Integration of Artificial Intelligence into Instructional Design

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Abstract: This scoping review explores the integration of artificial intelligence into instructional design. We analyzed 45 studies using inductive and deductive coding. The results identified seven key themes and revealed that AI primarily integrates into instructional design's design and evaluation phases. Findings highlight AI's transformative potential in instructional design and emphasize the evolving roles of instructional designers in adapting to AI-driven tools and methodologies.

Introduction

Artificial intelligence (AI) is rapidly evolving and has significantly influenced the field of instructional design (Namatherdhala, 2022). Research indicates a growing trend toward adaptive, personalized, interactive, and data-driven learning design facilitated by AI across various instructional design (ID) phases. In particular, within the design phase, Kaouni et al. (2023) proposed the development of AI-enabled adaptive e-learning models to address individual learners' needs in online education. Similarly, Ruiz-Rojas et al. (2021) analyzed the integration of generative AI tools within ID frameworks to enhance systematic and impactful learning experiences. Antonelli et al. (2023) explored a virtual reality laboratory's design, implementation, and evaluation, highlighting the role of AI-enhanced interactive learning experiences.

The application of machine learning (ML) has also refined instructional strategies and content delivery. For example, Kajiwara et al. (2023) designed and developed an ML-powered instructional role-playing game to teach machine learning in K-12 settings. Lee et al. (2023) investigated using unsupervised learning to develop adaptive, data-driven personas that help categorize and analyze learners' behavioral patterns.

At the same time, instructional designers engage with AI tools while encountering new challenges in integrating AI technologies into their professional practice. Ch'ng (2023) provided a novel perspective on AI's transformative impact on ID, suggesting a shift toward AI-enhanced design processes that redefine educators' roles by enabling them to focus on more complex and creative tasks through AI-designer collaboration. The study also anticipates the emergence of specialized ID roles, such as AI content strategists and AI technology specialists. While current research underscores AI's potential to transform instructional design, it also highlights the complexities and challenges instructional designers face in adapting to these technological advancements. Understanding these evolving dynamics is crucial for preparing instructional designers to leverage AI effectively while addressing its implications for educational practice and workforce development.

Despite the growing body of research, few studies have specifically examined instructional designers' practices in integrating AI into their workflows. Therefore, this review focuses on studies investigating AI integration into instructional design at large, aiming to provide a comprehensive understanding of how AI shapes instructional design practices.

Method

We conducted a scoping review to synthesize the current research focus on AI integration in instructional design (ID) practice. A scoping review is a literature review approach that examines the extent, range, and nature of research activity in a given field (Munn et al., 2018). It provides a broad overview of existing literature and is particularly useful for exploring emerging topics (Arksey & O'Malley, 2005). This approach is especially effective when prior research has not been comprehensively reviewed (Peters et al., 2015). In this study, we adapted the scoping review methodology to explore how AI has been incorporated into professional ID practice, with a focus on (a) the analysis, design, development, implementation, and evaluation (ADDIE) phases of instructional design and (b) the common themes that emerged across previous studies.

In October 2023, we conducted an initial literature search using databases commonly referenced in education and instructional design research, including ERIC ProQuest, Education Full Text, and Web of Science. We specifically targeted peer-reviewed journal articles published in English between 2013 and 2023. The search terms included "instructional design" AND ("artificial intelligence" OR "machine learning") and "learning design" AND ("artificial intelligence" OR "machine learning"). The initial search identified 183 records.

To streamline the selection process, we used Covidence, a screening and data extraction tool for systematic reviews, to remove duplicate records, reducing the dataset to 111 articles. We then screened titles and abstracts to assess relevance, focusing on instructional and learning design contexts. During this phase, we excluded articles outside the scope of ID, such as those related to software engineering and computer science. After this screening, 53 articles remained for full-text review. Following this comprehensive evaluation, we identified 45 studies that met the inclusion criteria for this scoping review.

We adopted an inductive approach to identify themes that emerged from the review. The coding process followed a structured sequence: first, an expert coded a sample article and discussed the coding decisions with two coders to establish a shared understanding of the criteria. The two coders then independently coded the next 10 articles. Following this step, the expert and coders compared their coding, discussed agreements and discrepancies, and reached a full consensus on the coded articles. After achieving this alignment, the coders proceeded to code the remaining articles independently. The initial agreement rate between the coders was 80%. To ensure accuracy and consistency, the expert reviewed all discrepancies and facilitated discussions until a full consensus was reached.

Results

Within the scope of this review, we developed coding criteria to assess the integration of AI in instructional design (ID) across five phases: analysis, design, development, implementation, and evaluation. After establishing these criteria, we initiated the coding process. In the initial phase, two coders and an ID expert collaboratively coded 10 articles to ensure a shared understanding of the coding framework. During this process, we excluded one article due to its low relevance to the study's scope, reducing the final sample to 44 articles. Subsequently, the two coders independently coded the remaining 35 articles. Their initial agreement rate was 75%, with consensus reached on 26 articles. In the final coding phase, the coders reviewed and discussed discrepancies, achieving full agreement on all but three studies. This process resulted in an overall agreement rate of 92%.

The overall coding results indicated that 10 articles explored AI integration in the analysis phase of instructional design. For the design phase, 25 articles addressed AI integration. Additionally, 10 studies examined AI applications in the development phase. In the implementation phase, 23 articles incorporated AI, while 34 studies discussed its integration in the evaluation phase. These findings highlighted the significant role AI technologies play in the evaluation phase of ID.

We identified seven key themes: (1) the use of machine learning-supported technologies to enhance educational outcomes, (2) the development of AI-integrated courses for practitioners, (3) the design and evaluation of simulated games and their impact on student outcomes, (4) the influence of mobile-assisted learning on student performance, (5) the analysis of automated evaluation systems, (6) the effects of intelligent tutoring systems on student learning, and (7) the role of AI-powered technologies and instructional design in shaping student outcomes, including learning gains and attitudes.

Discussion

The findings from this review reveal that AI integration within instructional design is most prominent in the evaluation and design phases. At the same time, comparatively fewer studies focus on its role in the analysis, development, and implementation phases. Additionally, the seven key themes identified in the literature highlight AI's broad influence on instructional processes, student engagement, and learning outcomes. These findings present several implications for instructional designers, educational institutions, and future research directions.

The results indicate that AI's presence is strongest in evaluation (34 studies) and design (25 studies), suggesting that AI is being leveraged primarily for assessment, feedback, and instructional material generation. The high focus on AI-driven evaluation aligns with the growing adoption of learning analytics, automated assessments, and AI-powered feedback mechanisms in education. Similarly, AI's integration into design reflects its role in course personalization, adaptive learning pathways, and content creation tools.

Conversely, AI's relatively limited presence in the analysis (10 studies), development (10 studies), and implementation (23 studies) phases raises questions about its full potential in ID. The analysis phase, which involves identifying learning needs and defining instructional goals, may still rely heavily on human expertise rather than AI-driven insights. Similarly, in the development phase, instructional designers may face challenges in incorporating AI-generated instructional materials while ensuring coherence and pedagogical alignment. Future research could explore how AI can enhance data-driven instructional needs assessments and automate aspects of material development to support ID professionals more effectively.

As AI becomes more embedded in instructional design, the role of instructional designers is shifting from content creators to AI-augmented learning architects. Designers now interact with AI-driven tools for content development, assessment, and adaptive learning design, requiring them to develop new competencies in AI literacy, data-driven decision-making, and ethical considerations in AI implementation.

The seven key themes identified in this review suggest that AI is expanding beyond automation and actively influencing instructional strategies. For example, AI-powered simulated games, mobile-assisted learning, and intelligent tutoring systems reshape how students engage with instructional content. However, while AI enhances engagement and interactivity, concerns remain about the authenticity of AI-driven learning experiences. One critical area of exploration is how AI-generated content impacts critical thinking and problem-solving skills. If students interact predominantly with AI-curated content and adaptive learning pathways, do they develop the ability to critically evaluate information, synthesize ideas, and engage in deep learning? Instructional designers must ensure that AI-powered learning environments foster autonomous, inquiry-based learning rather than passive AI-driven information consumption.

Conclusion

This review highlights AI's increasing integration into instructional design, with the strongest impact on design and evaluation. AI technologies enhance efficiency, support adaptive learning models, and automate instructional development and assessment aspects. However, these advancements necessitate a critical examination of AI's implications for instructional design practice, learner engagement, and the evolving role of instructional designers. Future research should focus on ensuring that AI integration remains pedagogically sound, ethically responsible, and aligned with human-centered instructional design principles.

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