Artificial Intelligence in Instructional Design: A Systematic Review

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***Abstract*—This systematic review investigated how Artificial Intelligence (AI) supports instructional design by synthesizing findings from 30 empirical studies. Guided by PRISMA guidelines, the review applied strict eligibility criteria to include studies from reputable journals published between 2020 and 2025 that explicitly examined AI's role in instructional or lesson design across K-12 and higher education contexts. The findings indicate a recent surge of interest in AI, as the studies included show an increasing trend from 2022 to 2024. Thematic analysis revealed five core functions of AI in instructional design: (1) Instructional design support, where AI tools assist in generating learning content and assessments; (2) Differentiated and personalized learning, using adaptive systems and intelligent tutoring technologies; (3) Collaborative planning and review, through co-design interactions between educators and AI tools; (4) Real-time feedback, leveraging learning analytics for responsive teaching; and (5) Risk management, emphasizing the importance of educator oversight to mitigate issues such as bias and content accuracy. The review highlights AI's integrative value in instructional design while underscoring the need for human judgment to ensure ethical and contextually relevant applications.**

***Keywords*—artificial intelligence, instructional design, lesson planning, systematic review, educational technology, teacher support**

I. Introduction

Instructional Design (ID) plays a crucial role in creating effective, engaging, and learner-centered educational experiences by combining pedagogical theories, learning strategies, and technology to optimize learning outcomes [1, 2]. With the increasing complexity of modern education, particularly in digital and online learning environments, instructional designers are tasked with incorporating emerging technologies to enhance learning experiences and personalize instruction [3–5]. One such transformative technology is Artificial Intelligence (AI), which offers new opportunities for improving the design, delivery, and evaluation of instruction.

AI applications in instructional design range from adaptive learning platforms that customize content based on learners' needs to generative AI tools that assist designers in developing content and assessments [3, 6, 7]. AI also supports data-driven decision-making by analyzing learner performance data to inform instructional adjustments and personalized learning paths [8]. Additionally, intelligent tutoring systems, natural language processing tools, and recommendation engines are increasingly integrated into the instructional design process to enhance learner engagement and learning efficiency [9, 10].

Despite the growing number of studies highlighting the potential of AI in instructional design, these studies are dispersed across multiple fields, including educational technology, instructional design, and computer science. There remains a lack of a comprehensive synthesis of how AI tools are applied across the instructional design process [11, 12]. While some research has explored how AI supports computational thinking and language learning, the specific integration of AI tools into instructional design frameworks remains underexplored [13].

A systematic review is needed to consolidate the existing knowledge on how AI supports instructional design, providing a clearer understanding of the different AI tools being used, the stages of instructional design where they are applied, and their impact on instructional design quality. Such a synthesis would not only benefit instructional designers and educators seeking to effectively integrate AI but also researchers and policymakers aiming to develop guidelines and best practices for AI-supported instructional design [14, 15].

This systematic review aims to explore how AI supports instructional design by synthesizing insights from existing literature. The purpose is to provide a deeper understanding of AI's role in instructional design processes and to inform future research and practice in this evolving field.

II. Methodology

A. Study Selection and Search Strategy

To ensure a systematic and reproducible selection of studies, this review followed PRISMA guidelines, employing a multi-stage process that included database searching, duplicate removal, title and abstract screening, full-text review, and final inclusion based on predefined eligibility criteria [16].

The criteria ensured the inclusion of studies that explicitly examine how AI supports instructional design, lesson design, or lesson planning. To be eligible, studies needed to be empirical (qualitative, quantitative, or mixed methods), published in peer-reviewed journals or conference proceedings between 2020 and 2025, and focus on how AI tools support instructional design processes. Studies conducted in K-12, higher education, or professional training contexts were all eligible. Studies were excluded if they discussed AI in education broadly without directly addressing instructional design, were non-empirical (conceptual papers, literature reviews, or editorials), or focused exclusively on student-centered AI applications without considering the role of AI in supporting instructional designers' work [17].

A comprehensive literature search was conducted using SCOPUS, EBSCOhost, JSTOR, and ProQuest, databases known for their extensive indexing of educational and technology research. These databases were selected to ensure broad coverage of relevant literature. Boolean operators were used to combine key terms, with the final search string: "Artificial Intelligence" or "AI" and "Instructional Design" or "Lesson Design" or "Lesson Planning". Search filters were applied to restrict results to peer-reviewed empirical studies published in English between 2020 and 2025. Search strategies were further customized for each database's indexing system to maximize the retrieval of relevant studies.

The study selection process was managed using Covidence, a systematic review management tool that facilitated screening, duplicate removal, and selection. Following automatic duplicate removal, two independent reviewers conducted title and abstract screening, evaluating each study against the eligibility criteria. Studies that did not explicitly address AI's role in instructional design were excluded. Full-text reviews were conducted for the remaining articles to confirm their relevance, assess methodological rigor, and ensure they provided empirical evidence on how AI supports instructional design processes. Discrepancies between reviewers were resolved through discussion and consensus.

B. Data Extraction and Analysis

A structured data extraction and inductive thematic analysis process was conducted to systematically gather and analyze data from the 30 included studies. Data extraction was carried out using Covidence, a systematic review management tool, which facilitated blinded extraction by two independent reviewers. Extracted data included publication details, research context, types of AI tools used, supported instructional design tasks, and reported benefits and challenges. Discrepancies between reviewers were resolved through discussion and consensus, ensuring consistency and reliability.

Following data extraction, inductive thematic analysis was applied to examine how AI tools support instructional design. Each study was reviewed, and specific AI applications and instructional design tasks were coded directly from the data, allowing patterns to emerge organically. These initial codes were iteratively reviewed, refined, and grouped into broader categories representing recurring instructional design functions [18].

Through continuous comparison and consolidation across studies, overlapping codes were merged, and related categories were further refined into a final set of overarching themes. This inductive, bottom-up process, moving from specific codes to general themes, ensured that the final themes were grounded directly in the data rather than imposed from existing frameworks.

III. Results and Discussion

A. PRISMA Screening Results

Following the PRISMA guidelines, a total of 555 studies were identified through searches in Scopus (n = 225), EBSCO (n = 131), JSTOR (n = 104), and ProQuest (n = 95). After the removal of 77 duplicate records using Covidence, 478 studies remained for title and abstract screening. During this phase, 391 studies were excluded for failing to meet eligibility criteria.

A total of 87 full-text articles were retrieved and assessed for eligibility. After full-text review, 30 studies met the inclusion criteria and were included in the systematic review. The primary reasons for exclusion at this stage included studies being non-empirical (n = 13), studies focusing on irrelevant interventions (n = 10), or studies using inappropriate research designs (n = 34). The final set of 30 studies provides a comprehensive view of how artificial intelligence tools are used to support instructional design across various educational contexts. The PRISMA flow diagram Fig. 1 summarizes the full selection process.

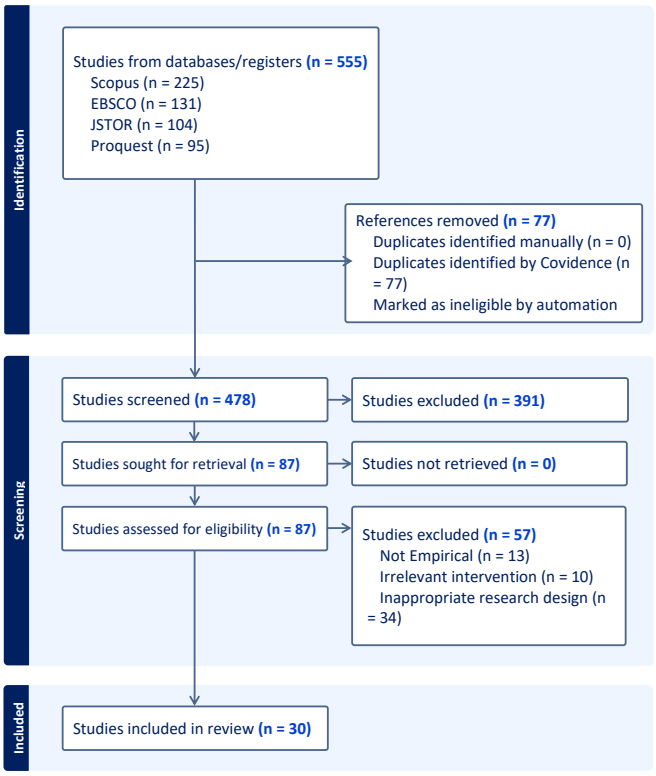

Fig. 1. PRISMA selection process.

B. Study Demographics

Table 1 presents the demographic profile of the 30 studies included in this systematic review on the use of Artificial Intelligence (AI) in instructional design. The table summarizes the distribution of studies based on year of publication, country of origin, and educational context (i.e., higher education or K-12). This overview provides insights into the temporal trends, geographic spread, and contextual focus of recent research in the field.

The demographic distribution of the 30 studies included in this systematic review of AI in instructional design reveals a strong upward trend in recent research activity. A majority of the studies (73.33%) were published in 2024, indicating a significant surge of interest in the integration of artificial intelligence within instructional design in the most recent year. This increase is followed by studies published in 2023 (16.67%) and 2022 (10%), suggesting that the topic has rapidly gained scholarly attention in the last three years.

In terms of geographic origin, the United States contributed the highest number of studies (26.67%), followed closely by China (23.33%), highlighting the dominant roles

of these countries in the AI and education research landscape. Other contributing countries include South Korea (10%) and Turkey (6.67%), with the remaining studies distributed across diverse regions such as Europe (e.g., Belgium, Switzerland, Spain), Asia (e.g., Japan, UAE), and Central America (e.g., Guatemala), each accounting for 3.33% of the sample. This reflects a broad, international interest in the application of AI to instructional contexts, though predominantly led by technologically advanced nations.

Table 1. Study demographics

Study Demographics	Details	Frequency	Percentage
Year	2022	3	10%
	2023	5	16.67%
	2024	22	73.33%
	Total	30	100%
Country	United States	8	26.67%
	China	7	23.33%
	South Korea	3	10%
	Turkey	2	6.67%
	Croatia	1	3.33%
	Japan	1	3.33%
	Italy	1	3.33%
	Guatemala	1	3.33%
	Belgium	1	3.33%
	Spain	1	3.33%
	Switzerland	1	3.33%
	Sweden	1	3.33%
	UAE	1	3.33%
	Lithuania	1	3.33%
	Total	30	100%
Study's Context	Higher Ed.	16	53.33%
	K-12	14	46.67%
	Total	30	100%

Regarding the educational setting, a relatively balanced distribution is observed between higher education (53.33%) and K-12 education (46.67%), suggesting that research on AI in instructional design is being explored almost equally across both levels. This balance may reflect a growing recognition of AI's potential in diverse learning environments, from foundational to advanced education systems.

C. Thematic Findings

1) Instructional design support

A dominant and recurring theme across the studies is Instructional Design Support, where AI acts as a co-designer, accelerating the generation of lesson materials, assessments, and instructional sequences [19–22]. In particular, ChatGPT was frequently highlighted for its ability to rapidly produce draft lesson plans, quizzes, and rubrics aligned with established instructional frameworks such as backward design [23] and the 5E model [24]. This automation of routine tasks enables teachers to shift their attention to higher-order design decisions, such as ensuring alignment with student needs, institutional priorities, and local contexts [12, 25]. However, nearly all studies emphasized that AI serves as a collaborative tool rather than a fully autonomous designer. Teachers maintain final authority over the accuracy, relevance, and cultural appropriateness of all AI-generated content [26].

2) Differentiated and personalized learning

Closely linked to design support is differentiated and personalized learning, where AI tools dynamically tailor content and feedback to individual learners based on real-time performance data [27, 28]. Intelligent Tutoring Systems (ITS), including ALEKS, MATHia, and Khan Academy, exemplify how AI adapts learning pathways by analyzing student responses and adjusting instructional complexity and pacing [29, 30]. Beyond content delivery, AI tools such as Poe Chatbot also provide personalized formative feedback, helping students self-monitor their learning progress and adjust strategies in real time. However, the effectiveness of personalization is highly dependent on the quality and completeness of student data, with incomplete profiles limiting AI's ability to provide accurate recommendations [31, 32].

3) Collaborative planning and review

Collaborative Planning and Review also emerged as a critical theme, with AI tools like ChatGPT, Microsoft Copilot, and Co-Instructional Designer Bots functioning as collaborative partners in lesson planning and instructional refinement [33, 34]. These tools allow teachers to draft, review, and revise instructional materials in iterative cycles, blending AI-generated suggestions with teacher expertise and professional judgment [26]. For example, Microsoft Copilot integrates teacher input at multiple stages, ensuring that AI-generated lesson components align with both curriculum standards and classroom contexts [35, 36]. This iterative co-design process enables teachers to adapt lessons responsively based on emerging student needs and contextual shifts [37].

4) Real time feedback

The Real-Time Feedback theme highlights how AI provides continuous performance data and learning analytics that support adaptive instructional decision-making. Tools such as AI Learning Analytics platforms, Pair-Up, and I-assistant provide real-time dashboards tracking student engagement, collaboration patterns, and individual progress [28, 38, 39]. These data streams empower teachers to modify instruction in real time, adjusting pacing, grouping, or instructional strategies based on actual student needs [30]. However, the interpretation of real-time data must always be mediated by the teacher's professional judgment, as AI data alone often fails to capture socio-emotional and contextual factors impacting learning [40].

5) Risk management

Finally, risk management emerged as a cross-cutting theme, as teachers consistently identified the need to critically evaluate AI-generated content for accuracy, bias, and ethical concerns [24, 25]. Open-ended tools like ChatGPT and GPT-4 are particularly vulnerable to hallucinations and the generation of culturally insensitive content, requiring teachers to act as gatekeepers ensuring alignment with curricular goals and ethical standards [23, 37, 40].

IV. Conclusion

This systematic review provides a timely and comprehensive synthesis of how Artificial Intelligence (AI) is being used to support instructional design across various educational settings. The findings highlight AI's multifaceted role—as a co-designer, data analyst, feedback provider, and

planning assistant—demonstrating its capacity to enhance lesson development, personalize instruction, and support iterative improvement.

The increasing number of studies in recent years, particularly in 2024, reflects the growing interest and urgency in exploring AI's role in education. The geographic and contextual diversity of the studies also indicates global experimentation with AI tools in both K-12 and higher education settings.

Importantly, the review underscores that AI tools are most effective when used collaboratively with educators, not as replacements. Human oversight remains critical for ensuring relevance, cultural appropriateness, and ethical integrity. As AI tools continue to evolve, future research should explore scalable models for teacher-AI collaboration, investigate long-term impacts on learning outcomes, and develop guidelines to ensure responsible AI integration in instructional design.

Ultimately, this review contributes to a clearer understanding of AI's practical applications in education and offers a foundation for future innovations that align with instructional goals and ethical standards.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

M.A.G. conceptualized the study, conducted the literature search, and led the writing of the manuscript, reviewed and screened the articles using Covidence. C.P.S. contributed to the data extraction and thematic analysis, reviewed and screened the articles using Covidence. Both authors reviewed and approved the final version of the manuscript.

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