


# Themes and Tensions: A Bibliometric Review of AI in Design Education (2020-2025)

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This review provides a critical reading of recent literature on the application of artificial intelligence (AI) in design education, focusing on emerging themes corresponding to the advent of AI in the pedagogy of different design disciplines. Using systematic screening, bibliometric and thematic analyses, the study examines 114 peer-reviewed articles published since 2020. This work is a thematic and bibliometric synthesis that uses PRISMA as a reporting guide rather than a fully compliant systematic review with meta-analysis. Key themes include the integration of generative AI into curricula, the facilitation of personalised learning, the enhancement of creativity, ideation, and technical skills, and uncertainty of the future job market. The review indicates that while AI tools could serve as a catalyst for design education, they also introduce challenges such as risks to academic integrity, diminished originality and critical thinking, over-reliance, and ethical dilemmas regarding authorship. A central observation is that the literature itself leans markedly optimistic: benefits such as creative augmentation are frequently reported, often on the basis of short-term, self-reported, or small-scale studies, whereas troubling consequences such as de-skilling, homogenisation of student output, and epistemic dependence on generative tools are acknowledged in principle but rarely investigated with comparable rigour. This review therefore reads the prevailing enthusiasm with deliberate caution and treats this imbalance as a finding in its own right. It concludes by advocating for a balanced, ethically grounded approach positioning AI as a cognitive collaborator. Such an outcome, however, is contingent rather than assured, and current optimism should be tempered until documented risks meet the same evidentiary standards as the claimed benefits.

**Keywords:** Review, Artificial intelligence, Design education, Creativity, Digital literacy, Academic integrity.

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## 1. Introduction

The evolution of artificial intelligence (AI) has permeated numerous fields, affecting many traditional practices and pedagogies. Under the umbrella of design education, AI offers both potential and drawbacks. The theoretical framework for best practices of utilising GenAI in design education is still emerging and in its infancy. Recent years have witnessed significant changes in pedagogical strategies, creative processes, and the broader landscape of design learning across multiple design disciplines [1-5].

While early scholarship predominantly focused on technical integrations or the potential of AI as a tool for automation [6], the advent of AI in design education and domains of creative pedagogy soon emerged as a notable body of literature [7]. Traditionally, the machine was considered a tool for repetitive tasks; however, the current developments have expanded its role into domains of creativity, language, and the arts, which were unimaginable a decade ago [see 8]. The impact of AI is particularly evident in activities where human agency was considered essential in the very definition of authenticity and creativity [9]. While these activities are revolutionary, they raise many significant questions about their rapid, and most often unplanned, integration with education systems [2, 3, 10, 11]. After a few short years of having public access to these technologies, it is now evident that the next generation of designers, creative thinkers, architects, and alike would have to navigate a vastly different GenAI driven professional landscape where many of the jobs that exist today might become redundant [12, 13].

Design education in specific, which has traditionally been based on an interactive studio learning environment [for instance, see 14], is undergoing a transformative shift. The introduction of GenAI tools—large language models such as GPT, or media generators via text-to-image, image-to-image, immersive reality, text-to-video and sound cloning (via Stable Diffusion, Midjourney, and Dall-E), to name a few [see 12, 15, 16], has presented a double-edged pedagogical dilemma. On one hand, GenAI has opened up new avenues for creative exploration and can be considered catalyst and facilitator of creative outputs [see 15, 17, 18, 19]; on the other hand, it has brought forth many question marks regarding ethics, authenticity, human experience, overreliance on the technology and balance between human and machine contributions to the creative process [1, 3, 20, 21, 22].

Rapidly expanding body of literature highlights some of the potential of AI in transforming design pedagogy [3, 10, 23]. For instance, Fleischmann [1] showcases how generative AI tools can facilitate ideation and conceptual development, while Liu et al. [24] highlight the ability of these tools to support diverse cognitive styles [also see 17]. The most common trend in the emerging literature is recognising the potential of AI in the pedagogical narrative of design education while calling for caution and the necessity of developing frameworks [3, 20]. Iranmanesh and Lotfabadi [25] acknowledge the potential of generative AI tools in architecture pedagogy while also highlighting their negative dimensions, including overreliance, outcomes without process, and biases inherent in the AI patterns. An experimental study by An [26] shows that integrating AI into art education has the potential to enhance students' self-efficacy, while also highlighting the need for implementing proper policies and frameworks [also see 21, 26, 27, 28].

Moreover, integration of virtual and augmented reality with AI-powered tools has shown promising results in experimental pedagogical studies in interior design [29, 30]. Nevertheless, despite these emerging arguments, the scope and pace of the topic constantly widen the gap in developing frameworks for the role generative AI will play in design pedagogy. There is a pressing necessity to try to understand how AI can address diverse pedagogical needs, foster critical thinking, and maintain the creative integrity of traditional design methodologies.

The reality and widespread penetration of these technologies into the everyday practices of students worldwide make it an unavoidable yet challenging topic for design pedagogy discourses. Accordingly, there is a strong argument to be made for the necessity of periodically reviewing the rapidly emerging literature on this topic. This is critical, particularly given the unprecedented pace of technological change since the public release of many generative AI tools in 2020. What is more, the literature addresses both

opportunity and challenge; thus, this demands careful and ongoing examination of how generative AI can be effectively and responsibly integrated into design education systems worldwide. Accordingly, this study addresses this need by systematically exploring contemporary literature focusing on the intersection of AI, design education, and pedagogy published after 2020. The main keyword "design education" in this review refers to arts, architecture, interior architecture, product design, graphic design, painting, plastic arts, and fashion design; other disciplines, such as engineering, electrical, industrial, and software design, were excluded and require future investigation. This scoping decision is intentional. The review centres on studio- and atelier-based, craft- and composition-oriented design education, where the pedagogical traditions of iterative making, learning by doing, and critique differ from the engineering- and computing-oriented practices of software and interface design. The latter constitute a substantial and fast-moving literature of their own and would dilute the thematic coherence of the present synthesis. This exclusion, therefore, narrows the claim of the review and is itself acknowledged among its limitations. By synthesising insights from a broad array of design-related fields, this research aims to identify key themes, challenges, and opportunities that currently define AI's evolving role in design education.

It must be noted, once more, that the present review uses the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) checklist as an organising guide for transparent searching and selection, rather than as a fully implemented systematic review. Through this process, the paper aims to examine literature published between January 2020 and July 2025. Using this method, the review evaluates themes and patterns regarding the integration and application of AI technologies in design education/pedagogy.

## 2. Methodology

The PRISMA framework is a well-recognised guideline for conducting and reporting systematic reviews aiming for transparency and rigour [31]. The structured approach of the method ensures comprehensive identification, selection, and synthesis of relevant studies while trying to minimise bias and enhance reproducibility and transparency. It should be stated plainly that this review follows the PRISMA 2020 checklist as a structuring guide for the identification, screening, and selection stages, but does not satisfy every requirement of a fully compliant systematic review. In particular, screening and selection were carried out by a single researcher rather than two or more independent reviewers, so no inter-rater reliability statistic (such as Cohen's Kappa) is reported; no formal risk-of-bias or methodological-quality appraisal of the included studies was performed, with peer-reviewed indexing in the Web of Science Core Collection taken as the quality threshold; and the synthesis is interpretive and thematic rather than a meta-analysis of pooled effects. These choices are appropriate to a mapping review of an emerging, heterogeneous, and largely qualitative literature, but they constrain the strength of the claims that can be drawn and are revisited in the Limitations section. Accordingly, the following section elaborates on the process of selection of papers for this review based on the PRISMA 2020 checklist.

The study was initiated by searching the Web of Science (WoS) core collection. Since the paper focuses on social sciences and humanities, the WoS core collection offers a comprehensive view of the highest-quality peer-reviewed scientific works. However, other disciplines, such as medicine, often require additional indexing [32]. This review provides the following details: the search included all sub-datasets available within the Core Collection, including SCI, SCIE, SSCI, A&HCI, and ESCI [33]. The temporal scope for this study spans January 2020 to July 2025, ensuring a focus on recent advancements and contemporary discussions, the timespan of the search eliminates the limitations of WoS core collection in indexing and cataloguing historic literature [see 34]. It must be noted that

while this study does not claim to have explored all papers covering the topics, through the lens of WoS, an insightful snapshot can be created that is representative of the general trends in contemporary discourses.

The search process comprised the selection of keywords and the inclusion and exclusion criteria, followed by a close review of the content of the selected papers. The search keywords were selected based on the multidisciplinary nature of AI applications, particularly in design education (See Table 1). Keywords were selected based on the review of the prior literature and their thematic relevance [25]. The following initial search criteria were used, returning 1068 papers on July 9th 2025. The time span of the search covers the period from the debut of the first publicly available generative AI in 2020 to mid-2025. The descriptive year ranges shown in Figure 1 reflect the actual publication years recorded in Web of Science for the retrieved and retained records (the earliest indexed records in the final set carry a 2021 publication year and the latest carry 2025). After initial screening, 26 retracted publications were excluded, alongside 17 non-English articles, ensuring the relevance and accessibility of the dataset. Abstracts were closely monitored, and papers that did not engage an aspect of different fields of design education (not including software or interface design) or art/design education were excluded (n=801). The 224 remaining papers were sought for the retrieval of full text for further inspection. We were able to retrieve 203 full texts. Following a thorough full-text examination of the remaining 203 papers, 89 were excluded for reasons such as superficial mentions of generative AI or misalignment with the educational focus. These exclusions were due to a lack of substantive engagement with design education or focused on unrelated fields such as STEM visualisation or interface design. A few were targeting Machine learning and digital cartography, which are separate (and already established) fields of study. Consequently, the final dataset comprised 114 high-quality peer-reviewed documents from 79 sources. This collection provides a window into the most relevant and impactful studies within the domain of design education, focusing on the arts, architecture, interior architecture, product design, graphic design, painting, plastic arts, and fashion design.

Table 1. Search criteria of the review.

Inclusion: AI technologies	((TS=("artificial intelligence" OR "machine learning" OR "deep learning" OR "neural networks" OR AI))
+	AND
Inclusion: Design and pedagogy	TS=("design education" OR "art education" OR "architecture education" OR "interior design education"
	OR
	"design pedagogy" OR "art pedagogy" OR "architecture pedagogy" OR "interior architecture" OR "interior design" OR "graphic design" OR "product design" OR "fashion design"))
-	NOT
Exclusions	TS=("engineering design" OR "computer design" OR "software design")
+	AND
Timespan	PY=(2020-2025)

### 3. Bibliometric Analysis

The final dataset was analysed using Bibliometrix, an R package that is widely utilised for exploration and visualisation in reviews [see 35, 36]. The initial objective of the analysis is to identify thematic trends and the potential relationships between key concepts. Here, the study explored the papers from different perspectives, such as the authors' keywords,

followed by a deeper dive into the thematic content emerging from the content. Given the temporal limitations of the dataset (2020–July 2025), co-citation network analysis was deemed impractical. Instead, the analysis focused on the co-occurrence of keywords, conceptual and thematic structures within the literature. Figure 1 shows the general information about the selected papers. Across the globe, China has the most publications related to this topic, followed by Korea and India (Figure 2). At the time of writing this paper, Wen et al. [37], Chiu et al. [27] and Fan and Zhong [38] are the most central studies in the dataset.



Figure 1. Descriptive statistics of the final 114 papers selected for the review.

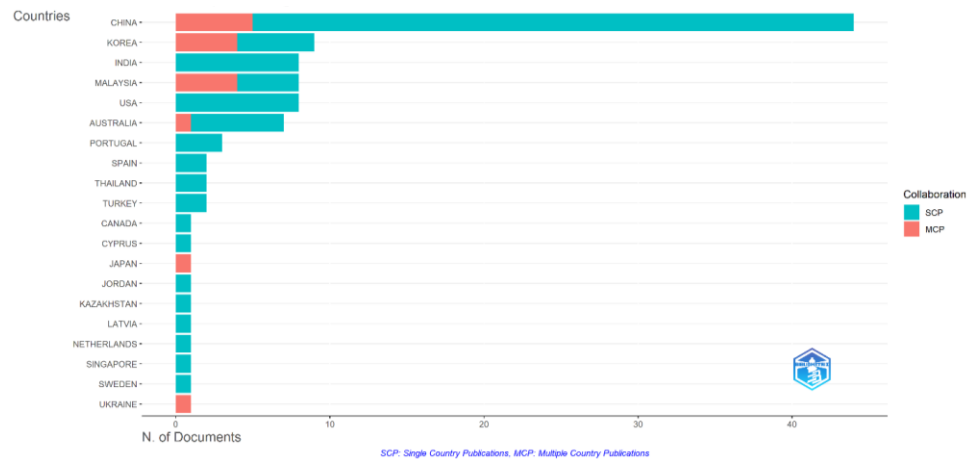


Figure 2. Corresponding author's countries.

### 3.1. Exploring Thematic Map of the Authors' Keywords

A thematic map using the authors' keywords was generated. The thematic map uses the walktrap clustering algorithm [35, 39] and provides a nuanced view of the research structure at the intersection of AI and design education. In this analysis, clusters of related terms are visualised on a two-dimensional map. Each cluster is assigned a "centrality" and "density" value based on the strength and nature of keyword co-occurrences. Callon centrality (horizontal axis) indicates how strongly a cluster is connected to others in the network. It reflects the relevance and influence of a cluster across the field. The vertical axis is representative of Callon density, and it shows the degree of internal development within each cluster. The vertical axis shows how strongly the keywords within the same cluster are linked to one another [40]. The walktrap algorithm identifies these communities by simulating random walks through the co-occurrence network. Through this process, keywords that frequently appear in the same research contexts are grouped together [41]. Accordingly, the placement of each cluster on the map corresponds to its quantitative centrality and density. On the basis of the placement of clusters on these two axes, four

themes can be extracted. Motor themes are high in both; niche themes are high in density and low on centrality; basic themes show high centrality and low density; emerging/declining themes are the ones low in both.

Here, the analysis shows "cognitive load," "interior design," "machine learning," "engagement," and "Midjourney" as motor themes. These are both central and well-developed, indicating that they are key drivers and mature focal points of current research. The motor themes are more general and have application across design education. Moreover, "teaching," "design thinking," "art design education," "digital art," and "design creativity" were shown to be niche themes. These themes are characterised by their strong internal development but limited connections to other major clusters, marking them as specialised or discipline-specific. Themes such as "visual" and "architecture education" are categorised as emerging or declining (all emerging in this case, due to the nature of the review). These themes are occupying more peripheral and less developed positions.

Table 2. Keyword themes with centrality, density, frequency, and quadrant values.

Theme	Centrality	Density	Frequency	Quadrant
teaching	0.083	43.75	6	Niche
interior design	0.000	50.00	2	Niche
machine learning techniques	0.000	50.00	2	Niche
visual	0.167	33.33	3	Emerging
Midjourney	0.778	50.00	5	Motor
cognitive load	0.500	75.00	6	Motor
design thinking	0.250	62.50	4	Niche
interior design	0.792	65.00	13	Motor
machine learning	0.561	40.00	10	Motor
technological	0.000	50.00	2	Niche
architecture education	0.000	25.00	4	Emerging
art design education	0.250	50.00	2	Niche
designed education	0.000	50.00	2	Niche
digital art	0.000	50.00	2	Niche
engagement	1.000	50.00	5	Motor
design creativity	0.000	50.00	2	Niche
Internet of things technology	0.000	50.00	2	Niche
art and design	0.000	62.50	4	Niche

### 3.2. Factorial (Correspondence) Analysis

In order to explore the structure of the literature, a factorial analysis (also known as correspondence analysis) was performed on the co-occurrence matrix of authors' keywords, using Bibliometrix [35, 42]. This statistical method reduces complex, high-dimensional keyword relationships into a two-dimensional space (Dimension 1 explains

the greatest share of conceptual variation among keywords, and Dimension 2 explains the second greatest conceptual share). The intention of this analysis is to show the most notable conceptual groupings and oppositions in the data. Each keyword is plotted as a point, and the distance between points reflects the frequency of their co-occurrence. Here, keywords that often appear together in the same articles cluster closely, while those with different contexts are positioned further apart [43]. Clusters are then detected and colored based on their conceptual proximity on the two axes. Accordingly, each cluster represents a distinct thematic grouping within the literature.

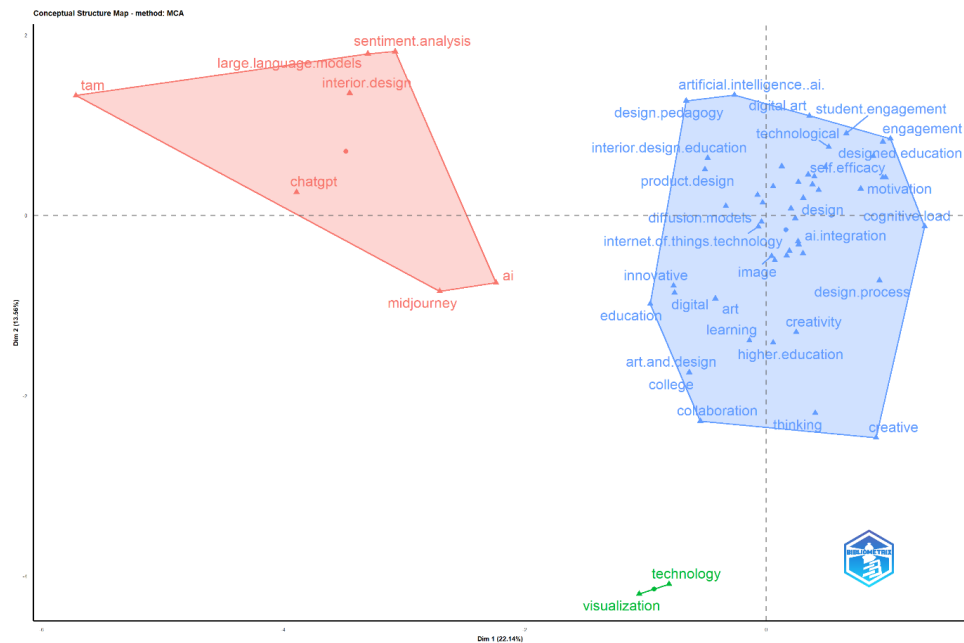


Figure 3. Graph of Factorial (Correspondence) Analysis.

The factorial analysis of authors' keywords identifies three clusters. The first is a primary well-integrated central core around AI, creativity, and design education, a secondary cluster focused on tools and platforms and a much smaller third cluster focusing primarily on visualisation, flanked by focused clusters on generative AI platforms, advanced AI agents, and technological visualisation. This structure highlights the field's intellectual integration as well as the emergence of specialised topics such as tool adoption and intelligent tutoring systems.

### 3.2.1. Cluster 1: Central Pedagogy & Creativity

The largest and most conceptually central cluster includes mostly pedagogy and creativity keywords. Cluster 1 groups together the core discourse of AI and its role in design and art education, creativity, pedagogical strategies, and student engagement. It represents the mainstream of scholarship, focusing on how generative AI and advanced technologies are transforming creativity, curricula, and learning experiences across various design disciplines [35, 44, 45, 46]. The presence of both general (such as education, teaching) and specific (such as architecture, product design) terms suggests a wide, interdisciplinary perspective [for instance, see 1, 3, 10, 18, 20, 47].

### 3.2.2. Cluster 2: Generative Tools and Platforms

The second cluster is smaller but distinct; it highlights the rapid emergence of practical, generative AI platforms (such as Midjourney, ChatGPT, LLMs). This cluster reflects a subfield which is focused on the application, experimentation, and implications of specific generative tools within the design process and classroom. A notable observation regarding this cluster is the strong presence of interior design education. Cluster 2 is signalling new directions in digital creativity and tool adoption [for instance, [see 16, 19, 48, 49, 50](#)]. This cluster also includes keywords related to advanced AI systems and their role as co-creative agents. The link to the intelligent tutoring system and interior design indicates interest in both the technical issues and specific disciplinary applications. The presence of this cluster puts more emphasis on the growing impact of advanced, interactive AI on design education [[46, 49, 51](#)].

### 3.2.3. Cluster 3: Technology & Visualisation

This smallest cluster represents research at the intersection of technological development and design visualisation. The focus is likely on how visualisation techniques and new technologies are used to communicate, model, and teach design concepts. The presence of this cluster points to the continued importance of digital visualisation as both a technical and pedagogical theme [[23, 30, 52, 53, 54](#)].

## 4. Thematic Analysis of AI in Design Education Based on the Content

Although the bibliometric analysis of the literature provides some insights into the present and emerging patterns in the literature, a deeper dive into the content is necessary to explore more details. The authors' keywords and abstract might not provide insight into the full spectrum of these discussions. Accordingly, a detailed thematic analysis was conducted on the full content of selected studies. This approach moves beyond simple frequency counts, aiming to identify the main pedagogical, technological, and conceptual themes that structure current discourse. Through this synthesis, the analysis highlights how AI is affecting design education in a multitude of ways.

The eight themes presented in this section were systematically derived through an iterative, multi-stage thematic analysis of the full-text content. First, papers were closely read, and open coding of each article was conducted. The study aimed to cluster the recurring themes highlighted in the body of the text together. Both deductive and inductive strategies were employed: while initial codes were informed by prior reviews and the prior keyword bibliometric analysis [[55](#)], the coding remained open to emergent and context-specific dimensions unique to the dataset. The themes were continually compared, clustered, and refined through constant qualitative comparisons. The aim here was to ensure that the identified themes were robust and reflected both the qualitative richness of the literature and its conceptual structure as visualised by bibliometric tools. To make this process more transparent and to address the interpretive nature of single-coder thematic work, two points should be made explicit. First, the coding and theme construction were performed by one researcher; the absence of a second independent coder means that no measure of coding agreement is reported, and the resulting themes should be read as a structured interpretation rather than an inter-subjectively verified classification. Second, the eight themes are not independent of the bibliometric layer but were cross-walked against it: the motor and niche clusters identified through the keyword co-occurrence and factorial analyses (for example, cognitive load, Midjourney, interior design, and design thinking) map onto the creativity-and-ideation, tools-and-platforms, and pedagogy-and-curriculum themes, providing a

degree of convergent triangulation between the quantitative and qualitative strands. Readers should nonetheless treat the theme counts as indicative of prevalence in the corpus rather than as precise effect estimates.

The final eight themes capture the breadth and depth of the current discourse: from macro-level transformations in pedagogy and curriculum. Each theme encompasses specific sub-themes. This approach enables a richer reading of the dataset and allows for a more transparent identification of the main trajectories. In the end, existing gaps and future research potentials are addressed.

#### *4.1. Theme 1: Transformations in Pedagogy and Curriculum*

##### *4.1.1. Integration of AI in Curriculum*

AI is being increasingly influential in both core and elective curricula across design disciplines. In this cluster, many studies focus on the development of innovative teaching models that leverage AI-driven tools. These studies address methods such as blended learning [56], flipped classrooms with conversational AI [4, 47, 51], project-based approaches [57], and AI-augmented studio settings [48, 58].

In this cluster, many of the studies indicate that AI tools make design curricula more iterative and responsive to real-world creative and technological shifts. Moreover, they also indicated that these tools have the potential to foster better personalisation of learning experiences [59]. Here, some studies emphasise that incorporating AI in the curriculum supports both creative ideation and the acquisition of digital skills, and can provide immediate, formative feedback for learners [18, 60, 61, 62]. The literature also recognises the need for creating frameworks and ethical guidelines to balance technological innovation with foundational design values [2, 10, 54]. Accordingly, there seems to be a consensus in the literature to address the advent of AI tools within the pedagogical framework of design education [for instance, see 1, 47, 56, 60, 63].

##### *4.1.2. Shift to Student-Centred and Experiential Learning*

One of the intense and recurring discussions in the selected literature is the impact of AI tools in moving toward more student-centred, experiential learning. These discussions emphasise active engagement in project-based learning [61], as well as methods such as role-playing [64] and personalised digital experiences [47]. Studies show that AI-powered environments support individual and personalised learning trajectories, promoting both creative risk-taking and mastery of technical skills [52, 65].

There is also a consensus on the need to foster AI literacy [19], digital competence [66], and creative problem-solving alongside traditional design skills [3, 19, 46]. Within the scope of the reviewed literature, it could be argued that AI technologies have shown the potential to enhance student agency, independent learning, and provide personalised feedback. These discussions support thriving for deeper understanding, comprehensive learning and reflection [24, 51, 64, 65]. Several studies further highlight the importance of critical thinking and abilities to make students ready for the changing landscape of digital design [23, 45].

## 4.2. Theme 2: Creativity, Ideation, and the Design Process

### 4.2.1. Augmenting Creativity and Ideation

The impact of AI on creativity and ideation in design education is still divisive and controversial in the emerging literature [20, 21]. While some studies warn against the negative impact of utilising these tools, others offer precedents and compelling discussions to the contrary [1, 10]. Nevertheless, a substantial body of literature frames AI as an inspiration generator, idea-expander, and collaborative creative partner, especially effective during the early and conceptual phases of design [3, 15, 17, 20]. AI-driven tools have also been shown to be able to facilitate both divergent thinking (exploring multiple solutions and broadening ideation) and convergent thinking (refining and selecting among options). In this regard, these tools have the potential to enable rapid prototyping and iterative visual development [2, 18, 23, 67]. Many studies emphasise how GenAI platforms support creative risk-taking by lowering barriers to experimentation with new things, this is usually the case regarding things that students might previously see outside their time or capacity [68], and consequently, fostering novel visual languages and representations [19, 23, 52, 61].

### 4.2.2. Limits and Tensions

Although the reviewed papers are clear about AI's potential to facilitate creativity and provide emerging possibilities, the literature also openly puts forth some concerns about superficiality [10], the commodification of creativity [1], and over-reliance on automated outputs if AI is used uncritically [10, 22, 47]. In some studies, educators and students reported some frustration when AI tools fall short in nuanced, context-sensitive, or highly original tasks, often producing generic or contextually inappropriate outcomes [3, 20]. What is more, several authors warn that unreflective adoption can dull critical engagement and stifle the development of authentic design voices [1, 2, 10, 69]. It is worth noting how these tensions enter the literature. In most of the reviewed sources, they surface as conceptual cautions, editorial commentary, or secondary observations arising from studies whose primary aim is to demonstrate an AI affordance, rather than as the central, empirically operationalised object of investigation. Concerns such as superficiality, over-reliance, and the dulling of critical engagement are therefore frequently asserted but seldom measured directly, isolated from confounding factors, or followed beyond the duration of a single course or intervention. This is not a criticism of individual authors so much as a structural feature of an early-stage field, but it does mean that the evidentiary weight behind the risks remains lighter than the frequency of their mention might suggest.

### 4.2.3. Co-Creation and Human-AI Partnership

Recent studies also seem to converge on the critical necessity of developing frameworks and pedagogies that balance the generative power of AI with human-centric, reflective, and essential practices of design. This discussion, which is very common in most papers addressing the issue, emphasises the idea of AI as a co-designer or collaborator, not a replacement for human creativity [for instance, see 3, 17, 19, 45, 70, 71]. This model is supported by efforts to develop curricula and assignments that are focused more on reflection and intentionality. Accordingly, via co-creation approaches, encouraging students to use AI-generated ideas as starting points for further exploration and transformation is highlighted [18, 47, 56, 72]. Thus, the importance of fostering metacognitive awareness, critical engagement, and ethical responsibility in the deployment of AI within the creative process must be further explored [15, 46, 52, 73].

### *4.3. Skills Development and Learning Outcomes*

#### *4.3.1. Technical, Cognitive, and Creative Skills*

Within the scope of the explored literature, the integration of AI in design education is reported to help with the development of a broad range of student skills [52, 56]. Some studies highlight the positive impact of AI on technical competencies such as computational design, programming, data analysis, and advanced graphic communication [18, 23, 48, 74]. Beyond technical skills and automation, AI-driven tools—and AI-enhanced environments—have shown potential in improving cognitive skills such as critical thinking, self-reflection, and metacognition as students, more and more, become aware of interpreting and critiquing AI-generated outputs [3, 46, 47, 75, 76].

Many interventions using AI have shown improvements in self-efficacy [26, 28, 47, 77], motivation [75, 76], engagement [52, 61], and overall user experience for design students [56, 59, 60]. These outcomes are especially pronounced in blended and flipped classroom models, as well as in project-based and experiential learning environments supported by AI feedback and automation [4, 46, 51].

#### *4.3.2. Employability and Professional Preparation*

Another recurring theme in this collection is centred around employability, professional readiness and uncertainty regarding the future job market [13, 21, 57, 78, 79, 80]. Many of the explored papers indicate that AI-driven tools, collaborative work with intelligent systems, and an emphasis on AI literacy and adaptability are viewed as essential by both educators and industry stakeholders [21, 46, 66, 80]. Accordingly, it could be argued that including AI in design curricula not only equips students with immediate technical skills but also helps prepare them for rapidly evolving industry expectations. The literature is clear about the uncertainty of the future job market, where AI literacy is essential and the ability to learn new technologies continually is increasingly valued [3, 10, 23, 81].

### *4.4. Diversity, Accessibility, and Personalisation*

#### *4.4.1. Addressing the Role of AI in Diverse Learning Styles*

AI tools are increasingly used to cater to a broad spectrum of learning preferences, making design education more inclusive and responsive to individual needs [56, 82, 83]. Chandrasekera et al. [46] highlight the importance of adaptive platforms and AI-driven systems aligned with pedagogical models like VARK (Visual, Auditory, Reading/Writing, Kinesthetic). The literature seems to support the positive role of AI in creating personalised experiences for visual, auditory, and kinaesthetic learners [15, 20, 46, 49, 59, 84]. These AI-oriented methods both recognise and actively adapt to learners' cognitive styles, abilities and aptitudes, enabling differentiated instruction and maximising engagement for students with varying backgrounds and skills [3, 49].

#### *4.4.2. Reducing Barriers and Broadening Access*

Providing new possibilities for students by assisting in complex tasks is well-recognised in the reviewed literature as one of the potential strengths of AI. AI-powered tools, immersive learning platforms, and recommendation systems are actively lowering barriers to entry in computational and design education. This is especially the case for students who want to expand their design by using computational tools without prior programming experience

[19, 23, 60, 75]. These technologies make advanced design workflows and computational thinking accessible to a broader audience, broadening participation across diverse learner populations. The literature reports that such platforms not only reduce the technical "learning curve" but also enable flexible, self-paced, and geographically distributed learning, thus democratising access to high-quality design education [29, 30, 76, 85].

#### 4.5. Ethics, Authorship and Authenticity

##### 4.5.1. Risks and Challenges

The majority of the explored literature, at some point, indicates potential risks related to the misuse of generative AI in design education [20, 22, 57, 86]. Key concerns that were identified in the reviewed literature include plagiarism [87], the use of AI to shortcut creative work, diminished originality, and potential biases in AI-generated outputs [21, 45, 88]. What is more, questions around authorship, creative ownership, and intellectual property are increasingly prominent as AI becomes common practice in design studio education and classrooms [1, 2, 10, 20].

For example, Fleischmann [1] critiques the "commodification of creativity" that can arise when AI tools are used without critical moderation, warning that overreliance on generative AI might negatively impact the creative process and lead to generic outcomes [also see 10]. Anson et al. [20] report that while students see value in AI as an inspiration source, some also express frustration at its inability to execute nuanced or highly original tasks, raising fears of unethical shortcutting. Iranmanesh and Lotfabadi [10] argue for the urgent need to develop clear frameworks for responsible AI use in architectural pedagogy. Several studies call for explicit training in ethical and transparent AI usage in design curricula and the necessity of teaching critical reflection, authorship ethics, and digital literacy [3, 22, 54, 72]. A pattern can be observed across these studies: the risks are recurrently named and the calls for ethical training are very common; however, the supporting evidence is predominantly argumentative or anecdotal. Most authors mention the risks, but there is very little tangible evidence regarding how to address them. Claims about plagiarism, diminished originality, and the erosion of critical engagement remain largely conceptual. There is a dire need for more longitudinal studies. The frequency with which these concerns appear should therefore be read as evidence of shared professional unease rather than as a settled, empirically demonstrated effect. This is a notable gap that the prevailing enthusiasm for AI's affordances has so far left conspicuously unaddressed.

##### 4.5.2. Balancing Innovation and Integrity

The explored body of literature stresses the importance of a balanced, integrative approach that preserves both innovation and academic/professional integrity [10, 15, 20, 49, 54]. Here, it is evident that the best practices encourage educators to act as guides and mediators. Skipworth et al. [70] emphasise safeguarding the unique role of human authorship and the joy of creative work as AI becomes more embedded in design practice [also see 89]. Some studies also highlight the importance of harmonious integration of AI with traditional methods. In this perspective, it is critical to position AI as a co-creative partner rather than a replacement [11]. What is more, reflection and critique need to be supported, ensuring that the learning process remains authentic and learner-driven [21, 90, 91]. Accordingly, clear ethical guidelines, transparency about tool usage, and strong educator involvement are presented as essential for nurturing a culture of responsible creativity and for upholding academic standards in the age of AI [20, 92].

#### *4.6. Social, Cultural, and Collaborative Impacts*

##### *4.6.1. Collaboration and Interdisciplinarity*

AI has become a catalyst for new forms of collaboration both within and across traditional design disciplines [49, 72, 93]. Many studies in this corpus highlight how generative AI and intelligent systems can potentially support interdisciplinary teamwork. This approach has the potential of linking architecture, product, interior, graphic, and art education. It might also be capable of enabling novel forms of human–AI collaboration in design processes [3, 20, 46, 94, 95]. AI platforms facilitate not only peer-to-peer but also human-to-machine co-creation, expanding the creative possibilities and encouraging collaborative ideation across disciplinary and technological boundaries [19, 48, 70]. In this case, bibliometric analyses show a growing pattern of interdisciplinarity and increasingly interconnected collaborative networks among scholars, institutions, and countries, as well as emerging human-machine interaction [3, 23, 96].

##### *4.6.2. Cultural Adaptation and Global Perspectives*

There is increasing awareness in the literature that AI integration in design education must be adapted to diverse cultural, institutional, and market contexts [15, 51]. Comparative studies examine how cultural norms, national education systems, and market realities shape the adoption and perception of AI tools in design classrooms [45, 51]. This is critical because the built-in biases in the training datasets might mainstream the dominant cultures. For example, there are papers showing contrasts between Western and Asian (including Chinese and Vietnamese) approaches to AI adoption in curriculum design, teacher attitudes, and student engagement [51, 78, 97]. The literature also highlights the globalisation of design pedagogy, where best practices and challenges are shared across borders, and educators advocate for culturally responsive AI integration strategies that respect local values and promote global competencies [3, 20, 98].

#### *4.7. Technology Acceptance*

##### *4.7.1. Students' and Educators' Attitudes*

The reviewed literature also shows general positive attitudes among students toward AI in the context of design education. The literature seems to highlight this when these technologies provide tangible benefits such as enhanced creativity, ease of experimentation, and engaging learning experiences [12, 28, 52, 70, 99], albeit, these studies are often based on self-reported data. While scepticism or uncertainty is common, some studies show that acceptance of AI by students increases with exposure, familiarity, and visible improvements in learning outcomes [19, 70, 90, 99].

In contrast, the attitudes of educators are more varied. Acceptance often depends on perceived ease of use, the relative advantage of AI over existing methods, and the technology's compatibility with current teaching practices. It is also notable that the educators' own confidence or self-efficacy with these technologies plays a role in the extent to which they are accepted [1, 10, 28, 47]. Some teachers might embrace AI as a valuable tool for augmenting instruction and enriching the classroom experience. In contrast, others express caution about potential risks, loss of pedagogical control, or concerns over ethical and assessment issues [3, 4, 21, 48].

#### 4.7.2. The Role of Educators

It could be argued that despite the increasing sophistication of AI tools, educators remain indispensable as mediators, guides, and ethical gatekeepers in design education. Studies highlight the critical role of teachers in ensuring responsible use of AI. The contextualising AI-generated outputs within the broader pedagogical and disciplinary framework and educational rigour has also been highlighted [1, 2, 3, 10, 20, 62]. Educators need to move toward fostering digital literacy, encourage critical reflection, and help students understand both the affordances and limitations of AI [21, 54, 73]. Ultimately, and based on the reviewed literature, it could be argued that successful AI integration depends not just on technological capability but on thoughtful, adaptive teaching practices that preserve the centrality of human judgment, creativity, and ethics in design education [100].

#### 4.8. The Evolving Studio: Hybrid and Virtual Environments

In the explored literature, AI seems to be central in transforming and reimagining the traditional design studio. A growing number of studies document the spread of virtual and AI-enhanced studios, including metaverse environments and online collaborative platforms [29, 48, 83, 90, 94, 101]. These AI-supported settings allow for enhanced collaboration among students and faculty, facilitate both peer and expert reviews, and foster what Özorhon et al. [48] describe as a "polyphonic" or multi-voiced design discourse.

The literature also points out that such environments could potentially expand access to international expertise, support flexible and adaptive teaching methods, and enable richer, more diversified conversations around design processes and outcomes [23, 47, 58, 102]. Furthermore, immersive technologies and AI-driven tools are argued to have the potential to lower geographical and logistical barriers, making advanced design education more accessible and collaborative on a global scale.

### 5. Critical Gaps and Future Directions Identified in the Literature

This review was also able to identify several gaps and opportunities for future research on AI in design education. Many of these gaps share a common root, which is that the corpus is dominated by studies framed around what AI enables, while the conditions under which it harms learning remain comparatively understudied. These recurring concerns have been observed throughout this review. Superficiality, the commodification of creativity, over-reliance, diminished originality, and the loss of critical engagement are stated often but tested rarely. These critical potential negative issues are seldom operationalised or tested in measurable settings. The gaps below should therefore be read not as isolated omissions but as symptoms of an evidence base that has documented promise far more thoroughly than it has documented cost.

First, across the literature, there seems to be a general call for longitudinal studies that go beyond short-term interventions [1, 2, 3, 23, 56].

Second, while most of the explored literature focuses on higher education, the implications and potential of AI on design education in K-12, vocational, and continuing education settings need more attention [23, 29, 76].

A third gap concerns the lack of discipline-specific frameworks for AI adoption. While generalisable insights are valuable, this review indicates the need for nuanced approaches

capable of respecting the unique cultures, workflows, and goals of different design fields [10, 20, 54, 67, 70, 103].

Fourth, training in the ethical and reflective use of AI remains rare, constituting a clear gap that warrants further detailed exploration. Although most papers emphasise the importance of this fact, highlighting the need to address it, there is a lack of tangible, evidence-based studies in this domain. AI-literacy—and its impact on other types of literacy—is a critical future research domain that needs more investigation. It is evident in the reviewed literature that pedagogical models for critical, ethical, and creative engagement with AI must be developed and integrated into curricula to prepare students for responsible use of these rapidly evolving technologies where the future jobs in design discipline are hazed with uncertainty [1, 2, 47, 54, 61].

Finally, the literature is moving beyond seeing AI as a mere tool. It is increasingly argued that the role of AI needs to be defined as a co-agent or collaborator in the creative process [1, 2, 3, 46]. This shift raises profound theoretical, ontological and practical questions about authorship, agency, authenticity, and the nature of creativity in design education.

## 6. Conclusion

This review provided a brief synthesis of the rapidly evolving and emerging literature (2020-2025) addressing the scholarly narratives of artificial intelligence in design education. From the reviewed literature, it could be inferred that there seems to be a paradigm shift towards increased personalisation, interdisciplinarity, and collaboration occurring in design education. The analysis indicates that AI has emerged as both a catalyst and a disruptor, affecting traditional pedagogical models, curriculum structures, and creative processes essential in design.

It must be stated, however, that the reviewed corpus is asymmetrically leaning toward the affordances of AI rather than its hazards. This optimism is itself a property of the current literature and is partly a methodological artefact. Enthusiastic, short-horizon intervention studies are easier to design, publish, and cite than the longitudinal, critical, or null-result work needed to substantiate concerns about de-skilling, the homogenisation of design output, the weakening of independent critical and creative judgement, and a growing epistemic dependence on generative systems.

Through thematic analysis, the review was able to identify and explore some key areas of interest. Notably, the integration of AI in the curriculum and pedagogy of design disciplines supports not only technical skill development but also critical and creative capacities. This has been shown to enhance student engagement and motivation further. The role of AI as an inspiration generator and co-creative partner is emphasised in the emerging literature, as well as its ability to expand ideation, rapid prototyping, and visual iteration. Nevertheless, it must be noted that the literature also shows a variety of tensions, challenges, and concerns, including risks of plagiarism, diminished originality, lack of contextual sensitivity, and ethical dilemmas in authorship.

The findings highlight that AI-powered platforms accommodate a variety of learning styles and broaden access to design education, particularly for non-traditional learners. However, significant gaps remain. There is a pressing need for longitudinal research on the long-term effects of AI integration in design education, as well as the development of discipline-specific frameworks, and greater attention to equity and intercultural dimensions. The literature calls for systematic training in critical, ethical, and reflective engagement with

AI, and for theoretical models that move beyond seeing AI as a mere tool to recognising it as a cognitive co-agent or collaborator in the creative process.

Finally, as AI continues to leave its mark on the intellectual and social landscape of design education, new research must address these gaps by adopting holistic and multidisciplinary approaches. Collaboration among educators, researchers, industry professionals, and students will be essential in harnessing the opportunities and navigating the risks of AI integration. Equally, the discipline would be served by a more sceptical research: one that actively seeks disconfirming evidence, reports null and adverse outcomes, and resists the assumption that wider adoption is inherently progressive. Ultimately, the goal should be to foster a design education ecosystem that engages technological innovation critically rather than embracing it without hesitation.

### *6.1. Limitations of the Study*

While the study has aimed for a systematic and comprehensive review process, it must be noted that it is subject to several limitations. Foremost, this review is best characterised as a thematic and bibliometric mapping that is guided by, but does not fully satisfy, the PRISMA 2020 standard for systematic reviews; the limitations below should be read with that framing in mind. First, the search relied on a single database, the Web of Science Core Collection. Although this collection offers high-quality, consistently indexed peer-reviewed records suited to bibliometric analysis, it omits relevant work catalogued elsewhere, including conference proceedings and journals indexed primarily in Scopus, Google Scholar, ERIC, or comparable sources. For a fast-moving field such as generative AI, where conference venues carry substantial weight, this single-database design constrains the comprehensiveness of the corpus, and the findings should be read as representative of Web of Science-indexed discourse rather than of the entire literature. Second, the screening and selection were conducted by a single researcher rather than by two or more independent reviewers; consequently, no inter-rater reliability statistic (such as Cohen's Kappa) could be computed, and the selection is subject to single-assessor bias. Third, no formal risk-of-bias or methodological-quality appraisal of the included studies was undertaken; peer-reviewed status within the Core Collection was treated as the quality threshold, which means that studies of uneven methodological strength were synthesised together. Fourth, the thematic analysis, while systematic in procedure, is interpretive: a full codebook, the initial code list, and the categorisation tree underlying the eight themes were not published with this manuscript, and the synthesis therefore reflects a single analyst's structured reading rather than an independently audited coding scheme. Fifth, the scope was deliberately limited to studio- and atelier-based design fields and excluded software and interface design; this keeps the synthesis coherent but leaves out an adjacent area that is itself strongly affected by generative AI and that future reviews should address directly. Beyond these methodological points, the analysis is further constrained by the restriction to papers published in English, potentially overlooking related studies in other languages; the review also did not explore books and edited volumes. Future studies are encouraged to address these limitations by including broader data sources, adopting longitudinal designs, and incorporating the voices of diverse stakeholders. Finally, this is a rapidly evolving field of study; therefore, overgeneralisation must be avoided, and new studies must be explored and cross-referenced.

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