

Design Principles for Multimedia Learning Aids in Language Education: A Systematic Literature Review

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Received: 30 October 2024 | Accepted: 15 December 2024 | Published: 28 December 2024

Abstract: The integration of multimedia learning aids in language education has garnered significant attention due to their potential to enhance learning experiences and improve language acquisition. This systematic literature review, guided by the PRISMA framework, synthesizes research on the design principles of multimedia learning aids to establish evidence-based guidelines for effective instructional design. The study aims to identify core design principles, analyze their theoretical underpinnings, and evaluate their impact on language learning outcomes. The review process involved a rigorous search strategy across Scopus and Web of Science databases, yielding 2,563 initial publications. After applying inclusion and exclusion criteria, 26 studies were shortlisted, and 7 studies were selected for detailed qualitative analysis. The findings reveal six key design principles grounded in Cognitive Load Theory and Multimedia Learning Theory: spatial contiguity, coherence, modality, redundancy, personalization, and signaling. These principles highlight the importance of integrating visual and auditory elements, minimizing extraneous content, and tailoring multimedia tools to learner needs. Results demonstrate that carefully designed multimedia aids significantly enhance learners' engagement, retention, and comprehension in language education. The analysis also underscores the interplay between theoretical frameworks and practical implementation strategies, emphasizing the role of adaptive learning technologies in addressing diverse learner needs. This study contributes to the growing body of knowledge in educational technology by offering a comprehensive framework for developing effective multimedia learning aids. The findings provide actionable recommendations for educators and instructional designers to optimize the design and application of digital tools in language learning contexts. Future research is encouraged to explore emerging technologies, such as augmented reality and artificial intelligence, to further advance multimedia learning in language education.

Keywords: multimedia learning, language education, instructional design, educational technology, systematic review, design principles, e-learning, second language acquisition

Cite this article: Rosmani Abdul Halim, Muhammad Sabri Sahrir, Nurazzeleena Abdullah & Widad Ma. (2024). Design Principles for Multimedia Learning Aids in Language Education: A Systematic Literature Review. *Global Journal of Educational Research and Management (GERMANE)*, 4 (4), p. 71-94.

INTRODUCTION

The integration of multimedia learning aids in language education has emerged as a critical area of investigation in educational technology research, particularly as digital tools and resources become increasingly prevalent in modern pedagogical practices (Haleem et al., 2022). The effective design of these multimedia learning materials plays a pivotal role in facilitating second language acquisition and enhancing overall learning outcomes (Intiana et al., 2024). However, despite the widespread adoption of multimedia resources in language education, there remains a significant need to systematically examine and synthesize the underlying design principles that contribute to their effectiveness.

The rapid advancement of educational technology has led to a proliferation of multimedia learning aids, ranging from interactive applications and video-based instruction to augmented reality tools and adaptive learning platforms (Nizami et al., 2023). These technological innovations present both opportunities and challenges for language educators and instructional designers (Paniagua & Istance, 2018). While multimedia resources offer unprecedented possibilities for creating engaging and immersive learning experiences, their mere incorporation does not guarantee improved learning outcomes (AlGerafi et al., 2023). The effectiveness of these tools is intrinsically linked to their design principles and implementation strategies.

Previous research has demonstrated that carefully designed multimedia learning aids can significantly enhance language acquisition by providing multiple modes of representation, facilitating cognitive processing, and supporting various learning styles (Clark & Mayer, 2023). However, the literature also indicates considerable variation in the effectiveness of different multimedia designs, suggesting the critical importance of identifying and implementing evidence-based design principles (Alpizar et al., 2020). This variation highlights the need for a comprehensive understanding of the design elements that optimize learning outcomes in language education contexts.

The intersection of cognitive load theory, multimedia learning theory, and second language acquisition principles presents a complex theoretical framework that must be carefully considered in the design of educational multimedia resources (Mitchell et al., 2019). Understanding how these theoretical foundations interact and influence learning outcomes is essential for developing effective multimedia learning aids (AlShaikh et al., 2024). Moreover, the rapid evolution of technology and changing learner needs necessitate a continuous re-evaluation of design principles to ensure their relevance and effectiveness in contemporary educational settings (Sato et al., 2023).

This systematic literature review synthesizes and analyzes existing research on design principles for multimedia learning aids within the context of language education. By examining empirical studies, theoretical frameworks, and practical applications, the review aims to:

1. Identify evidence-based design principles that enhance the effectiveness of multimedia learning aids in language education
2. Analyze the theoretical foundations underlying successful multimedia design approaches
3. Evaluate the impact of various design elements on language learning outcomes
4. Provide practical recommendations for educators and instructional designers

The findings of this review will contribute to the growing body of knowledge in educational technology and language pedagogy, while also offering practical insights for the development and implementation of effective multimedia learning resources. This systematic examination is particularly timely given the increasing reliance on digital learning tools and the need for evidence-based guidelines in their design and deployment.

LITERATURE REVIEW

This study investigates the integration of adaptive navigation support and open student modeling with social comparison and visualization techniques, introducing an approach called Open Social Student Modeling (OSSM) to address challenges in online educational resource utilization. Through four classroom studies in programming language education, the research examined various OSSM visualization designs for single and multiple learning content types, aiming to establish effective design principles and assess their impact on personalized guidance and social learning. The study evaluated how OSSM interfaces can support multiple parallel learning content types while maintaining community engagement and personalized navigation. Results demonstrated the OSSM system's significant motivational impact, encouraging broader topic exploration and promoting ahead-of-schedule learning engagement. Notable findings included students' self-regulation in selecting appropriate difficulty levels, leading to consistent performance across varying problem complexities, while the navigation-supported OSSM visualizations with comprehensive content collections fostered uniform group performance. The research concludes that the combination of adaptive navigational support, open student modeling, and social visualization effectively enhances both navigational efficiency and student motivation, successfully guiding learners to relevant content while encouraging engagement with diverse learning materials. These findings contribute to the broader understanding of how personalized and social learning approaches can be effectively integrated to improve online educational resource utilization (Hsiao & Brusilovsky, 2017).

Building upon previous research on educational technology and adaptive learning systems, this study focuses on the development and implementation of a computer-based revision tool for non-Afrikaans-speaking international students at Stellenbosch University's Language Centre, specifically those enrolled in the Beginner Afrikaans Vlak 1 course. While earlier research emphasized the integration of adaptive navigation and social modeling in online learning environments, this study addresses a specific need identified through formal course evaluations and needs analyses, where students expressed interest in digitally accessible revision materials for their communicative and discourse competence-focused coursework. The research applies four of Mayer's (2009) design principles to create a computer program intended to enhance vocabulary retention among international students learning Afrikaans as a beginner language. This investigation extends previous findings on educational technology effectiveness by examining how these specific design principles influence vocabulary acquisition and retention in a second language learning context, particularly addressing the unique challenges faced by international students seeking Afrikaans proficiency during their stay in South Africa (Beukes, 2019).

Following earlier research on educational technology adaptations and language learning platforms, this study examines the role of Digital storytelling (DST) and learning design in Language MOOCs (LMOOCs), particularly as Higher Education Institutions increasingly adopted MOOCs during the COVID-19 pandemic. While previous studies have explored vocabulary retention and computer-based learning tools in language acquisition, this investigation addresses a significant gap in LMOOC research by employing a connectivist framework to analyze teaching and learning dynamics in Digital Learning Environments (DLEs). Through a mixed-methods study of three Norwegian for beginners (NfB) LMOOCs on FutureLearn, the research investigates how implementing a comprehensive narrative structure based on DST principles can enhance participant engagement, retention, and completion rates in language learning MOOCs. The findings support the hypothesis that incorporating DST-based narrative structures, guided by connectivist principles, contributes to developing higher-quality DLEs in MOOCs, particularly in language learning contexts, thus

extending our understanding of effective digital language education beyond traditional computer-assisted learning approaches (De Caro-Barek, 2022).

The integration of disruptive technologies in educational settings has revolutionized the development of student knowledge, skills, and competencies, particularly in applied linguistics and foreign language instruction through computer-assisted language learning (CALL) and mobile-assisted language learning (MALL). While these technological advancements offer significant potential, their effective implementation necessitates a thorough understanding of educational theories and instructional design models to ensure meaningful learning outcomes. To address this need, this study examines the application of the ADDIE instructional design model in developing a blended syllabus for teaching Arabic as a foreign language in South African higher education institutions, with a specific focus on less commonly taught languages (LCTLs). The research encompasses an investigation of student attitudes towards the designed blended syllabus, which incorporates diverse web-based tools and e-learning specifications, including Learning Tools Interoperability (LTI) and Shareable Content Object Reference Model (SCORM). Through this comprehensive approach, the study provides a framework for developing instructional materials that can be adapted for teaching Arabic and other languages, thereby contributing to the broader field of language pedagogy and instructional design (Mohammed et al., 2021).

This research investigated the development and implementation of a digital learning platform (DLP) for English language learners at Thai junior high schools, emphasizing the critical importance of personalizing digital tools to accommodate individual learning needs and behaviors. Utilizing the successive approximation model (SAM) (Herrholtz, 2020) for instructional design, the study employed rapid prototyping and continuous feedback mechanisms while ensuring alignment with the Basic Education Core Curriculum 2008, the Common European Framework of Reference for Languages (CEFR), and PISA reading literacy standards. The platform's architecture, built on open standards and web services for optimal integration and data exchange, incorporated the TIGA English teaching model, which encompasses tasks (T), language input (I), genre (G), and authentic assessments (A) to foster comprehensive language skill development. The implementation phase involved 8 schools, 7 teachers, and 212 students, with data collection conducted through questionnaires (analyzed quantitatively using means and standard deviations) and group discussions (analyzed qualitatively for thematic content). While the findings revealed generally positive feedback regarding the platform's effectiveness, several limitations were identified, including the need for additional learning activities, more comprehensive teacher guidelines, and GUI improvements, thereby providing valuable insights for future digital learning environment enhancements and implementations (Poonpon et al., 2024).

This study conducted a comprehensive quantitative meta-analysis to examine the efficacy of blended learning implementations in the context of Education 4.0 and the Fourth Industrial Revolution, particularly as the global health pandemic has accelerated the adoption of online teaching methodologies. Despite extensive literature advocating various technological roles in education, the inconsistent definitions of "blended learning" have hindered a thorough understanding of its potential, necessitating a systematic investigation of its effectiveness across different delivery platforms. The meta-analysis examined 96 carefully selected samples based on established theoretical definitions, categorizing them into three distinct delivery methods: Web-based applications, standalone applications, and devices. Using Cohen's *d* formula (1988; 1992) to calculate effect sizes (ESs), the study evaluated the overall effectiveness of each delivery method and compared their combined ESs based on similar delivery types and dependent variables. The findings revealed that all three delivery methods effectively enhanced learner performance, particularly in language teaching and learning

contexts. Notably, this research makes a significant contribution by being the first to categorize technological interventions into concrete, concise groupings, providing stakeholders with valuable insights for platform selection across different disciplines and establishing a foundation for future research in blended learning implementation, particularly in comparing the effectiveness of different interventions under Web-based and standalone application categories in relation to specific dependent variables (Mahmud et al., 2022).

This study addresses the persistent challenge in English as a Foreign Language (EFL) contexts of achieving communicative competency, particularly noting the disconnect between learners' theoretical knowledge of the language ("know what") and their practical ability to use it meaningfully ("know-how") in authentic situations. While students often demonstrate proficiency in understanding grammar rules, they frequently struggle to apply this knowledge in genuine communicative contexts, largely due to the limited integration of real-life task complexity in traditional classroom settings. To address this pedagogical gap, the research employed a design-based research approach, implementing an e-learning environment founded on initial design principles of authentic activities across three pre-university level EFL classes in North Cyprus over two research cycles. Through comprehensive data collection methods including semi-structured interviews, work samples, and observations, coupled with ongoing literature review, the study yielded 11 refined design principles specifically tailored for the EFL context, aimed at enhancing competency-based foreign language acquisition and bridging the gap between theoretical knowledge and practical application (Ozverir et al., 2017).

In response to the growing influx of migrants and refugees in Europe and the subsequent pressures on educational systems, this qualitative study, conducted as part of the Moocs4Inclusion project by the Joint Research Centre (JRC) between July and December 2016, investigated the potential role of free digital learning (FDL) in promoting educational inclusion. While existing research provides general design principles for FDL targeting migrants and refugees, this study uniquely disaggregates the analysis into three primary purposes: language learning, civic integration and employment, and higher education. Through semi-structured interviews with 24 representatives from 10 FDL initiatives and four focus groups comprising 39 migrants and refugees, the research examined various implementation approaches, assessed user awareness and adoption rates, and evaluated migrant and refugee perceptions of current FDL offerings. The findings revealed significant overlaps between FDL initiatives' purposes and their design principles, leading to the development of specific recommendations for optimizing FDL initiative design for migrant and refugee populations, while considering their distinct educational purposes and needs within the European context (Muñoz et al., 2018).

This research examines the evolution of mobile learning as the next generation of e-learning, focusing on a comprehensive five-year mobile language learning project designed for Japanese university students, reflecting the increasing ubiquity of mobile devices in daily life and educational contexts worldwide. Through a multi-faceted data collection approach incorporating online surveys, server logs, user registration information, interviews, and quiz performance analysis, the study investigated Japanese students' mobile learning patterns, educational requirements, content preferences, and potential concerns regarding mobile learning implementation. The findings from this longitudinal investigation not only illuminate the current state of learner engagement in mobile learning environments but also provide valuable insights for the development and optimization of future mobile learning projects and systems, particularly in the context of language education and broader educational technology applications (Wang et al., 2016).

This study examined the self-regulatory learning behaviors of community college students enrolled in an online introductory language course, specifically analyzing their engagement with digital learning resources through the lens of six dimensions of self-regulated learning. Through a detailed analysis of reflective journals, the research revealed distinctive patterns in learning behaviors across different proficiency levels, with only high-performing students demonstrating active performance monitoring strategies. Furthermore, significant variations were observed in time management approaches and learning methodologies among students at different performance levels, while a universal challenge emerged regarding sustained motivation throughout the course duration. These comprehensive findings underscore the critical importance of implementing targeted scaffolding mechanisms in online language learning environments, particularly focusing on four key areas: performance monitoring, learning methodology selection, time management strategies, and motivation maintenance, thereby contributing to the broader understanding of effective online language learning support systems (Hromalik & Koszalka, 2018).

This research examined the effectiveness and user reception of WEBGRAM, a web-based multimedia grammar learning system designed for elementary-level English language learners, focusing on its implementation of audio-visual aids for contextual grammar presentation and interactive revision exercises including gap-filling, combo-box, and drag-and-drop activities. Through a comprehensive evaluation approach that combined quantitative measurements of learner satisfaction, attention, and participation with qualitative assessments of materials content, visual and instructional design, usability, practicality, and effectiveness, the study provided insights into the system's impact on grammar learning. The findings demonstrated that learners not only developed positive attitudes toward the WEBGRAM system but also exhibited high levels of engagement with the multimedia-annotated grammar learning materials, suggesting the potential effectiveness of web-based multimedia approaches in grammar instruction for elementary-level language learners (Baturay et al., 2010).

This systematic review examines the evolution and impact of Artificial Intelligence (AI) in educational contexts over the past three decades, with particular focus on the emerging role of Intelligent Virtual Agents (IVAs) and Animated Pedagogical Agents (APAs) within Intelligent Computer-Assisted Language Learning (ICALL). While AI has significantly advanced educational technologies through intelligent tutoring systems, adaptive learning systems, educational chatbots, and teaching robots, recent developments in natural language processing, machine learning, and computer graphics have enhanced the human-like qualities and believability of IVAs as interactive learning facilitators. Despite their potential to personalize instruction and improve learning outcomes across various knowledge domains, empirical research examining the impact of AI-powered IVAs on EFL learners' academic achievement remains notably limited. Through a comprehensive analysis of interventionist IVA studies published between 2015-2020 in EFL settings, this review investigates the key affordances of IVAs, identifies major barriers to their adoption in language learning contexts, and examines prevalent CALL research trends, ultimately providing pedagogical implications for effective IVA implementation in L2 contexts while highlighting critical areas for future research investigation (Katsarou et al., 2023).

This research examines the expansion of adult learning ecology into digital spaces through the lens of the Digital Learning Ecology (DLE) framework, which encompasses three crucial dimensions: context, design, and motivation, specifically addressing the needs of low-literate adult learners who have historically been underserved by educational technology. The study presents a mobile learning application developed for the Barbara Bush Foundation XPRIZE Adult Literacy competition, implementing the DLE framework by integrating context-proximal content to enhance learner engagement, improve multiple literacies, and promote

persistent participation. Through a systematic mapping of DLE dimensions to specific application features, underpinned by cognitive learning principles, the research demonstrates significant learning outcome improvements for low-literate adults, as validated by both internal author evaluations and external XPRIZE assessments. Notably, the study revealed that many low-literate adults also exhibited limited digital literacy, highlighting the necessity for more accessible user interface designs with enhanced signifiers beyond standard universal design principles, ultimately suggesting that carefully crafted mobile solutions based on the DLE framework can effectively expand learning opportunities for low-literate adults across both formal and non-formal learning environments (Nedungadi et al., 2023).

This systematic review examines the implementation of digital game-based learning (DGBL) technology in foreign language (English) education within preschool and elementary school settings, introducing a comprehensive DGBL classification schema comprising four key components: design principles, language content, pedagogical factors, and feedback mechanisms. Through a meticulous analysis of 110 published articles from January 2010 to April 2022, filtered to 50 studies specifically focusing on students aged 2-10 years, the research demonstrates DGBL's significant impact on enhancing motivation, creativity, and problem-solving abilities in language acquisition. The study synthesizes both the potential and challenges of DGBL implementation, particularly highlighting design and development issues related to novel technologies, while proposing emerging technologies such as artificial intelligence, blockchain, deep learning, and AR/VR, along with software engineering processes, as potential solutions for advancing DGBL research and addressing health concerns and technological challenges. This comprehensive analysis not only provides fundamental insights for game classification schema design but also establishes a framework for future DGBL implementation in foreign language learning contexts, emphasizing the importance of evolving technologies and development operations in educational gaming systems (Ongoro & Fanjiang, 2024).

This case study investigates the implementation of the flipped classroom approach in English education at an Algerian University, addressing the contemporary demand for innovative pedagogical methodologies that enhance learner engagement and participation. While existing research often focuses on simply substituting traditional in-class instruction with video lectures and utilizing class time for group discussions, this study explores a more comprehensive instructional design framework for the flipped classroom model, specifically examining English education learners' experiences with digital storytelling in a flipped learning environment. The research aims to bridge the gap between conventional implementations of flipped classrooms and the need for structured instructional design frameworks, providing insights into how digital storytelling can be effectively integrated into the flipped classroom methodology to enhance language learning outcomes and student engagement (Hafidi & Mahnane, 2018).

This research examines the implementation of computerized dynamic assessment (C-DA) through iSpring Quiz Maker to evaluate and enhance English listening comprehension among 172 junior high school L2 English learners, focusing on three critical question types: overview, detail, and inference questions. Through the automated assessment system's ability to generate comprehensive results including current abilities, mediated performance, learning needs, and learning potential scores (LPS), the study revealed significant findings: overview questions posed the greatest challenge to participants, the C-DA mediation proved most effective for inference questions, and students' LPS levels correlated with distinct patterns of difficulty across question types, with low-LPS students struggling with inference questions while mid- and high-LPS students required more support with detail questions. Notably, the research demonstrated that students with identical scores often exhibited vastly different listening

comprehension challenges across the three question types, highlighting the C-DA system's capacity to provide a more nuanced understanding of EFL learners' English listening abilities, thereby offering valuable insights for tailoring instructional design and pedagogical approaches to meet individual learning needs. (Kao & Kuo, 2023).

This research introduces VEC3D, an innovative 3D virtually synchronous communication platform designed to enhance English communicative competence among EFL undergraduate students, addressing the limitations of traditional text-based and web-based virtual reality educational systems through the integration of immersive 3D graphics, real-time voice interaction, and goal-based instructional design. Unlike conventional virtual learning environments that often lack immersive qualities and interactive capabilities, this architecture provides learners with unprecedented autonomy in virtual communications while facilitating the achievement of diverse shared learning objectives. Through an ethnographic study examining how learners perceive their virtual experiences and employ communication strategies (CSs), the findings demonstrate that VEC3D successfully promotes positive student attitudes and interactive learning experiences, thereby offering a more engaging and effective e-learning solution compared to previous virtual reality educational applications in language learning contexts (Shih & Yang, 2008).

This qualitative study examines the effectiveness of online learning for writing skill development during the COVID-19 pandemic, focusing on an EFL student's final project (TA) at the English Department of Politeknik Negeri Padang, where visual images were integrated into a brochure writing project. Through analysis of the student's writing documents and evaluations from three experienced English teachers using the "Analytical Marking Scheme," the research identified two significant areas of progress between the first and final drafts: enhanced content quality demonstrated through improved vocabulary variation and logical organization of ideas, and minimal impact of grammatical, punctuation, and spelling errors on overall message conveyance. While the findings demonstrate the student's successful adaptation to online learning and improved writing performance through visual image integration, they also highlight the necessity for more innovative learning designs in online education, emphasizing the crucial role of teachers as facilitators in fostering student engagement and autonomy, particularly given the challenging nature of remote learning for both educators and learners during the pandemic (Khairat, 2021).

This Design Based Research (DBR) study evaluated the effectiveness of the English Oral Presentation Application (EOPA), a mobile learning tool designed to enhance oral presentation and online collaboration skills among English learners, through a comprehensive analysis of 30 Taiwanese undergraduate students' experiences during a six-week training course. Utilizing an adapted Technology Acceptance Model (TAM) questionnaire and focus-group interviews, the research revealed mixed perceptions among students, with 37% finding EOPA beneficial for learning while 33% reported usability challenges. Through a Complex Dynamic Systems analysis of the interview data, the study identified key attractor and repeller dynamic states within the learning system, including language and presentation skills development, multimedia learning material effectiveness, app design considerations, online collaboration capabilities, anxiety management, and self-regulation skill limitations. These findings not only contribute to the refinement of EOPA and its oral presentation learning framework but also demonstrate how the identification and analysis of dynamic states can significantly inform and improve mobile learning design strategies, particularly in language education contexts (Barrett et al., 2022).

This study examines the application of cognitive load theory in second language acquisition (SLA), specifically investigating how split-attention and integrated instructional formats affect

cognitive load and influence online reading comprehension and vocabulary learning in multimedia environments. Through an experimental design involving 20 intermediate ESL students at an Australian language institution, participants were randomly assigned to four distinct conditions: Split-Attention No Dictionary (SAND), Split-Attention with Online Dictionary (SAOD), Integrated Format No Dictionary (IFND), and Integrated Format with Online Dictionary (IFOD), with the integrated format physically embedding comprehension questions within the reading text, while the split-attention format maintained traditional separation between text and questions. The findings revealed that the integrated reading format significantly enhanced reading comprehension compared to the split-attention format, while dictionary access in SAOD and IFOD groups led to improved vocabulary test performance despite increased task completion time, with split-attention format users demonstrating higher frequency of dictionary consultations than their integrated format counterparts. These results provide valuable insights for multimedia instructional designers and ESL teachers regarding the optimization of online learning environments to manage cognitive load effectively while enhancing second language learning outcomes (Al-Shehri & Gitsaki, 2010).

This research investigates the educational potential of short-form videos on social media platforms, specifically examining their application in foreign language learning (FLL) through an analysis of 34 Portuguese language learning videos on TikTok using an adapted version of Mayer's multimedia learning principles. The study addresses the current knowledge gap regarding the effectiveness of these platforms for language learning by validating these resources within a theoretical framework, revealing the principle of signaling as the most prevalent among the analyzed videos. Through a comprehensive analysis of the relationship between the number of implemented principles, cognitive processing dimensions, and user engagement metrics (views and likes), the findings demonstrate a positive correlation between the number of principles incorporated and video popularity, with the fostering generative processing dimension serving as a key mediating factor. These insights not only validate the practical application of short videos as effective FLL resources but also provide valuable guidance for developing targeted instructional design strategies in online foreign language learning environments, contributing to the broader understanding of how social media-based educational content can be optimized for language acquisition (Zhang et al., 2023).

This study investigates the implementation of mobile learning applications in language education, specifically examining the effectiveness of Mondly Kids and Language Drops-Kahoot in facilitating English and Spanish language acquisition among children, responding to the increasing global demand for multilingual competence in academic and professional contexts. Through the development of age-appropriate, personalized learning scenarios utilizing these interactive mobile applications, the research evaluated their impact across three distinct student groups, focusing on classroom implementation and student work samples. The findings demonstrate that mobile-based language learning not only enhances children's learning experiences and motivation to acquire new languages but also significantly improves their speaking abilities and critical thinking skills during language learning sessions, supporting the integration of information, communication, and ubiquitous technologies (ICT) as effective pedagogical tools in modern language instruction (Konstantakis et al., 2022).

This research examines the development and implementation of PAUER, a computer-assisted language testing (CALT) platform sponsored by the Spanish Ministry of Education from 2007-2010, building upon foundational interface design principles established by Fulcher (2003), Chapelle & Douglas (2006), and Garcia Laborda (2007), while addressing the growing need for unified interfaces and working areas in computer-based language testing environments. Drawing from interface validation studies by Garcia Laborda & Magal Royo (2007) and contemporary developments in platforms like IATEFL and TOEFL, the study analyzes the

platform's visually enhanced learning approach, focusing on information transmission methods, icon meanings, visual presentation strategies, and underlying pedagogical principles. As higher education increasingly transitions to online environments, this analysis of PAUER's design principles and implementation strategies provides valuable insights for similar digital learning platforms worldwide, contributing to the evolving understanding of effective interface design in educational technology, particularly within the context of language testing and assessment. (Laborda, 2009).

MATERIAL AND METHODS

Identification

In the identification phase, the process began with locating study materials aligned with the research focus on the classification of multimedia learning. The primary keyword utilized was 'classification of multimedia learning.' The initial step involved identifying this keyword and exploring related terms, synonyms, and equivalent phrases through dictionaries, thesauri, encyclopedias, and a review of existing literature. Following this, comprehensive search strings were developed specifically for the Web of Science and Scopus databases (refer to Table 1). As a result of this systematic approach, the advanced search yielded a total of 2,563 publications from the selected databases, providing a robust foundation of resources for further analysis. This method ensured the inclusion of diverse and relevant materials essential for the exploration of multimedia learning classification, which is central to the study's focus on enhancing technical skills and creativity in arts education through technology within teacher training institutes.

Table 1. The search string

	The search string
Scopus	TITLE-ABS-KEY (("design principles" OR "instructional design" OR "educational design") AND ("multimedia learning" OR "multimedia aids" OR "educational technology"))
WoS	https://www.webofscience.com/wos/woscc/summary/59a3ef90-d52a-498f-9abf-8cc12026dcfa-012b79144a/relevance/1

Screening

During the screening phase, the collection of potentially relevant research materials was meticulously evaluated to determine alignment with the predefined research questions. For this study, the focus was on selecting research items relevant to the classification of multimedia learning, ensuring they meet the established content-related criteria (see Table 2). In this step, duplicate entries were systematically removed from the initial pool of identified materials. The first stage of the screening process excluded 2,537 publications that did not meet the inclusion criteria, narrowing the scope to 26 studies for further review. These studies were assessed using specific inclusion and exclusion criteria tailored to the objectives of this research.

The primary criterion for selection was the relevance of the literature to the study's focus, as academic articles represent a key source of practical insights and recommendations. Additional materials, such as review papers, meta-analyses, meta-syntheses, book chapters, and conference proceedings, were also considered if they aligned with the research topic but were excluded if they lacked recent or directly applicable findings. To maintain consistency and rigor, The review was confined to publications written in English and restricted to materials published between 2020 and 2024. Furthermore, four duplicate publications were identified

and removed to ensure the final dataset's integrity. This refined screening approach ensured that only the most relevant and high-quality resources were included for analysis, supporting the study's focus on advancing multimedia learning classification in the context of enhancing arts education through technology.

Table 2. The selection criterion is searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Timeline	2020 – 2024	< 2020
Literature type	Journal (Article)	Conference, Book, Review
Publication Stage	Final	In Press
Subject Area	Computer Sciences and Science Social	Besides Computer & Engineering / Others
Country	All countries	-

Eligibility

The final review sample was established after applying all inclusion and exclusion criteria. A detailed disclosure of the research items included in this sample is essential, as it provides clarity on the specific studies that form the foundation for the review's findings. During the eligibility stage, a total of 26 articles were initially identified. At this stage, the titles and key content of each article were thoroughly reviewed to ensure they met the inclusion criteria and were directly relevant to the research objectives of this study on multimedia learning classification. Consequently, 19 publications were excluded due to their titles and abstracts lacking significant relevance to the study's focus or empirical basis. Ultimately, 7 articles were deemed suitable for detailed evaluation and analysis (refer to Figure 1).

Data Abstraction and Analysis

An integrative analysis was utilized as one of the key assessment strategies in this study to examine and synthesize various research designs, including quantitative, qualitative, and mixed-method approaches. The primary aim was to identify significant themes and subthemes related to the classification of multimedia learning. The process began with the data collection stage, which served as the foundation for thematic development. As illustrated in Figure 1, the analysis involved a thorough review of 26 publications to extract assertions and materials relevant to the objectives of this study.

Significant studies on multimedia learning were then evaluated, focusing on their methodologies and research findings. Based on the evidence, themes were collaboratively developed by the research team, ensuring alignment with the study's goals. Throughout the data analysis process, a reflective log was maintained to document key observations, interpretations, and challenges encountered. Any discrepancies in the thematic design process were resolved through collaborative discussions among the researchers, ensuring consistency and coherence.

To further validate the findings, the identified themes and subthemes were reviewed by experts in the fields of educational technology and instructional design. This expert validation process ensured the clarity, relevance, and suitability of the themes within the context of multimedia learning. Finally, the themes were refined and adjusted to provide a comprehensive and consistent framework for analyzing and interpreting the study's findings.

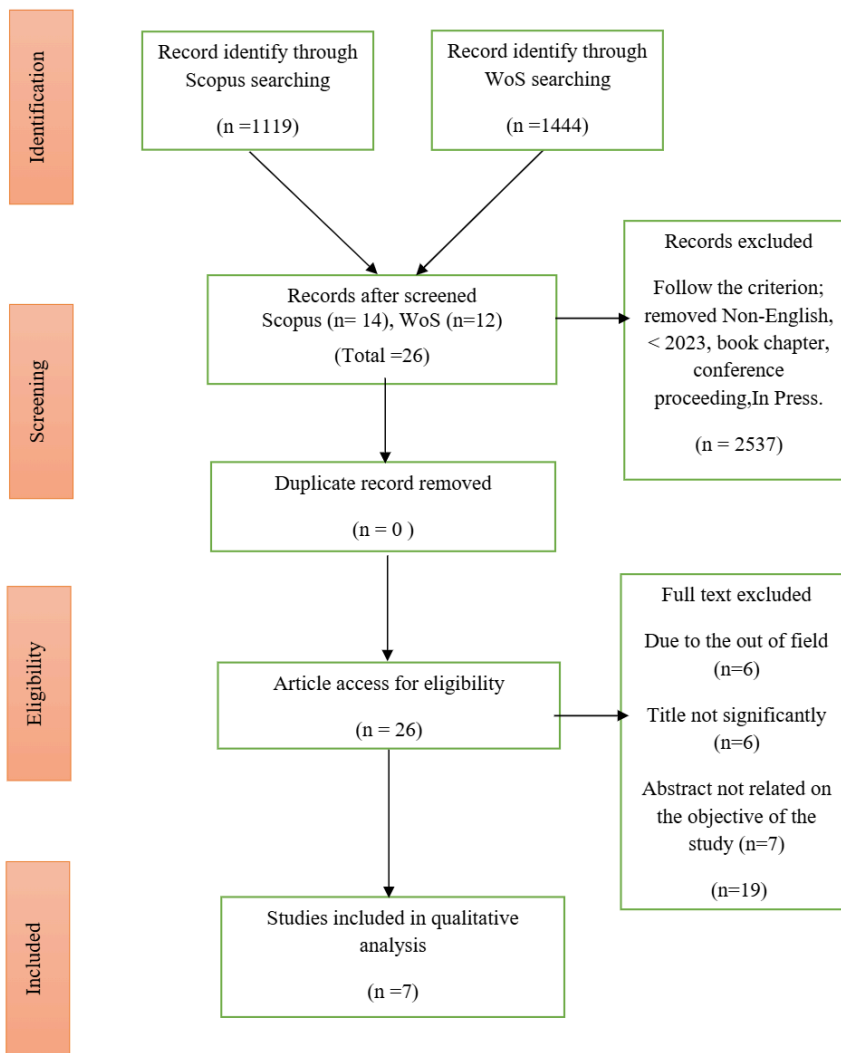


Figure 1. Flow diagram of the proposed search study (Moher D, Liberati A, Tetzlaff J, 2009)

RESULT AND FINDINGS

Professional Development and Learning Design Competencies

Professional organizations and researchers in instructional design and technology (IDT) have long sought to identify essential competencies for professionals in the field, utilizing methods such as job announcement analyses, surveys, and interviews. While previous studies predominantly focused on practitioners' perspectives or insights drawn from job postings and

program descriptions, this study explored the perspectives of leading scholars on IDT competencies, curriculum, research priorities, and the future trajectory of the field. Qualitative data from semi-structured interviews with 21 scholars from 16 U.S. universities revealed several critical findings. Six core competencies essential for IDT professionals were identified, along with actionable strategies to enhance the IDT curriculum. Additionally, five key themes emerged regarding research priorities within the field, while seven themes highlighted potential future directions for IDT. These findings underscore the need for targeted curricular reforms to address gaps in evaluation and align educational practices with evolving industry demands, as identified in prior studies. Together, these insights provide faculty, researchers, and practitioners with a roadmap to refine IDT programs, ensuring students are equipped to navigate and contribute to the rapidly evolving landscape of instructional design and technology (An, 2024).

This qualitative study investigated how learning design and educational technology degree programs prepare students to engage in evaluation practices. By analyzing the curricula of 16 graduate instructional design programs and conducting 29 semi-structured interviews with faculty and recent graduates, the study identified nine themes grouped into three meta themes: (a) the role of problem-solving in evaluation, (b) the alignment of evaluation activities within instructional design, and (c) the relevancy of evaluation in the field. Key findings revealed that evaluation is often underemphasized in these programs. Contributing factors include limited time in the curriculum, restricted client resources, employer disinterest, and insufficient faculty expertise in evaluation. The study highlights the need to prioritize evaluation in instructional design coursework and offers recommendations to enhance evaluative practices in graduate programs (DeVaughn & Stefaniak, 2020).

Table 3. AECT standards accompany the National Council for Accreditation of Teacher Education (NCATE) requirements for academic programs (Bowman et al. 2015)

AECT competencies	Standard 1 content knowl- edge	Standard 2 content peda- gogy	Standard 3 learn- ing environments	Standard 4 profes- sional knowledge & skills	Stand- ard 5 research
Creating	X	X	X		
Using	X	X	X		
Assessing/evaluating	X	X	X		X
Managing	X	X	X	X	
Ethics	X	X	X	X	X
Diversity of learners			X		
Collaborative practice				X	
Leadership				X	
Reflection on practice				X	
Theoretical founda- tion					X
Method					X

The image provided shows the relationship between the AECT (Association for Educational Communications and Technology) competencies and their alignment with the five standards of teacher education programs as guided by NCATE (National Council for Accreditation of

Teacher Education) requirements. The AECT standards are critical in preparing educators in the field of instructional technology and educational media, ensuring alignment with professional competencies.

According to Bowman et al. (2015), the AECT standards encapsulate core competencies under five overarching categories:

1. Standard 1: Content Knowledge - Focuses on educators' ability to create, use, and manage educational resources effectively while integrating theoretical foundations and methods into practice.
2. Standard 2: Content Pedagogy - Highlights assessing, evaluating, and designing instruction that meets diverse learners' needs through pedagogically sound strategies.
3. Standard 3: Learning Environments - Emphasizes managing and designing effective learning environments, addressing diversity, and fostering collaborative practices to optimize student engagement.
4. Standard 4: Professional Knowledge and Skills - Encompasses ethics, leadership, and reflective practice as key components in promoting professional growth and maintaining high educational standards.
5. Standard 5: Research - Encourages research-driven practices, where educators use data to inform decisions, assess instructional effectiveness, and advance the field of educational technology.

These standards are intricately linked to AECT competencies such as creating, using, managing, and evaluating educational technologies, as well as understanding ethical considerations and diversity in learners. The integration of collaborative practices and leadership skills is pivotal in fostering environments conducive to professional and student growth. Moreover, reflection on practice and adherence to theoretical foundations ensure that educational strategies are both innovative and evidence-based.

The alignment of AECT competencies with NCATE requirements underscores the emphasis on preparing educators to meet the demands of a rapidly evolving digital education landscape. By ensuring a comprehensive framework for instructional design, technology integration, and professional practice, these standards provide a foundation for continuous improvement and innovation in educational systems. This alignment is essential for fostering pedagogical excellence and equipping educators to address the challenges of 21st-century learning environments.

Technological Innovation in Instructional Design

Simulation-based training offers unique advantages, such as remote access, mastery learning, and immediate feedback, making it valuable for teacher training in behavior management. This study evaluated the *Interactive Virtual Training for Teachers* (IVT-T) by observing seven education majors performing tasks, completing usability scales, and participating in interviews. The results showed that IVT-T was generally usable but had design issues affecting user performance. Key problems included learning challenges (36%), screen design flaws (19%), unclear terminology (17%), and system limitations (3%). Interviews highlighted strengths, such as realistic characters and classroom settings, but suggested improvements like adding more contextual cues, addressing multiple behaviors simultaneously, and enhancing classroom visuals. These findings align with prior calls for improving instructional tools and emphasize the potential of simulation in teacher training, offering practical recommendations to enhance usability and instructional design for better learning outcomes (Shernoff et al., 2020).

In response to Bennett, Agostinho, and Lockyer's (2017) exploration of university teachers' design processes, this study addresses a critical gap in supporting educators navigating the challenges of designing for learning during the ongoing digital shift. Society's transition to digital environments has created a state of liminality (Turner, 1987), marked by uncertainty, limited resources, and evolving belief systems. While Bennett et al. focused on teachers' design processes through interviews, their findings underscore a significant disparity between what teachers currently have and what they need to design effectively. The study identifies the need for a practical, meaningful, and conceptually grounded approach to guide teachers through this transition. Specifically, it highlights the importance of developing support strategies that are attuned to the teachers' mental states and circumstances as they adapt to digital environments. To address this, a framework of guiding questions is proposed, informed by social constructivism, agile mindsets, productive failure, and the dynamics of designing in liminality. These findings contribute to the broader discussion on enhancing instructional design support by emphasizing actionable strategies for bridging the gap between teacher needs and available resources. This work builds on existing research, offering a forward-thinking approach to empower educators in navigating the complexities of digital transformation (Galyen et al., 2021).

Digital media have transformed the design of educational instruction, introducing learning environments that integrate various presentation modes, sensory modalities, and realities. Augmented Reality (AR) represents a key advancement, merging physical and virtual elements while offering new opportunities to apply multimedia learning principles. However, the AR-specific effectiveness of these principles remains underexplored. This study investigated two fundamental multimedia learning principles within AR environments: (1) the spatial contiguity principle, leveraging AR's ability to spatially integrate virtual and physical elements, and (2) the coherence principle, examining the contextual interplay of audiovisual elements in AR. Two video-based AR studies were conducted. The first study ($N = 80$) explored how integrated versus separated presentations of virtual and physical visuals affected cognitive load, task load, and knowledge acquisition. The second study ($N = 130$) examined the effects of omitting or adding matching or non-matching sounds on the same variables. Results revealed limited significant effects but provided valuable descriptive insights into the interaction of visual and auditory elements in AR learning contexts. These findings suggest nuanced impacts of multimedia principles when applied to AR and underscore the importance of further research to refine theoretical applications. The results align with broader discussions on optimizing instructional design in emerging digital environments and highlight the potential for AR to enhance multimodal learning when effectively designed (Krueger & Bodemer, 2022).



Figure 2. Two screenshots from the video were used in the study (Krueger & Bodemer, 2022).

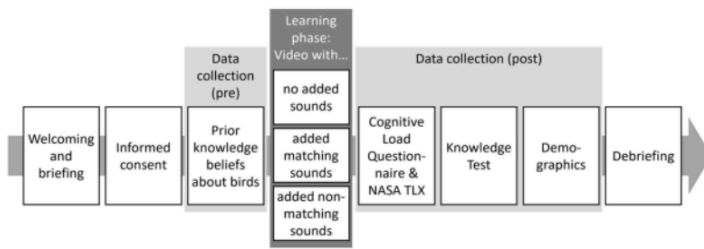


Figure 3. Procedure in study (Krueger & Bodemer, 2022).

Figure 2 displays two screenshots taken from the video used in the study by Krueger and Bodemer (2022). These images depict a woodpecker and a bullfinch, each accompanied by captions that detail the birds, including their habitat, behavior, and appearance. The forest setting in the background further contextualizes the content, aligning it with the study's naturalistic theme.

Additionally, Figure 3 illustrates the procedural flow of the research study in the form of a structured diagram. It outlines each step in the methodology, beginning with welcoming and briefing, followed by informed consent, prior knowledge assessment about birds, and the learning phase. The learning phase includes three conditions: videos with no added sounds, matching, and non-matching sounds. Subsequent steps include a cognitive load questionnaire and NASA TLX, a knowledge test, demographic data collection, and the final debriefing. This figure clearly and comprehensively represents the study's systematic approach.

Overall, the images serve as helpful visual aids that support and complement the information presented in the text, allowing the reader to better understand the context and research design of the study.

Cognitive Approaches to Educational Technology

This article builds on Tracey and Hutchinson's (2019) exploration of empathic design in instructional practice, specifically in redesigning courses to foster collaboration among diverse professionals such as physicians, radiobiologists, and radiation physicists. Their work emphasizes the importance of considering learners' cognitive and emotional experiences in instructional design. While empathic design is crucial for both traditional and digital learning environments, this study highlights the need for instructional designers to account for a broader range of emotional experiences that influence learning. Cognitive Load Theory (CLT) provides a valuable framework for addressing these emotional dimensions by linking them to intrinsic, extrinsic, and germane cognitive loads. This approach helps instructional designers anticipate potential emotional responses tied to cognitive processing demands. The findings underscore the necessity of integrating affective considerations into instructional strategies, offering insights for refining digital learning experiences. When aligned with the previous discussion on cognitive load and digital design, this study reinforces the call for evidence-based, learner-centered design practices. It advocates for instructional methodologies that not only manage cognitive demands but also address the emotional landscape of learners, paving the way for more holistic and effective educational experiences (Huh, 2021).

Cognitive Load Theory (CLT) provides evidence-based instructional guidelines grounded in human cognitive architecture. Drawing on evolutionary psychology, the theory distinguishes between biologically primary knowledge—generic skills essential for survival and acquired

unconsciously—and biologically secondary knowledge, which is domain-specific and requires explicit instruction. While primary knowledge develops naturally, secondary knowledge is processed through a working memory that is limited in both capacity and duration before being stored in long-term memory. Once stored, unlimited information can be retrieved from long-term memory to guide appropriate actions. The theory emphasizes instructional strategies that reduce cognitive load, particularly for complex tasks, ensuring working memory resources are optimized for effective learning. These strategies are increasingly supported by educational technologies, which enhance the delivery and management of complex information. Building on the previous discussion of designing for learning in digital environments, CLT offers a critical foundation for creating instructional methods that align with teachers' evolving needs during the transition to digital. By addressing cognitive constraints, these approaches can better support educators in navigating the challenges of instructional design, reinforcing the importance of integrating evidence-based practices into digital learning frameworks (Sweller, 2020).

Table 4. Summary of some of the instructional effects generated by cognitive load theory

Instructional Effect	Description
Worked example	Studying worked examples is superior to solving the equivalent problems
Split-attention	If multiple sources of information need to be considered simultaneously, physically integrating them is superior to requiring learners to split their attention between them
Modality	If a diagram and text need to be considered simultaneously and the text is simple and short, presenting the text in spoken rather than written form is superior
Transient	High element interactivity information should be presented in permanent rather than transient form or presented in smaller chunks
Redundancy	Eliminating unnecessary information results in superior learning
Expertise reversal and element interactivity	With increases in expertise and decreases in element interactivity, information that is essential for novices becomes redundant for more expert learners, decreasing learning
Working memory depletion	Working memory use depletes working memory resources that recover after rest

Cognitive Load Theory (CLT) provides key guidelines for designing effective learning materials. First, the worked example effect suggests that beginners learn better by studying step-by-step examples rather than solving problems on their own, as it reduces unnecessary mental effort. The split-attention effect highlights the importance of combining related information, such as text and visuals, in one place to avoid confusion and make understanding easier. Similarly, the modality effect shows that using spoken words alongside visuals is more effective than written text for simple materials. The transient information effect recommends presenting complex information in a lasting form, like static text or images, or breaking it into smaller, manageable chunks. The redundancy effect emphasizes the need to eliminate extra or repeated information, as it can overwhelm learners. Meanwhile, the expertise reversal effect advises tailoring materials to the learner's experience level—beginners benefit from detailed guidance, while advanced learners may find it unnecessary. Lastly, the working memory depletion effect reminds us that too much mental effort can exhaust learners, making breaks essential for maintaining focus and productivity. Together, these principles help simplify learning and improve knowledge retention.

Table 5. The research article's findings are based on the proposed search criterion

Title	Authors	Strategies Recommended	Methodology	Key Findings
Professional Development and Learning Design Competencies	(An, 2024)	<ul style="list-style-type: none"> - Targeted curricular reforms - Align educational practices with industry demands 	Qualitative semi-structured interviews with 21 scholars from 16 U.S. universities	<ul style="list-style-type: none"> - Identified 6 core competencies for IDT professionals - Highlighted 5 key research priorities - Outlined 7 potential future directions for Instructional Design and Technology (IDT)
Evaluation Practices in Learning Design Programs	(DeVaughn & Stefaniak, 2020)	<ul style="list-style-type: none"> - Prioritize evaluation in instructional design coursework - Enhance evaluative practices in graduate programs 	<ul style="list-style-type: none"> - Curriculum analysis of 16 graduate instructional design programs - 29 semi-structured interviews with faculty and recent graduates 	<ul style="list-style-type: none"> - Evaluation is often underemphasized in programs - Limitations include limited curriculum time, restricted resources, and insufficient faculty expertise
Interactive Virtual Training for Teachers (IVT-T)	(Shernoff et al., 2020)	<ul style="list-style-type: none"> - Improve simulation-based training by: <ul style="list-style-type: none"> - Adding more contextual cues - Addressing multiple behaviors - Enhancing classroom visuals 	<ul style="list-style-type: none"> - Observation and evaluation of seven education majors: <ul style="list-style-type: none"> - Task performance - Usability scales - Interviews 	<ul style="list-style-type: none"> - IVT-T is generally usable but with design issues - Identified problems: learning challenges (36%), screen design flaws (19%), unclear terminology (17%)
Supporting Teachers in Digital Design Transition	(Galyen et al., 2021)	<ul style="list-style-type: none"> - Develop support strategies attuned to teachers' mental states - Propose a framework of guiding questions 	<ul style="list-style-type: none"> - Exploratory study based on: <ul style="list-style-type: none"> - Social constructivism - Agile mindsets - Productive failure concepts 	<ul style="list-style-type: none"> - Identified the need for practical support in digital environment design - Proposed framework to bridge the gap between teacher needs and available resources
Multimedia Design Principles in Augmented Reality	(Krueger & Bodemer, 2022)	<ul style="list-style-type: none"> - Further research on multimedia principles in AR - Optimize instructional design in digital environments 	<ul style="list-style-type: none"> - Two video-based AR studies (N=80 and N=130): <ul style="list-style-type: none"> - Explored spatial contiguity principle - Examined coherence principle 	<ul style="list-style-type: none"> - Limited significant effects - Provided insights into visual and auditory element interactions in AR learning
Cognitive Load Theory in Instructional Design	(Huh, 2021)	<ul style="list-style-type: none"> - Integrate affective considerations into instructional strategies - Account for emotional experiences in learning 	Theoretical analysis using Cognitive Load Theory (CLT)	<ul style="list-style-type: none"> - Emphasized linking emotional experiences to cognitive processing - Advocated for learner-centered design practices
Cognitive Load Theory and Educational Technology	(Sweller, 2020)	<ul style="list-style-type: none"> - Develop instructional strategies that reduce cognitive load - Optimize working memory resources 	Theoretical exploration of cognitive architecture and learning processes	<ul style="list-style-type: none"> - Distinguished between biologically primary and secondary knowledge - Highlighted the importance of managing cognitive load in complex tasks

DISCUSSION AND CONCLUSION

The review of the literature on professional development and learning design competencies highlights the critical role of instructional design and technology (IDT) professionals in shaping the future of education. Through a multifaceted approach, this research has uncovered invaluable insights into the core competencies, curriculum priorities, research agendas, and emerging trends within the IDT field.

The identification of six core competencies essential for IDT professionals, ranging from content knowledge and pedagogy to learning environment design and research-driven practices, underscores the breadth and depth of skills required to excel in this dynamic field. Complementing these core competencies, the proposed strategies to enhance IDT curricula demonstrate a strong commitment to addressing gaps and aligning educational offerings with industry demands.

Furthermore, the research priorities and future trajectories outlined in this study provide a roadmap for faculty, researchers, and practitioners to navigate the evolving landscape of instructional design and technology. The emphasis on areas such as evaluation, problem-solving, and the relevancy of IDT practices reflects the field's responsiveness to the changing needs of learners and educational institutions.

Importantly, the alignment of AECT standards with NCATE requirements underscores the crucial role of accreditation and professional competencies in ensuring the quality and consistency of IDT programs. This integration of national standards and best practices serves to equip educators with the necessary knowledge, skills, and dispositions to thrive in the 21st-century learning environment.

By synthesizing these findings, the present study offers a comprehensive framework for strengthening IDT education and research. The insights gleaned from this work can inform the development of robust and relevant degree programs, foster interdisciplinary collaborations, and drive the continuous improvement of instructional design and technology practices. As the field continues to evolve, this research provides a solid foundation for navigating the challenges and opportunities that lie ahead.

The research presented in this collection of articles highlights the evolving landscape of instructional design and technology (IDT), showcasing the innovative ways in which technological advancements are shaping educational practices and pedagogical approaches.

The evaluation of the Interactive Virtual Training for Teachers (IVT-T) system underscores the potential of simulation-based training in teacher education, particularly in the domain of behavior management. The findings revealed areas for improvement in usability and instructional design, providing practical recommendations to enhance the learning outcomes for pre-service teachers. This study aligns with previous calls for improving the quality and effectiveness of instructional tools, highlighting the importance of user-centric design processes.

Addressing the challenges faced by university teachers in designing for learning during the digital transformation, the proposed framework of guiding questions offers a valuable resource to support educators navigating the complexities of this transition. Grounded in social constructivism, agile mindsets, and the dynamics of designing in liminality, this approach emphasizes the need for meaningful and conceptually sound strategies that are attuned to teachers' mental states and circumstances.

Furthermore, the investigation of multimedia learning principles within augmented reality (AR) environments expands the understanding of how learners interact with and process

information in these emerging digital contexts. While the findings revealed limited significant effects, the descriptive insights provide a foundation for further research to refine the theoretical applications of multimedia learning in AR-based instructional design.

Collectively, these studies contribute to the broader discussion on enhancing instructional design support, leveraging technological innovations, and empowering educators to navigate the evolving landscape of digital education. The practical recommendations, conceptual frameworks, and empirical findings presented in these articles offer valuable insights for researchers, faculty, and practitioners alike, guiding the development of effective and engaging learning experiences.

As the field of IDT continues to evolve, the research outlined in this literature review underscores the importance of user-centered design, evidence-based practices, and a deep understanding of the interplay between technology, pedagogy, and learner needs. By embracing these principles, the educational community can harness the power of technological advancements to foster transformative learning environments and prepare students for the challenges and opportunities of the 21st century.

The research presented in this collection of articles highlights the critical role of cognitive approaches in shaping the design and implementation of educational technology. The studies draw upon established theoretical frameworks, such as Cognitive Load Theory (CLT), to provide evidence-based guidelines for creating effective and engaging learning experiences.

The exploration of empathic design in instructional practice underscores the importance of considering learners' cognitive and emotional experiences in the instructional design process. By integrating affective considerations into instructional strategies, this approach advocates for a more holistic understanding of the learner's landscape, encompassing both cognitive processing demands and emotional responses. This aligns with the broader call for learner-centered design practices that address the multifaceted nature of learning.

Building on this foundation, the CLT framework offers a robust theoretical basis for understanding human cognitive architecture and its implications for instructional design. The theory's distinction between biologically primary and secondary knowledge, as well as its emphasis on strategies to manage cognitive load, provide valuable insights for educators and instructional designers navigating the evolving landscape of digital learning environments.

The summary of instructional effects derived from CLT further reinforces the practical application of this theory. Principles such as the worked example effect, split-attention effect, modality effect, and expertise reversal effect offer concrete guidelines for designing learning materials that align with learners' cognitive capacities and prior knowledge. By incorporating these evidence-based strategies, instructional designers can optimize the delivery and management of complex information, thereby enhancing learning outcomes.

Collectively, these studies underscore the importance of integrating cognitive approaches into the design and development of educational technologies. By understanding the cognitive constraints and processing mechanisms that underlie learning, instructional designers can create learning environments that effectively support learners' cognitive and emotional needs. This holistic approach to instructional design holds the potential to foster more engaging, efficient, and meaningful educational experiences, ultimately empowering learners to thrive in the dynamic and evolving landscape of digital education.

The research presented in this collection of articles highlights the critical role of instructional design and technology (IDT) professionals in shaping the future of education. The review identifies essential competencies for IDT professionals, proposes strategies to enhance IDT curricula, and outlines research priorities and emerging trends within the field. Cognitive

approaches, such as Cognitive Load Theory, are also explored, underscoring the importance of integrating evidence-based practices and addressing learners' cognitive and emotional needs in the design and implementation of educational technologies. Collectively, these studies provide a comprehensive framework for strengthening IDT education and research, guiding the development of effective and engaging learning experiences that prepare students for the challenges and opportunities of the 21st century.

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