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AI-ENHANCED LEARNING EXPERIENCES FOR GEN Z MULTIMEDIA STUDENTS: A UX-DRIVEN CONCEPTUAL FRAMEWORK

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Abstract:

Gen Z learners represent the first generation to grow up fully immersed in digital ecosystems, shaping learning behaviours that emphasise multimodality, interactivity, and a preference for personalised, immediate feedback. As artificial intelligence (AI) becomes increasingly embedded in higher education, there remains a conceptual gap in understanding how AI capabilities, user experience (UX) principles, and Gen Z learning characteristics can be integrated to support meaningful multimedia learning. This paper addresses this gap by developing the AIMUX Framework, a user-experience-driven conceptual model designed to guide the design of AI-enhanced multimedia learning environments. The framework was constructed through a systematic conceptual analysis that synthesised literature on AI in education, multimedia learning theory, and UX design. It was subsequently examined through expert validation, during which specialists in AI-based learning, multimedia pedagogy, and UX design reviewed the framework's clarity, relevance, and conceptual coherence. Their feedback informed refinements to the definitions, dimensional boundaries, and structural relationships within the model. The final AIMUX Framework comprises five interrelated dimensions; Adaptive intelligence, Interactive engagement, Multimodal delivery, User-centred trust and transparency, and eXperience optimisation, which collectively describe how AI can support cognitively, emotionally, and experientially rich learning for Gen Z learners. The framework offers a theoretically grounded and practically relevant foundation for educators, designers, and researchers seeking to integrate AI meaningfully into multimedia learning contexts, while also providing a basis for future empirical work.

Keywords:

Artificial Intelligence, Multimedia Learning, User Experience, Gen Z, Multimodal, Interactive, Conceptual Framework

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Introduction

Gen Z learners, having grown up fully immersed in digital media ecosystems, display learning behaviours that prioritise multimodal content, interactivity, autonomy, and immediacy (Seemiller & Grace, 2016; Seemiller & Grace, 2019). These preferences are highly visible in multimedia and creative technology programmes, where students expect learning experiences that reflect the visual richness and rapid feedback loops of the platforms they use daily. As higher education institutions move toward digital-first pedagogies, the need for learning environments that meaningfully engage Gen Z becomes increasingly critical (Bond et al., 2021).

Artificial intelligence (AI) has accelerated innovation in education, offering affordances such as intelligent tutoring systems, personalised learning pathways, automated feedback, and predictive analytics (Zawacki-Richter et al., 2019; Dwivedi et al., 2023). Within multimedia learning specifically, AI can scaffold creativity, support design processes, manage cognitive load, and provide tailored guidance aligned with Mayer's Multimedia Learning Theory, where meaningful learning depends on how verbal and visual information are integrated (Mayer, 2021). These AI capabilities closely match Gen Z's expectations for responsiveness, adaptivity, and multimodal engagement.

Yet, the effectiveness of AI-driven learning tools rests heavily on user experience (UX). Learners' acceptance, trust, and sustained use of AI tools are shaped by usability, perceived transparency, clear feedback mechanisms, and emotional comfort within the interface (Kizilcec, 2016; Bunt et al., 2021). Poor UX design can lead to cognitive overload, an issue well documented in multimedia learning research, whereas well-designed UX reduces mental effort and increases engagement, satisfaction, and learning efficiency (Mayer, 2021).

Although the adoption of AI in education is expanding, research still lacks a unified framework that integrates AI pedagogical capabilities, UX design principles, and Gen Z learner characteristics, particularly in multimedia learning contexts. Existing studies often examine these components separately, creating a gap in holistic design guidance for educators and developers (Sanchez-Prieto et al., 2021; Bond et al., 2021).

To address this, the present conceptual paper proposes the 'Artificial Intelligence in Multimedia User Experience' (AIMUX) Framework, a UX-driven model that integrates five core dimensions: Adaptive intelligence, Interactive engagement, Multimodal delivery, User-centred trust & transparency, and eXperience optimisation. This framework combines insights from multimedia learning, AI in education, and UX research to guide the development of AI-enhanced learning environments that resonate with Gen Z's digital habits, cognitive preferences, and emotional expectations. By grounding AI design in validated UX principles and multimedia learning theory, the AIMUX Framework offers a forward-thinking foundation for designing inclusive, engaging, and effective learning experiences in multimedia education. While the AIMUX Framework synthesises established literature on AI in education, multimedia learning, and user experience design, its theoretical contribution lies in how these domains are conceptually integrated. Rather than positioning adaptivity, interactivity, and multimodality as parallel design features, AIMUX theorises their functional interdependence within AI-enhanced multimedia learning environments. In doing so, the framework advances existing work by explaining not only what elements should be present in AI-supported learning,

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but how and why UX-aligned AI mechanisms support cognitive processing, emotional engagement, and creative learning among Gen Z learners.

Problem Statement

Gen Z learners represent a cohort with distinctive digital habits, attention patterns, and learning expectations shaped by constant exposure to social media, multimodal content, and rapid feedback loops (Seemiller & Grace, 2019). However, higher education practices, particularly in multimedia programmes, have not kept pace with these evolving learner profiles. Many existing learning environments remain instructor-centred, static, and inadequately responsive to the cognitive and motivational needs of Gen Z, resulting in reduced engagement, shallow learning, and limited creative exploration (Bond et al., 2021).

Artificial intelligence (AI) offers opportunities to transform educational experiences through personalisation, adaptive pathways, automated feedback, and intelligent support systems (Zawacki-Richter et al., 2019; Dwivedi et al., 2023). In multimedia learning specifically, AI can scaffold complex creative tasks, reduce cognitive load, and optimise instructional sequencing, areas aligned with Mayer's (2021) principles of multimedia learning. Despite this potential, the practical impact of AI in higher education remains restricted. Most AI tools used in classrooms are adopted in an ad hoc manner, lack pedagogical alignment, and are not designed with Gen Z's experiential expectations in mind.

Furthermore, current literature on AI in education remains largely fragmented across disciplinary boundaries. Studies that examine AI capabilities predominantly emphasise algorithmic efficiency, predictive accuracy, or automated assessment functions (Zawacki-Richter et al., 2019; Dwivedi et al., 2023). While these technological perspectives are essential, they seldom address the learner's lived experience, emotional response, or cognitive load, which are factors that are fundamental to meaningful learning. Conversely, research grounded in user experience (UX) focuses heavily on usability, interaction patterns, and interface design, yet often overlooks the pedagogical affordances and constraints of AI systems (Bunt et al., 2021). This creates a disconnect between technological innovation and actual educational value.

At the same time, scholarship on Gen Z learning characteristics highlights their preference for autonomy, multimodal interaction, instant feedback, and emotionally responsive environments (Seemiller & Grace, 2019; Bond et al., 2021). However, these insights remain underutilised in AI-based instructional design, where Gen Z's cognitive tendencies and motivational needs are rarely embedded into system architecture. Mayer's multimedia learning theory reinforces that effective learning depends on managing cognitive load and integrating visual–verbal processing (Mayer, 2021), yet many AI tools fail to align with these principles, contributing to learner overload or disengagement.

This lack of integration across AI pedagogy, UX principles, and Gen Z learning theory has resulted in a critical interdisciplinary gap. There is currently no comprehensive framework that unifies (a) AI's adaptive and generative capabilities, (b) UX design elements that foster trust, usability, and emotional comfort, and (c) the multimodal, creative, and interaction-rich learning needs of Gen Z, particularly in multimedia education, where cognitive complexity is already high and effective scaffolding is essential.

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The absence of such a holistic framework limits educators' and designers' ability to create AI-enhanced multimedia learning environments that are both pedagogically grounded and experientially meaningful. As AI adoption accelerates in higher education, the lack of structured guidance increases the risk of producing systems that are technologically advanced yet misaligned with learner cognition, emotionally unsupportive, and ineffective in promoting deep learning (Rai et al., 2023). Therefore, there is an urgent need for a user-experience-driven conceptual framework that articulates how AI can be intentionally, transparently, and pedagogically integrated into multimedia learning to support Gen Z learners in cognitively, emotionally, and creatively meaningful ways. These gaps collectively demonstrate the need for a unified conceptual model that integrates AI, UX, and Gen Z learning characteristics, as the absence of such alignment limits the ability of AI systems to connect technological capability with learner cognition and experience.

Purpose of the Study

The purpose of this conceptual paper is to propose the AIMUX Framework, a user-experience-driven model that integrates artificial intelligence (AI) capabilities, multimedia learning principles, and Gen Z learner characteristics to guide the design of effective AI-enhanced learning environments in multimedia education. By synthesising insights across these three domains; AI pedagogy, UX design, and multimodal learning, the framework aims to address the current fragmentation in research and practice, where AI tools are often adopted without clear pedagogical grounding or alignment with learners' cognitive and emotional needs. The AIMUX Framework provides a structured foundation for educators, designers, and developers to intentionally craft learning experiences that are adaptive, engaging, transparent, and responsive to the expectations of Gen Z learners. Ultimately, this study seeks to advance both theory and practice by offering a holistic model that supports the thoughtful and meaningful integration of AI into multimedia learning contexts.

Literature review

The literature relevant to this study spans three major domains: Gen Z learners' characteristics and multimedia learning behaviours, the evolving role of artificial intelligence (AI) in education, and user experience (UX) principles that shape learners' interaction with technology-enhanced environments. A comprehensive review of these areas is essential to establish the theoretical foundations for the AIMUX Framework and to understand how each domain contributes to the design of effective AI-enhanced learning experiences. Existing studies reveal significant insights into multimodal learning, AI's pedagogical affordances, and UX factors such as usability, transparency, trust, and cognitive load. However, these bodies of research often operate in isolation, resulting in fragmented understandings that obscure how AI, UX, and learner characteristics should intersect in multimedia education. By synthesising key findings from these domains, the following sections outline the conceptual groundwork necessary for developing a holistic framework that aligns AI capabilities with Gen Z's learning needs through a user-experience-driven approach.

Gen Z Learners and Multimedia Learning

Gen Z students are often described as highly visual, socially connected, and accustomed to rapid information access, consistent with early descriptions of digital-native learners (Prensky, 2001; Seemiller & Grace, 2019). They are marked differently from previous cohorts due to their immersion in digital ecosystems from early childhood. Their learning expectations centre on immediacy, autonomy, multimodal richness, and high interactivity which are the

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preferences shaped by platforms such as TikTok, YouTube, and Instagram (Seemiller & Grace, 2019). Empirical studies highlight that Gen Z values learning environments that mirror these fast-paced, visually driven digital cultures, often preferring environments that offer short bursts of information, personalised choices, and opportunities for participatory engagement (Bond et al., 2021).

In multimedia education specifically, these learners thrive when instructional approaches integrate visual, auditory, and interactive elements that support exploration and creative expression. Mayer's Multimedia Learning Theory (2021) establishes that meaningful learning occurs when learners can integrate words and visuals through processes that minimise extraneous cognitive load while enhancing generative processing. For Gen Z, this theoretical foundation is especially relevant because their learning behaviours align with high levels of media fluency but also heightened susceptibility to cognitive overload due to fragmented attention patterns (Mayer, 2021).

Studies on Gen Z's learning motivations further suggest that they expect technology-mediated environments to be adaptive, engaging, and relevant to real-world creative practices. They respond positively to systems that provide immediate feedback, autonomy, and personalised pathways—characteristics that traditional multimedia classrooms often struggle to deliver consistently (Mohamad et al., 2024). This growing misalignment between learner expectations and instructional realities underscores the need for more responsive, technology-enhanced learning frameworks.

Artificial Intelligence in Education

Artificial intelligence has become a transformative force in education, offering capabilities that can enhance personalisation, adaptivity, assessment, and student support. Zawacki-Richter et al.'s (2019) systematic review revealed a rapid expansion of AI applications in higher education, including intelligent tutoring systems, predictive analytics, automated feedback, and adaptive learning environments. These affordances directly address several known challenges in multimedia learning, such as tailoring instruction to individual skill levels and providing iterative feedback during creative production.

AI systems can also help manage cognitive load by sequencing content, recommending resources, or detecting learning difficulties in real time, the functions that align strongly with Mayer's principles of guided multimedia processing (Mayer, 2021). Dwivedi et al. (2023) argue that AI's emerging capabilities enable both micro-level learning enhancements (e.g., personalised hints, multimodal content generation) and macro-level transformations (e.g., reimagining instructional models). However, despite this potential, adoption in higher education remains inconsistent. Many AI-driven tools are implemented without pedagogical grounding, resulting in systems that are technologically sophisticated but educationally ineffective.

A key limitation in current AIED research is that the focus tends to be on algorithmic accuracy or system performance rather than the learner's lived experience. Holmes et al. (2019) emphasise that successful integration of AI requires frameworks that connect technological affordances with human learning principles, an element that remains lacking in many deployments. In multimedia learning contexts, this gap is especially critical because learners

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navigate complex creative tasks requiring not only cognitive support but also emotional reassurance, interface clarity, and feedback transparency.

These gaps point to the need for a holistic framework that situates AI not merely as a set of tools, but as part of a larger design ecosystem that includes UX, pedagogy, and learner psychology.

User Experience (UX) in AI-Enhanced Learning Systems

User experience (UX) plays a fundamental role in determining the effectiveness of AI learning tools. Research consistently shows that learners' trust, motivation, and engagement in AI-driven environments are shaped by factors such as usability, transparency, emotional support, and perceived fairness (Kizilcec, 2016; Rai et al., 2023). Effective AI-enhanced learning requires interfaces that reduce friction, support intuitive navigation, and align with human cognitive tendencies, principles long emphasised in UX scholarship (Norman, 2013). Poor UX design, characterised by confusing interfaces, unclear AI feedback, and lack of user control, can increase extraneous cognitive load and impede learning performance (Bunt et al., 2021). These issues are particularly consequential in multimedia education, where learners already manage high cognitive demands associated with creative and technical tasks.

Transparency is a core component of AI-driven UX. Kizilcec (2016) demonstrated that when learners understand how and why an AI system makes recommendations, their trust increases, reducing anxiety and improving acceptance. Emotional design principles, such as empathetic feedback and supportive conversational cues, further contribute to sustained engagement, especially among Gen Z learners who expect personalised digital interactions (Sanchez-Prieto et al., 2021).

Despite these findings, most AI tools are not built with robust UX frameworks. Bunt et al. (2021) argue that the gap between AI capabilities and user-centred design remains one of the most significant barriers to meaningful adoption. Existing systems often prioritise algorithmic sophistication over intuitive design, limiting their educational value. For multimedia learners, such misalignment is detrimental: an AI tool that is difficult to navigate or cognitively overwhelming can directly undermine creativity, exploration, and learning flow.

This convergence of evidence underscores the need for frameworks that bring together AI pedagogy, UX design, and learner characteristics. By integrating these domains, educators and developers can design AI-enhanced multimedia learning environments that support cognitive efficiency, emotional well-being, and sustained engagement, elements that are crucial for Gen Z learners.

Methodology: Systematic Conceptual Analysis Approach

The development of the AIMUX Framework was guided by a systematic conceptual analysis, a methodological approach commonly used to construct theoretical models through the integration of diverse scholarly perspectives. This approach, as outlined by Jabareen (2009), is particularly suitable for studies that synthesise complex, multidisciplinary bodies of knowledge such as artificial intelligence, multimedia learning, and user experience design.

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The process began with an extensive literature search across major academic databases, including Scopus, Web of Science, ScienceDirect, SpringerLink, and Google Scholar. The search focused on works published between 2016 and 2024 in order to capture recent developments in AI-powered learning environments, contemporary UX design principles, and emerging evidence on Gen Z learning behaviours. Foundational works predating this period, such as Mayer's multimedia learning principles, were also included due to their enduring relevance to multimedia education. Search terms combined variations of "artificial intelligence in education," "multimedia learning," "Gen Z learners," "user experience in learning systems," and "adaptive learning technologies," ensuring a comprehensive representation of relevant scholarship.

The initial pool of studies was refined through a screening process that prioritised peer-reviewed journal articles, scholarly books, and systematic reviews. Publications were selected if they directly addressed educational applications of AI, explored UX considerations in technology-enhanced learning, or examined the cognitive and behavioural characteristics of Gen Z learners. Works that lacked theoretical grounding, empirical rigour, or relevance to higher education were excluded. This refinement resulted in a curated body of literature that included seminal contributions by Mayer (2021), Zawacki-Richter et al. (2019), Bond et al. (2021), Dwivedi et al. (2023), and others.

Following the selection process, the literature was analysed using an iterative thematic synthesis. This involved reading, coding, and categorising overlapping ideas across studies to identify recurring patterns, tensions, and theoretical intersections. Three broad thematic domains emerged from this process: the learning preferences and digital behaviours of Gen Z students; the pedagogical affordances and limitations of AI within higher education; and the role of user experience in shaping trust, engagement, and cognitive load in technology-mediated environments. These themes revealed substantial fragmentation in the literature, with each domain advancing independently despite their clear conceptual interdependence.

The final stage involved conceptually integrating these themes to construct the AIMUX Framework. Guided by Jabareen's model-building logic, the synthesis focused on identifying the conceptual relationships that link AI adaptivity, multimodal learning processes, and UX principles. Through iterative refinement and comparison across sources, five interrelated dimensions were identified as central to an effective AI-enhanced multimedia learning environment: adaptive intelligence, interactive engagement, multimodal delivery, user-centred trust and transparency, and continuous experience optimisation. Together, these dimensions form a cohesive framework that aligns technological affordances with pedagogical intentions and learner-centred design considerations.

To ensure rigour, the analysis employed triangulation across multiple domains, relied on high-impact and authoritative sources, and applied iterative validation to avoid conceptual redundancy. This systematic conceptual analysis provides a transparent and defensible foundation for the framework, ensuring that the AIMUX model is theoretically grounded, methodologically robust, and practically relevant for guiding AI integration in multimedia education.

Figure 1 summarises the methodological phases used to construct the AIMUX Framework, beginning with literature identification and ending with conceptual integration.

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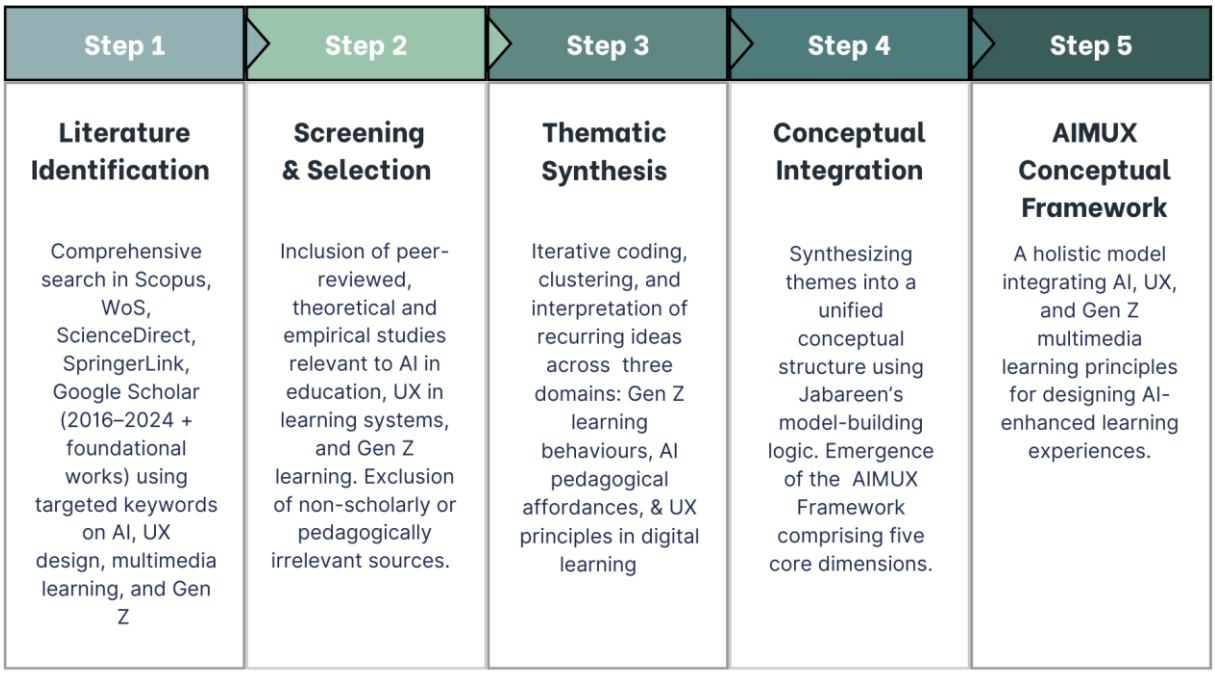

Figure 1: Methodology for Constructing AIMUX Framework

The Artificial Intelligence in Multimedia User Experience' (AIMUX) Framework

The AIMUX Framework is proposed as a holistic, user-experience-driven model that aligns artificial intelligence (AI) capabilities with multimedia learning principles and Gen Z learner characteristics. This framework emerged from the systematic conceptual analysis, which revealed persistent fragmentation across AI pedagogy, UX research, and Gen Z learning literature (Zawacki-Richter et al., 2019; Bond et al., 2021; Mayer, 2021). AIMUX positions AI not simply as a technological enhancement but as a pedagogical and experiential partner whose value depends on how effectively it supports cognitive processing, emotional well-being, and creative engagement in multimedia environments.

The framework consists of five interdependent dimensions: Adaptive intelligence, Interactive engagement, Multimodal delivery, User-centred trust and transparency, and eXperience optimisation. Each dimension reflects critical factors identified in the literature on AI-enhanced learning (Dwivedi et al., 2023), multimedia learning theory (Mayer, 2021), and UX-driven system design (Bunt et al., 2021; Kizilcec, 2016).

Adaptive intelligence emphasises the capacity of AI to personalise learning pathways, offer timely corrective feedback, and adjust content difficulty. Functionally, adaptive intelligence operates as the pedagogical core of the framework by aligning content difficulty, feedback timing, and learning pathways with learners' evolving cognitive states, thereby reducing extraneous cognitive load while supporting generative processing. Empirical studies show that adaptivity significantly enhances motivation and supports cognitive load management when grounded in clear pedagogical principles (Mayer, 2021; Chen et al., 2020). For multimedia learners, such adaptivity is especially important because creative production tasks involve iterative decision-making, which benefits from targeted scaffolding and real-time guidance.

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Interactive engagement draws from evidence that Gen Z learners respond positively to participatory, exploratory, and gamified learning environments (Seemiller & Grace, 2019; Bond et al., 2021). Through AI-mediated interaction, learner engagement is sustained by enabling continuous feedback loops, exploratory actions, and dialogic exchanges that promote agency and persistence in complex multimedia tasks. AI enables this interactivity through conversational agents, intelligent prompts, and adaptive branching scenarios that maintain engagement and promote persistence. In multimedia education, where experimentation, critique, and refinement are integral, AI-supported interactions can deepen learning by making creative processes more responsive and personalised.

Multimodal delivery is grounded in Mayer's cognitive theory of multimedia learning, which shows that combining verbal and visual information enhances retention and understanding when cognitive load is managed effectively (Mayer, 2021). AI can support multimodal learning by automatically generating alternative representations, simplifying complex visuals, or offering narrated explanations. Studies in AI-mediated learning environments indicate that multimodal content improves comprehension and supports diverse cognitive styles, especially for digitally fluent learners such as Gen Z (Holmes et al., 2019). Within AIMUX, multimodal delivery supports learning by coordinating visual, verbal, and auditory representations in ways that optimise dual-channel processing and prevent representational overload.

User-centred trust and transparency reflect UX research demonstrating that learners' acceptance of AI depends on clarity, predictability, and perceived fairness of system behaviour (Kizilcec, 2016; Rai et al., 2023). Research consistently demonstrates that transparent and explainable AI significantly enhances user trust and willingness to rely on AI-mediated decision-making (Shin, 2021). By making AI behaviour predictable and explainable, this dimension reduces learner uncertainty and supports sustained reliance on AI-mediated feedback and guidance. When users understand why AI recommendations are made, trust increases and anxiety decreases, which are factors particularly important for Gen Z learners who expect intuitive and emotionally supportive technologies. UX shortcomings, on the other hand, can lead to disengagement even when the AI is pedagogically sound (Bunt et al., 2021). eXperience optimisation emphasises the dynamic nature of AI as a system that continuously learns from user behaviour. Research shows that data-driven refinement of learning experiences leads to significant gains in satisfaction, efficiency, and performance (Dwivedi et al., 2023). For multimedia environments, where task complexity varies and learner progression is nonlinear, continuous optimisation ensures that the system remains aligned with learners' needs and institutional goals. This enables the system to refine instructional responses over time, ensuring that AI support remains aligned with learner needs and contextual demands.

Together, these five dimensions form an integrated conceptual framework that addresses the limitations in current AI-enhanced learning environments. Conceptually, AIMUX distinguishes *adaptivity* as AI-driven pedagogical adjustment, *interactivity* as learner–system behavioural engagement, and *multimodality* as representational design across information channels, thereby avoiding overlap between cognitive, behavioural, and representational functions. AIMUX synthesises pedagogical principles, UX considerations, and Gen Z digital behaviours to offer a coherent guide for designing AI-driven multimedia learning experiences that are cognitively effective, emotionally supportive, and creatively empowering. Figure 2 presents the final AIMUX model and its five interrelated dimensions.

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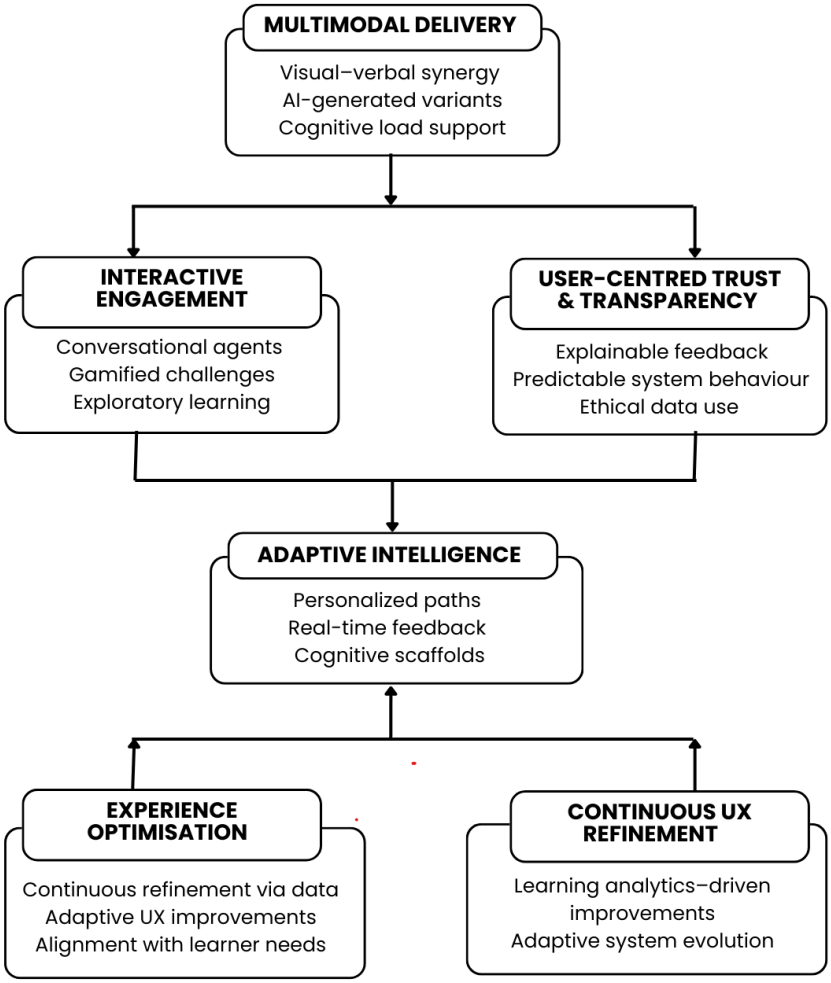

Figure 2: The AIMUX Framework

Expert Validation of the AIMUX Framework

To ensure the conceptual robustness and practical relevance of the AIMUX Framework, a comprehensive expert validation process was undertaken. Conceptual frameworks, particularly those that synthesize multiple theoretical traditions, benefit from systematic critique by domain specialists who can identify strengths, limitations, and opportunities for refinement. The validation was conducted through independent expert review, enabling structured critique and iterative refinement of the framework.

Experts were selected purposively to reflect the three disciplinary pillars underpinning the framework: artificial intelligence in education, multimedia learning, and user experience design. Each individual possessed recognised expertise through scholarly publications, research supervision, or practical involvement in educational technology innovation. Five experts agreed to participate, representing universities and research centres where AI-enhanced learning, UX design, or multimedia pedagogy constitute significant areas of activity. This diversity ensured that the framework was examined from technological, pedagogical, and experiential perspectives.

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Each expert received a detailed documentation package that included a full narrative description of the AIMUX Framework, operational definitions of its five dimensions, and an explanatory diagram reflecting its cyclical structure. They were also provided with a validation form modelled on established content validity procedures, which asked them to evaluate the clarity, relevance, and representativeness of each dimension, as well as the coherence of the framework as a whole. Ratings were given on a four-point scale, and experts were encouraged to provide extended written commentary to elaborate on their assessments.

The first phase of validation consisted of independent review. Experts examined the conceptual grounding of each dimension and assessed whether the components logically captured the educational, cognitive, and experiential requirements of Gen Z multimedia learners. Their quantitative ratings were analysed using the Content Validity Index method, calculating both item-level and scale-level indices. The results demonstrated high levels of agreement, with the overall scale-level validity exceeding the commonly accepted threshold for conceptual adequacy. Every dimension in the framework reached acceptable item-level validity, indicating that experts found the model both relevant and theoretically defensible.

In addition to numerical assessments, qualitative feedback played an essential role in refining the framework. Experts highlighted the strength of positioning adaptive intelligence at the centre, as it reflects the core pedagogical function of AI in tailoring instruction and managing cognitive load. They also emphasised that the inclusion of trust and transparency aligns closely with current concerns regarding AI acceptance, ethics, and learner agency. Several experts, however, identified areas where conceptual boundaries required sharpening. In particular, they noted that interactive engagement and multimodal delivery occasionally appeared to overlap and recommended further clarification to distinguish the behavioural nature of engagement from the representational focus of multimodality. Others encouraged a more explicit acknowledgement of ethical considerations within the transparency dimension, especially in relation to data use and algorithmic fairness.

Following this feedback, the framework underwent a round of revisions. Definitions were refined to strengthen conceptual precision; distinctions between behaviour, modality, and cognition were articulated more clearly; and the transparency dimension was expanded to incorporate ethical and emotional aspects of learner–AI interaction. The iterative optimisation process that characterises AI systems was also made more explicit within the eXperience Optimisation dimension to better reflect the cyclical nature of adaptive technological environments. Once revisions were complete, the refined framework was redistributed to experts for verification. Their subsequent responses confirmed that the adjustments strengthened coherence and improved practical applicability.

The validation process ultimately confirmed that the AIMUX Framework is theoretically grounded, pedagogically meaningful, and sufficiently comprehensive to guide the design of AI-enhanced multimedia learning environments for Gen Z learners. The integration of quantitative and qualitative expert input provided a rigorous foundation for the final version of the framework, ensuring that it reflects both contemporary research insights and practical considerations relevant to higher education and digital learning design. Figure 3 illustrates the summary of the expert validation process of AIMUX framework.

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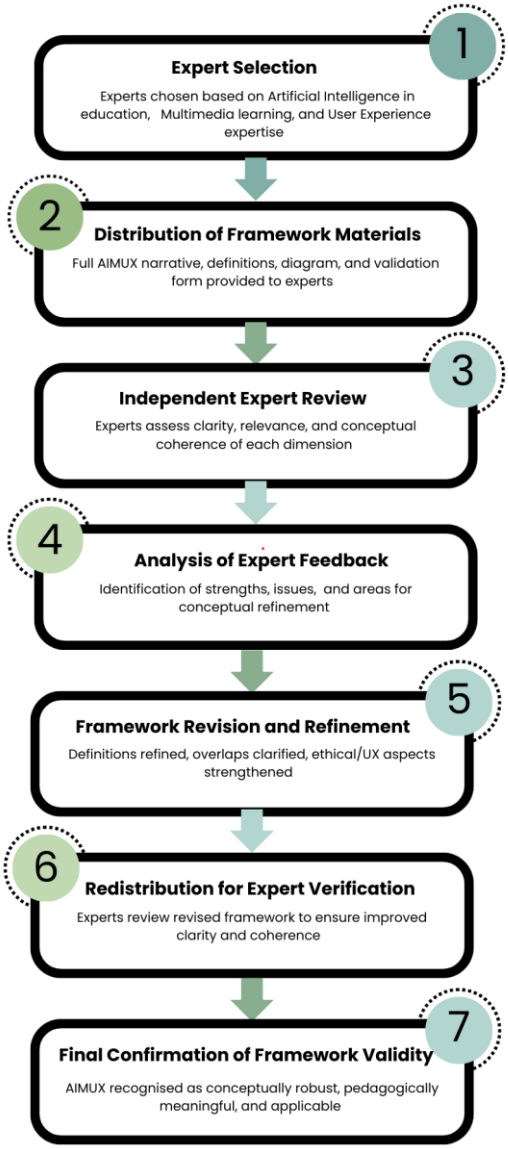

Figure 3: Expert Validation Process of AIMUX Framework.

Discussion

The findings from the conceptual analysis and expert validation provide strong support for the AIMUX Framework as a coherent and timely contribution to the discourse on AI-enhanced multimedia learning. The framework directly addresses the gaps identified in the literature review, particularly the siloed development of research on AI capabilities, UX design principles, and Gen Z learning behaviours. The discussion therefore situates AIMUX as a model that not only synthesises these bodies of knowledge but also extends them by emphasising the interdependence of cognitive, technological, and experiential factors.

The centrality of adaptive intelligence aligns closely with the longstanding principles of multimedia learning articulated by Mayer (2021), which emphasise cognitive support, segmentation, and personalised scaffolding as mechanisms for reducing load and improving comprehension. Much of the AI-in-education literature echoes this, pointing toward AI's capacity to personalise learning pathways and provide adaptive feedback (Zawacki-Richter et

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al., 2019; Chen et al., 2020). However, these studies often treat adaptivity as a technical affordance rather than a pedagogical mechanism. AIMUX extends this understanding by positioning adaptivity not as an optional enhancement but as a foundational requirement for effective AI-supported multimedia learning. Experts reinforced this view, recognising adaptive intelligence as the pedagogical anchor that ensures AI-driven environments remain responsive to learner diversity.

The literature on Gen Z learning emphasises immediacy, autonomy, and interactivity as defining characteristics of this cohort (Seemiller & Grace, 2019; Bond et al., 2021). The Interactive engagement dimension directly responds to these behavioural expectations by highlighting the role of conversational agents, adaptive prompts, and exploratory learning structures in sustaining motivation. While previous studies have demonstrated that interactivity enhances student engagement, they rarely specify how AI should mediate such interaction in multimedia contexts. AIMUX provides this missing conceptual clarity by situating interactivity within an AI-mediated ecosystem designed to support iterative creative processes.

Similarly, multimodal delivery reflects the established theoretical grounding of multimedia learning theory. Studies consistently show that learning is strengthened when verbal and visual channels are aligned effectively and when cognitive load is regulated (Mayer, 2021). Yet, as AI technologies become increasingly capable of generating multimodal content, the literature has not adequately addressed how such capabilities should be pedagogically structured. AIMUX contributes to this discourse by articulating the conditions under which AI-mediated multimodality supports understanding rather than overwhelming learners, a distinction that experts emphasised as critical.

One of the clearest connections to the literature emerges in the dimension of user-centred trust and transparency. Research on AI ethics and learner trust warns that opaque systems can undermine acceptance and engagement, especially when learners cannot discern how decisions or recommendations are made (Kizilcec, 2016; Rai et al., 2023). Expert feedback strongly echoed these concerns, underscoring the importance of explainability, fairness, and emotional reassurance. AIMUX advances this domain by embedding transparency not as a peripheral consideration, but as a central structural requirement for AI-enhanced learning environments, particularly for Gen Z learners who expect intuitive and emotionally intelligent digital interactions.

The dimension of eXperience optimisation extends current literature on learning analytics and adaptive system design by emphasising continuous improvement cycles. While previous studies acknowledge that AI systems evolve through data-driven refinement (Dwivedi et al., 2023), AIMUX operationalises this process within a pedagogical framework. The cyclical relationship among the dimensions reflects contemporary understandings of AI as iterative and self-improving, and experts affirmed that this depiction aligns with real-world system behaviour.

The Discussion reveals that the AIMUX Framework synthesises, extends, and clarifies existing scholarship in multiple domains. It responds directly to the gaps outlined in the literature review especially the lack of an integrated, cross-disciplinary framework that accounts for both the technological and human dimensions of AI-enhanced learning. By offering a structured model

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grounded in theory and validated by experts, AIMUX contributes a conceptual foundation upon which future empirical studies, design prototypes, and instructional models can be built.

Implications of the AIMUX Framework

The AIMUX Framework carries significant implications for practice, design, policy, and future research in AI-enhanced multimedia learning. As higher education increasingly integrates artificial intelligence into teaching and learning, the need for pedagogically grounded and learner-centred design models becomes more urgent. This framework provides a structured lens through which educators, system designers, and researchers can conceptualise and implement AI-driven environments that align with Gen Z learners' cognitive, behavioural, and emotional expectations.

One key implication relates to instructional design practice. AIMUX encourages educators to move beyond superficial adoption of AI tools and instead design learning experiences where adaptivity, multimodality, and interactivity are deliberately aligned with established principles of multimedia learning. Rather than treating AI as a supplementary enhancement, instructors can use the framework to guide decisions about sequencing, scaffolding, and representational form, ensuring that technology supports rather than complicates cognitive processing. This is particularly important in multimedia courses, where learners navigate complex creative tasks that benefit from personalised scaffolds and iterative feedback mechanisms.

The framework also provides critical guidance for AI system developers and UX designers. By foregrounding trust, transparency, and emotional responsiveness, AIMUX highlights design features that directly influence learner acceptance and engagement. Developers can use the framework to ensure that AI systems provide explainable feedback, maintain predictable interaction patterns, and uphold ethical data practices. The emphasis on user-centred design shifts the focus from technological sophistication alone to holistic learner experience, aligning system behaviour with the expectations of digital-native learners who value clarity, responsiveness, and control.

At a broader level, the framework has important implications for institutional and policy decision-making. As universities adopt AI technologies, AIMUX offers a conceptual foundation that can inform procurement, governance, and implementation strategies. Institutions can apply the framework to evaluate whether proposed AI solutions align with pedagogical priorities, support equitable learner experiences, and adhere to ethical standards. Its emphasis on trust and transparency is particularly relevant to emerging discussions on AI governance, data protection, and learner agency in higher education.

The framework further contributes to research methodology and theoretical development. AIMUX provides a conceptual scaffold that can be operationalised in future empirical studies examining learner behaviour, cognitive processing, and UX in AI-enhanced multimedia environments. Researchers may use the framework to design instruments, develop evaluation models, or build prototype systems that instantiate its five dimensions. It also opens pathways for comparative research examining how different forms of adaptivity, interactivity, or multimodality influence learner outcomes across disciplines. In doing so, AIMUX extends current scholarship by offering a theoretically integrated approach that brings coherence to previously siloed research traditions.

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Finally, the dimension of eXperience optimisation underscores the potential for continuous system improvement informed by learning analytics. This provides opportunities for institutions to develop dynamic learning systems that evolve with learner behaviour, enabling more responsive and personalised educational experiences over time. Such iterative refinement has the potential to transform the culture of multimedia education, promoting environments that are adaptive not only for learners but for institutions themselves.

The implications of the AIMUX Framework demonstrate its significance as both a conceptual and practical contribution. It provides a roadmap for designing AI-enhanced learning environments that are cognitively effective, emotionally resonant, ethically sound, and aligned with the lived experiences of Gen Z learners. As AI continues to evolve, frameworks such as AIMUX will be essential for guiding innovation in ways that uphold pedagogical integrity while leveraging technological potential.

Conclusion

This study set out to address a critical gap in the current discourse on AI-enhanced learning: the absence of an integrated, theoretically grounded framework that unites artificial intelligence capabilities, multimedia learning principles, and the distinctive expectations of Gen Z learners. Through a systematic conceptual analysis supported by expert validation, the AIMUX Framework was developed as a comprehensive model that foregrounds adaptive intelligence, interactive engagement, multimodal delivery, user-centred trust and transparency, and continuous experience optimisation. These dimensions reflect not only technological affordances but also the cognitive, emotional, and experiential needs of contemporary learners. The AIMUX Framework contributes to the field in several meaningful ways. It synthesises previously fragmented research across AI pedagogy, UX design, and learner psychology into a coherent structure capable of guiding both instructional practice and system development. By situating adaptivity and transparency as central design imperatives, the framework offers a pathway for developing AI-driven learning environments that are not only more effective, but also more ethical, accessible, and responsive to learner diversity. The validation findings further confirm the framework's theoretical soundness and practical relevance, demonstrating its potential to support the design and evaluation of multimedia learning experiences that meet the demands of digitally fluent learners.

While this paper provides a conceptual foundation, future research is needed to operationalise and empirically test the framework in real learning contexts. Studies employing design-based research, prototype development, or AI-mediated intervention trials could extend the framework's utility and reveal context-specific insights. Such work would not only validate the practical application of AIMUX but also inform ongoing refinements as AI technologies and learner behaviours evolve.

In a landscape where artificial intelligence is rapidly reshaping educational possibilities, frameworks like AIMUX are essential for ensuring that innovation remains pedagogically meaningful and human-centred. By aligning AI capabilities with principles of cognitive processing, multimedia learning, and user experience, the AIMUX Framework offers a forward-looking model for designing learning environments that support creativity, engagement, and deep learning for Gen Z multimedia students. Its contribution lies in both its conceptual integration and its potential to guide future research, policy, and practice in the era of AI-enhanced education.

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