers' professional knowledge to ethically integrate artificial intelligence (AI)-based tools into education," *Computers in Human Behavior*, vol. 138, p. 107468, 2023. <https://doi.org/10.1016/j.chb.2022.107468>
- [37] E. Kaasinen, A. Anttila, P. Heikkilä, J. Laarni, H. Koskinen, and A. Vääänen, "Smooth and resilient human–machine teamwork as an Industry 5.0 Design challenge," *Sustainability*, vol. 14, no. 5, p. 2733, 2022. <https://doi.org/10.3390/su14052773>
- [38] J. Alves, T. Lima, and P. Gaspar, "Is Industry 5.0 a human-centred approach? A systematic review," *Processes*, vol. 11, no. 1, p. 193, 2023. <https://doi.org/10.3390/pr11010193>
- [39] Y. Supriya et al., "Industry 5.0 in smart education: Concepts, applications, challenges, opportunities, and future directions," *IEEE Access*, vol. 12, pp. 81938–81967, 2024. <https://doi.org/10.1109/ACCESS.2024.3401473>
- [40] J. Davim, "Perceptions of Industry 5.0: Sustainability perspective," *BioResources*, vol. 20, no. 1, pp. 15–16, 2024. <https://doi.org/10.15376/biores.20.1.15-16>
- [41] A. Abulibdeh, E. Zaidan, and R. Abulibdeh, "Navigating the confluence of artificial intelligence and education for sustainable development in the era of Industry 4.0: Challenges, opportunities, and ethical dimensions," *Journal of Cleaner Production*, vol. 437, no. 15, p. 140527, 2024. <https://doi.org/10.1016/j.jclepro.2023.140527>

- [42] P. Fraga-Lamas, T. Fernández-Caramés, A. Da Cruz, and S. Lopes, “An overview of blockchain for Industry 5.0: Towards human-centric, sustainable and resilient applications,” *IEEE Access*, vol. 12, pp. 116162–116201, 2024. <https://doi.org/10.1109/ACCESS.2024.3435374>
- [43] D. Nopas, “Algorithmic learning or learner autonomy? Rethinking AI’s role in digital education,” *Qualitative Research Journal*, vol. 25, no. 1, pp. 45–62, 2025. <https://doi.org/10.1108/QRJ-11-2024-0282>
- [44] B. Martini, D. Bellisario, and P. Coletti, “Human-centered and sustainable artificial intelligence in Industry 5.0: Challenges and perspectives,” *Sustainability*, vol. 16, no. 13, p. 5448, 2024. <https://doi.org/10.3390/su16135448>
- [45] F. Hasson, S. Keeney, and H. McKenna, “Research guidelines for the Delphi survey technique,” *Journal of Advanced Nursing*, vol. 32, no. 4, pp. 1008–1015, 2008. <https://doi.org/10.1046/j.1365-2648.2000.t01-1-01567.x>
- [46] C. C. Hsu and B. A. Sandford, “The Delphi technique: Making sense of consensus,” *Practical Assessment, Research, and Evaluation*, vol. 12, no. 1, p. 10, 2007. <https://doi.org/10.7275/pdz9-th90>
- [47] E. Du Plooy, D. Casteleijn, and D. Franzsen, “Personalized adaptive learning in higher education: A scoping review of key characteristics and impact on academic performance and engagement,” *Heliyon*, vol. 10, no. 21, p. e39630, 2024. <https://doi.org/10.1016/j.heliyon.2024.e39630>
- [48] D. Russo, “Under the lens: Learning management system (LMS) platforms and DEIA components—Moving past the rhetoric and into reality,” *First Monday*, vol. 29, no. 11, 2024. <https://doi.org/10.5210/fm.v29i11.13345>
- [49] M. Rojas and A. Chiappe, “Artificial intelligence and digital ecosystems in education: A review,” *Tech. Know. Learn.*, vol. 29, pp. 2153–2170, 2024. <https://doi.org/10.1007/s10758-024-09732-7>
- [50] R. Sajja, Y. Sermet, M. Cikmaz, D. Cwiertyny, and I. Demir, “Artificial intelligence-enabled intelligent assistant for personalized and adaptive learning in higher education,” *Information*, vol. 15, no. 10, p. 596, 2024. <https://doi.org/10.3390/info15100596>
- [51] M. Taşkın, “Artificial intelligence in personalized education: Enhancing learning outcomes through adaptive technologies and data-driven insights,” *Hum. Comput. Interact.*, vol. 8, no. 21, p. 173, 2024. <https://doi.org/10.62802/ygye0506>
- [52] H. H. Batubara, F. Syukur, M. Junaedi, K. L. Purwanti, and A. Shanie, “Teachers’ perceptions and readiness for mobile artificial intelligence integration in elementary education,” *International Journal of Interactive Mobile Technologies (IJIM)*, vol. 19, no. 16, pp. 148–162, 2025. <https://doi.org/10.3991/ijim.v19i16.55711>
- [53] T. Anthuvan, S. Prabhuram, S. U. Wankhade, and K. Maheshwari, “Bring your own AI (BYOAI) in Indian B-schools: A PLS-SEM-validated diagnostic and governance framework for readiness and responsible integration,” *SSRN Electron. J.*, 2025. <https://doi.org/10.2139/ssrn.5394898>

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