

Innovative pathways for the teaching reform of university "design thinking" courses driven by generative AI

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Abstract. The iterative upgrading of artificial intelligence technology has promoted the widespread implementation of Generative Artificial Intelligence (GenAI) in higher education and teaching. Against this backdrop, based on an overview of the current status of generative AI integration into design education, this paper analyzes the impacts and challenges of this technology on design courses, and proposes a "five-in-one" innovative path for university design thinking courses, which integrates the theoretical layer, content layer, method layer, evaluation layer and support layer. It provides theoretical references for the innovation of design education in universities, so as to adapt to the diversified demands of talent cultivation brought by the development of new technologies in the digital intelligence era, and promote the digital transformation and sustainable development of education.

Keywords: generative artificial intelligence, design thinking, human-machine collaboration, teaching reform, innovative pathways

1. Introduction

Design Thinking is a course that integrates thinking theory and design practice, aiming to solve practical problems through multi-dimensional design methods with a user-centered approach. However, the traditional teaching model focuses on one-way knowledge transmission by teachers, and students remain in a passive receiving state [1]. In practical sessions, students usually complete their creations following the operation instructions of computer-aided software [2]. Since 2022, the rise of generative AI represented by ChatGPT, DeepSeek and others has driven the gradual shift of traditional design education from one-way instruction from teachers to students to a ternary collaborative teaching model of "teacher + AI + student". Relying on large-scale data training and intelligent algorithms, generative AI provides new technical support for the education sector [3]. Some scholars argue that using generative AI technology to analyze, evaluate and optimize instructional design schemes has become an urgent need to improve classroom teaching quality in the digital intelligence era [4]. Studies have found that integrating generative AI into packaging design classrooms can enhance teaching quality, enrich teaching resources, and help improve students' comprehensive design capabilities [5]. Artificial intelligence technology provides efficient content generation tools for design creation, and promotes the co-creation model of "human-AI collaboration" [6]. In particular, mainstream AI tools such as MidJourney and Stable Diffusion [7] can capture design intentions through prompts and

automatically generate text, image and video content, greatly improving the efficiency of human-machine collaboration [8]. This demonstrates that the integration of generative AI into design education prompts teachers to transform from knowledge transmitters to guides and innovation promoters for students' learning, which helps improve the overall implementation of design education and enhance students' learning efficiency.

Therefore, against the iterative development of artificial intelligence, traditional design education is confronted with problems such as unitary teaching content, insufficient technical training and outdated teaching models. Exploring the teaching reform ideas of design thinking courses driven by generative AI provides a reference for universities to cultivate compound talents who meet social needs and possess both innovation capabilities and digital literacy.

2. Overview of generative AI integration into design education

2.1. From auxiliary tools to "collaborative partners"

The evolution of generative AI from an auxiliary tool to a "creative assistant" is the result of the combined effects of technological development and creative demands. As an important branch of artificial intelligence, it learns from massive data and independently generates content forms such as text, images and videos. This automated content generation technology breaks through the limitations of step-by-step operation of traditional computer-aided software, and realizes the leap from "passively executing instructions" to "actively understanding intentions and generating content". As a teaching bridge connecting teachers, students and knowledge, generative AI has the ability to connect and integrate information from multiple fields and industries. In this regard, some studies hold that in the era of "artificial intelligence + education", human-machine collaborative teaching is the most prevalent teaching model [9]. Tool models represented by Midjourney, Stable Diffusion, DeepSeek and others can rapidly produce diversified information such as copywriting, conceptual design drawings, visual design schemes and 3D models through concise and precise language instructions.

To a certain extent, these scenario application models have changed the current teaching environment and teaching model, broken through the isolated interaction mode in traditional classroom teaching, and shifted teaching content from static to dynamic generation. Meanwhile, they support students in conducting interactive inquiry learning with AI, guiding students to explore independently through various problem scenarios, and promoting students to actively construct knowledge frameworks with the help of AI tools. If the above models are introduced into design courses, their powerful image, video and text generation capabilities can promote the transformation of the teaching environment from physical space to a combination of virtual and physical space, and facilitate the seamless connection of "teaching and learning". For design education, this marks a shift in the role of artificial intelligence in the design field: from an auxiliary tool to a collaborator participating in data sorting, analysis and design scheme generation. Therefore, generative AI is gradually evolving from an auxiliary tool to a capable assistant for in-depth creation, becoming an indispensable collaborative partner for creators.

2.2. Digital transformation of traditional design education

As digitalization moves from concept to reality, design education is facing dual transformation pressures from both inside and outside the university. Internally, as the cradle of future design innovation talents, if universities' curriculum systems and knowledge content structures lag behind the frontier of technological practice, it will affect educational effectiveness, cause a disconnect between talent cultivation and industry needs, and thus weaken graduates' social competitiveness. Some studies suggest that the integration of

education and digital technology contains many demands for the digital transformation of education, namely how to meet the individual development needs of learners, how to meet the needs of digital education, promote education to actively integrate with digital technology, and drive the digital transformation of education [10]. This indicates that the iteration of educational technology is the key to promoting the digital transformation of design education.

Similarly, for the external environment, the creative industry is accelerating the application of artificial intelligence tools to optimize work processes. The research, development and promotion of cultural and creative intelligent products powered by artificial intelligence technology have driven the development of industries such as film and television, music and live streaming, and continuously meet consumers' personalized and customized cultural consumption demands [11]. Correspondingly, the market demand for industry talents has shifted from focusing on proficiency in design software operation skills to possessing the ability to collaborate with AI in creation. Therefore, integrating generative AI into design education is no longer a multiple-choice question of "to do or not to do". Instead, it is necessary to think about the practical issues of "how to implement, how to deepen, and how to follow ethical norms". Educators need to proactively examine teaching methods and reconstruct the core knowledge system of the design discipline.

2.3. From preliminary exploration to layered and differentiated development

At present, some universities have accelerated the exploration of the integration of generative AI and design education by offering courses such as "Artificial Intelligence and Professional Integration" and "AI-Empowered Courses", forming replicable reform experiences. For example, Shanghai Jiao Tong University has launched micro-majors such as "AI + Innovative Design" and "AI + Art and Design"; Communication University of China has offered courses such as "AIGC Brand Design"; in the "Design Thinking and Methods" course at Henan University of Engineering, generative AI tools are integrated into teaching content, teaching methods, evaluation systems and other processes, which has improved students' comprehensive abilities and teachers' teaching efficiency [12]. However, from the perspective of overall practice, the current teaching exploration presents obvious layered and differentiated characteristics, as detailed below:

First, at the conceptual level, there is "technology panic" that students' creativity may be replaced by technology, as well as a tendency of "valuing quantity over quality" that overemphasizes technology generation, lacking in-depth thinking on the essence of design education in the era of artificial intelligence.

Second, when integrating AI-generated content into the curriculum system, the generated content is fragmented, lacking a systematic curriculum framework from theoretical foundation and innovation ability cultivation to practical guidance and achievement transformation.

Third, most practical teaching cases focus on tool operation and application, lacking the cultivation of students' critical design thinking and decision-making ability of "dominating artificial intelligence tools with humans as the lead".

Fourth, support systems such as teacher training, teaching resources, AI ethical norms and hardware facilities are generally lagging behind, restricting the in-depth development of digital teaching practice.

Overall, the integration of generative AI and design education is still in the early stage of tool-based application. Against the backdrop of technological changes, the upgrading of social talent demands and the urgent need to break through practical bottlenecks, the above status quo constitutes the realistic starting point for the reform of design courses.

3. Impacts and challenges of generative AI on design education

3.1. Challenges faced by traditional design education

The widespread application and continuous iteration of artificial intelligence have gradually exposed many practical problems in university design education, which are mainly manifested in the following aspects: First, teaching objectives lag behind. Some current courses still focus on imparting software operation skills, and are deficient in cultivating new core literacies such as curriculum content, software operation and AI collaborative co-creation ability. Second, there are shortcomings in course textbooks and teaching content. There is a lack of targeted professional textbooks, and in knowledge modules such as human-machine division of labor, AI design ethics and copyright law, the definition of design ethics such as plagiarism and piracy is vague, posing new challenges to creative integrity and intellectual property protection. Third, teaching methods fail to keep pace with the times. The model dominated by traditional lecturing and demonstration is difficult to adapt to new design processes such as human-machine collaboration and rapid iteration [13]. Fourth, the existing evaluation criteria can hardly clearly demarcate the boundary between AI-generated content and individual creative contributions. Fifth, some universities have insufficient basic condition support and lack relevant teaching resource support, resulting in teachers' lack of in-depth practice on the integration of AI technical principles, application boundaries and teaching methods, which constitutes a major obstacle to the advancement of educational reform. Therefore, the core philosophy of "skill-led" upheld by traditional design education has structural contradictions with the inherent demand of "human-machine collaborative creation", thus restricting the effective development of teaching practice.

3.2. Dual impacts on design courses

3.2.1. *Potential risks*

The introduction of generative artificial intelligence technology into university classrooms hides multi-dimensional problems and hidden dangers, which are mainly manifested as follows: First, the potential degradation risk of basic skills and critical judgment ability. If students rely excessively on AI-generated works, it may lead to insufficient training in basic skills such as sketch conception, shape deliberation, structure perception and software operation. In particular, when students lack the ability to deeply criticize and optimize the quality of synthetic content, the "one-click generation" function is more likely to weaken their ability of in-depth insight, aesthetic exploration and hands-on shaping. Second, the formation of design thinking inertia. When users rely too much on initial information such as AI-generated design texts, they are prone to blocked creative inspiration and lack of innovative thinking due to the lack of knowledge accumulation in field research and analysis and independent thinking processes [14]. Third, the risk of homogenization and resistance to innovation. Some studies suggest that the output of artificial intelligence is often presented in the form of highly condensed conclusions, lacking in-depth deconstruction of the knowledge generation process, and it is difficult to convey the disciplinary research paradigms and thinking modes implicit behind knowledge [15]. In particular, AI large models trained on public data tend to have similar visual effects in their output schemes, and the quality of results is mainly limited to the surface presentation of knowledge. In addition, improper guidance on the content generated by large models can easily lead to the risk of students' works falling into a stereotyped "AI style", thus inhibiting their creation of original works with depth and connotation. It can be seen that the potential risks of generative artificial intelligence cannot be ignored, and relevant measures must be taken to ensure that technology empowerment does not deviate from the direction of high-quality development of design education, and that educational reform matches the quality of talent cultivation.

3.2.2. Positive factors

Generative AI is like a double-edged sword, with both disadvantages and advantages for design education. Compared with traditional education, artificial intelligence technology breaks through the temporal and spatial boundaries of traditional classroom teaching, and can greatly enhance the intuitiveness of teaching [16]. This intuitiveness is often reflected in changes in teaching modes and knowledge representation methods, as well as people's understanding of teaching. Taking the Design Thinking course as an example, its positive effects are mainly manifested in the following aspects: First, unleashing creative potential and focusing on creative thinking. AI can replace a large number of repetitive and technical expressive work, freeing students from the tedious operation of computer-aided software, and allowing them to devote more energy to creative links such as pre-problem analysis, conception and divergence, and evaluation and optimization. Second, expanding the boundaries of expression and improving learning efficiency [17]. Crossing technical thresholds, students can quickly explore the generation paths of multiple design schemes with the help of AI tools, realizing the "instant" presentation of creativity. The design process and cycle are greatly shortened, supporting the iterative cycle of "conception-generation-evaluation-re-creation-optimization", shortening the design cycle and improving design efficiency. Third, promoting interdisciplinary integration and restructuring knowledge structure. The cross-penetration of computer technology including AI and humanities and social sciences breaks through the barriers of integration between technology and art, enabling students from different professional backgrounds to participate in the thinking collision of artificial intelligence together. Similarly, the Design Thinking course has expanded from focusing on theoretical foundations such as thinking types and thinking methods in the past to new knowledge dimensions including AI questioning logic, data literacy, innovative thinking, design ethics and so on.

4. Teaching reform paths of university "design thinking" courses driven by generative AI

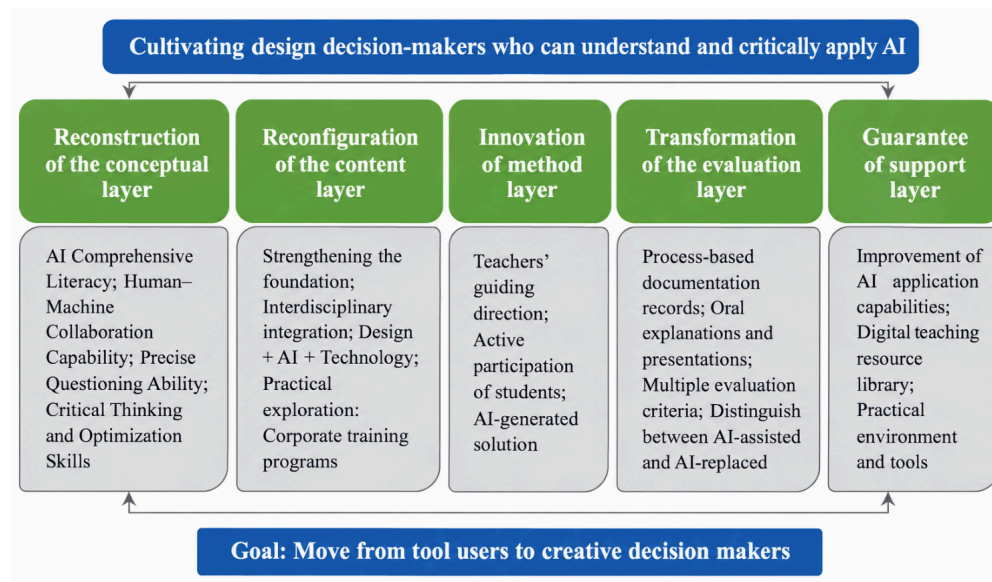


Figure 1. The "five-in-one" path of human-machine collaborative education reform

On the basis of dialectically understanding the teaching reform of university "Design Thinking" courses empowered by generative artificial intelligence, this paper establishes a hierarchical "five-in-one" path, gives

full play to the potential of technology in innovating teaching models and improving classroom teaching quality, promotes the deep integration of generative AI from the cultivation of human-machine collaboration concept to multi-dimensions such as concept, content, method, evaluation and support, and forms a reform framework covering the whole teaching process (see Figure 1), so as to facilitate the collaborative improvement of design education level and talent cultivation quality represented by Design Thinking courses.

4.1. Reshaping of the conceptual layer: cultivating digital literacy of "human-machine collaboration"

The primary task of teaching reform is to reconstruct the talent cultivation objective, that is, to cultivate innovative talents with artificial intelligence literacy and critical thinking ability, so as to strengthen human-machine collaboration ability. The core of human-machine collaboration is to realize the organic integration of technology and education in dimensions such as teaching process, resource allocation and evaluation system [18]. Therefore, the teaching objective of generative AI-empowered Design Thinking courses should focus on the "student-centered" personalized development goal. Break the traditional classroom teaching model, use AI to analyze students' individual differences, and meet the learning needs and learning rhythms of different students. And shift from cultivating understanders of theoretical knowledge such as thinking types and thinking characteristics, and users of auxiliary software, to cultivating creative practitioners and decision-makers who can master design methods and critically apply AI tools. Specifically, its core literacy includes the following four aspects:

First, cultivate students' comprehensive AI literacy, and enable them to understand the basic principles, capability boundaries and ethical limitations of AIGC [19]. For example, in teaching, analyze algorithm principle cases of AIGC-generated works to guide students to understand their advantages and limitations in visual elements and composition logic; meanwhile, combine practical cases of copyright disputes to analyze the advantages and disadvantages of AI, and strengthen students' awareness of the ethical boundaries of AI application.

Second, cultivate students' good awareness of human-machine collaboration, establish the correct cognition of AI as a tool for accompanying and assisting learning, and clarify the division of labor and collaboration modes between humans and AI at different stages. For example, by setting the task of "AI-assisted creative brainstorming", students lead the design theme, use AI tools to generate preliminary schemes with various expression styles, screen the first drafts that conform to the design positioning, and then select the best ones for scheme optimization.

Third, teachers transform from knowledge imparters to guides in the teaching process, cultivate students' ability to conduct effective dialogues with artificial intelligence, and enable them to master the thinking logic and questioning strategies of transforming design intentions into specific instructions. For example, by presenting generated design cases, compare and analyze the differences in effects between vague prompts and precise prompts; and combined with classroom exercises, guide students to transform vague design concepts into precise and hierarchical instructions, and master corresponding follow-up questioning skills.

Fourth, cultivate students' critical thinking and result optimization ability, enabling them to objectively judge, screen, optimize and re-create AI-generated content. For example, in the cultural and creative design practice of the Design Thinking course, guide students to use AI tools such as Midjourney to extract representative local cultural elements, comprehensively consider cultural connotation, market orientation, preferences of different consumer groups, modern aesthetic trends and so on, generate preliminary design schemes and carry out iterative optimization, and form cultural and creative product design schemes that fit contemporary consumption scenarios and users' emotional needs (see Table 1). Therefore, through specific

project-based learning, digital literacy education is integrated into the teaching practice of Design Thinking courses, helping students gradually master the core methods of human-machine collaborative creation, and ultimately promoting their evolution from traditional knowledge recipients and technology appliers to innovation leaders and human-machine collaborators.

Table 1. AI-assisted generation of intangible cultural heritage cultural and creative products

Number	Intangible Cultural Heritage (Image)→	Cultural and creative products		
1	 Fan-making skills	 Pendant & Ornament	 Lamps and lanterns	
2	 Pottery	 Earrings & Pendant	 Tea sets	
3	 Pickle production skills	 Ornament	 Lamps and lanterns	

4.2. Reconstruction of the content layer: building "progressive" course modules

In accordance with social development and market demand, iterate the teaching content of the Design Thinking course, and build a "three-level progressive" cultivation structure. First, consolidate the theoretical foundation and reconstruct teaching content. Add a generative artificial intelligence module, position commonly used AI tools such as Stable Diffusion and Liblib as intelligent "collaborators", and integrate them into processes such as "demand analysis—creative conception—scheme output—optimization iteration", connect curriculum knowledge points in series, and promote innovative teaching of human-machine collaboration. Meanwhile, refer to domestic documents such as the *Measures for the Management and Services of Scientific and Technological Ethics of Artificial Intelligence (Trial)* and the *Measures for the Identification of AI-Generated Synthetic Content*, integrate scientific and technological ethical requirements and synthetic content identification throughout the whole teaching process, lay a solid foundation for the integration of artificial intelligence and design education, and help students establish correct ethical concepts and copyright awareness.

Second, take interdisciplinary integration as the support, break professional barriers, and promote the multi-disciplinary integration model of "AI+". Adopt the mode of "AI + specific thematic content" (such as "AI + intangible cultural heritage cultural and creative design", "AI + short video advertising creativity", etc.), embed artificial intelligence as a core empowerment tool into specific teaching units, enable students to master the core points of AI-assisted image and video generation, and realize the deep integration of technology and other professional fields.

Third, take practical exploration as the core and introduce training projects. Through practical courses, graduation projects or enterprise projects, guide students to select appropriate AI tools, and focus on specific

scenarios or project themes, complete the process from demand analysis, creative conception, scheme optimization to work delivery with AI assistance, so as to highlight the innovation of practical teaching. By constructing progressive talent cultivation objectives, establish the logical chain of basic cognition, professional coupling and practical internalization, and realize the improvement of comprehensive practical ability.

4.3. Innovation of the method layer: exploring the "dual-teacher collaboration" teaching model

The innovation of teaching methods requires the rational construction of a ternary interaction model of "human-machine collaboration" (see Figure 2), the active establishment of a dual-teacher collaboration system of "teacher + AI", and the creation of a closely linked teaching community. First of all, teachers focus on direction guidance and high-level instruction, combine case teaching to create personalized and interactive classrooms, focus on key links such as design positioning of specific cases, core problem raising, prompt strategy training, innovative thinking guidance, critical review of schemes, prototype optimization strategies and scientific and technological ethical considerations, help students clarify design positioning and goals, focus on guiding them to sort out design ideas, optimize the structural logic of prompts, and guide students to distinguish the advantages and disadvantages of generated content, and explore the improvement direction of design schemes. Secondly, AI serves as an auxiliary carrier for collaborative creative generation, with multiple roles of real-time empowered "inspiration helper", "scheme collaborator" and "creative partner", capturing design intentions based on prompt instructions, and facilitating the rapid generation and iteration of design schemes [20]. Therefore, in the scheme generation collaboration session, it is necessary to guide students to critically distinguish the functional boundaries and role positioning of AI tools. Ultimately, through the closed-loop mechanism of "teachers controlling the overall direction, students adjusting prompt instructions, and AI generating compliant schemes", students can clearly understand the division of labor differences between humans and intelligent tools in the process of human-machine collaboration, and avoid the problem of ignoring humans as the main subject of creative responsibility due to excessive reliance on AI tools.

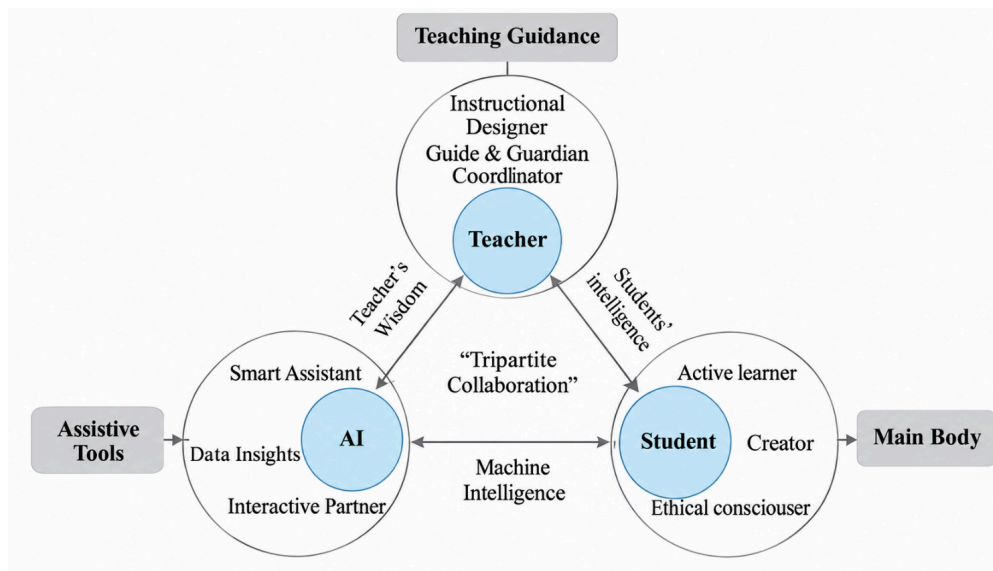


Figure 2. The division of labor model of "human-machine collaboration"

4.4. Transformation of the evaluation layer: establishing a multi-dimensional evaluation system for the "creative process"

Establish a diversified evaluation system of "process + result + ability", and realize the transformation from originally focusing on final results to focusing on the dynamic creative process. First of all, it is necessary to introduce a process-based documentation mechanism, requiring students to submit the final design scheme, which includes full-process logs such as original prompts, multi-round iteration screenshots, design generation process, manual optimization and adjustment, so as to truly reflect students' personal contributions and thinking paths. Secondly, through oral explanation or process reporting, guide students to elaborate on the specific division of labor, creative process and personal key contributions in the process of collaborating with AI tools, so as to evaluate students' collaboration awareness, achievement contribution, growth trajectory and so on. Finally, establish a multi-dimensional evaluation standard system. In addition to retaining traditional standards such as visual aesthetic effect, function realization and technical rationality, add process-based evaluation indicators such as "rationality of human-machine collaboration division of labor", "creative thinking and conception", "whether prompts are accurate and reasonable", "ethical norms and copyright awareness" [21], to measure students' comprehensive literacy in the process of human-machine collaborative creation from multiple aspects. Therefore, focusing on multi-dimensional evaluation indicators such as students' thinking evolution trajectory in the design process, rationality of AI tool application and ethical awareness, avoids judging the achievement level solely by the single dimension of the final work. At the same time, it helps to distinguish between two different behavioral phenomena: "AI-assisted creation" and "AI-replaced creation".

4.5. Guarantee of the support layer: strengthening the construction of teacher literacy and teaching resource system

To support the realization of talent cultivation objectives in the digital intelligence era, it is necessary to systematically promote the construction of supporting guarantee mechanisms. Specifically, it can strengthen teachers' digital capabilities in artificial intelligence application through approaches such as school-enterprise collaborative training, teacher internship practice, and special training on AI-empowered teaching; integrate university and enterprise resources, jointly build digital teaching resource libraries and virtual teaching and research offices, build a digital intelligence education platform, deepen the "industry-university-research-application" teaching scenarios, and ensure the advancement of teaching facilities and the feasibility of teaching content; build a practical teaching environment and provide stable access to AI tools to meet the needs of specific teaching links; or establish an on-campus teacher learning community to encourage design teachers to carry out practical teaching of relevant courses and share achievements [22]. Meanwhile, introduce the *Artificial Intelligence Education Ethics: Reference Framework (2026 Edition)* jointly issued by the Expert Advisory Committee of the World Digital Education Alliance and other organizations, clarify the ternary collaborative relationship of "teacher-student-machine" based on the concepts of "human as the subject, collaboration and symbiosis" proposed in the framework, guide human-machine collaboration, and stimulate innovation potential [23], and integrate core points such as creative integrity, ethical boundaries and copyright knowledge of AI-generated content into the curriculum system. This initiative aims to lay a solid foundation for the in-depth integration of artificial intelligence and education in the digital intelligence era.

5. Conclusion

The rapid development of generative artificial intelligence has driven the transformation of university design education from the educational paradigm of "knowledge transmission and reception" to "human-machine co-creation". This study proposes teaching reform and innovation paths from five dimensions: concept, content, method, evaluation and support layer, aiming to promote the deep integration of design courses and generative artificial intelligence technology. This path takes concept updating as the guide, content reconstruction as the core support, method innovation as the practical orientation, evaluation system as the quality guarantee, and the synchronous advancement of the support layer as a solid foundation for the implementation of the reform, so as to cultivate new design talents with the digital literacy of "human-machine collaboration". In this process, it is still necessary to guard against problems such as insufficient technological adaptability, insufficient integration depth and insufficient ethical risk prevention. In the future, it can expand the specific application of generative artificial intelligence in the teaching of Design Thinking courses, strengthen the guidance of ethical norms, and continuously optimize teaching models and curriculum content, so as to adapt to the diverse demands for design talents in the digital intelligence era, deliver more compound design talents with both creative ability and digital literacy to the industry, and facilitate the innovative breakthrough and high-quality development of design education.

Funding

Research on the Implementation Path of Integrating Suining Intangible Cultural Heritage Skills into the General Aesthetic Education Courses of Local Universities (SNGX26030)

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