Cultivating Innovative Modeling and Design Abilities in Art Curriculum Teaching That Integrates AI Technology

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ABSTRACT Artificial intelligence (AI) has become an important enabling technology for intelligent design, digital modeling, and human–computer collaborative innovation. To enhance students' innovative modeling and design capabilities, this study investigates the integration of AI technology into art curriculum teaching through a human–AI collaborative framework that combines independent conceptualization, AI-assisted generation, critical evaluation, and iterative optimization. The proposed approach incorporates contextualized design practice and a diversified evaluation system supported by AI feedback mechanisms to promote creative thinking, design reasoning, and adaptive learning. By emphasizing student-centered interaction rather than automatic content generation, the framework effectively balances computational assistance with originality and aesthetic judgment. The proposed strategy improves design efficiency while encouraging iterative refinement and critical analysis throughout the creative process. Furthermore, the integration of multimodal AI technologies provides methodological references for intelligent visual information processing, digital modeling, and computer-aided engineering design. The resulting human–AI collaborative paradigm offers potential value for computational design optimization and intelligent decision support in engineering applications related to Electromagnetic Waves, Antennas and Propagation, where data-driven modeling, visual interpretation, and adaptive design workflows are increasingly important.

INDEX TERMS artificial intelligence, human–AI collaboration, intelligent design, computational modeling

I. INTRODUCTION

AS the digital wave sweeps the globe, artificial intelligence (AI) technology is transforming the way manufacturing and research operate at an unprecedented pace, and the associated technical education sector is no exception. This rapid evolution requires a fundamental shift in pedagogical approaches to keep pace with the automated weaving and digitized material science industries. Art classes are crucial for cultivating students' aesthetic abilities and creative thinking; therefore, reforming art teaching models is urgently needed. Innovative design skills are a core competency in art education, traditionally relying on teacher experience and repeated student practice. However, this traditional approach is gradually revealing its limitations in the face of increasingly diverse design demands.

II. THE SIGNIFICANCE OF INTEGRATING AI TECHNOLOGY INTO ART CURRICULUM TEACHING

A. EXPANDING THE BOUNDARIES AND POSSIBILITIES OF DESIGN THINKING

In traditional art classes, students' modeling and design thinking is limited by the materials they have mastered and the aesthetic concepts they have formed. The addition of AI technology has broken certain boundaries. By using intelligent image generation and visual language conversion tools, students can quickly select the design elements they need from a large number of design references, and reorganize and creatively use these elements, thereby greatly expanding the imaginative space and practical path of modeling and design, and providing more solid technical support for the generation of innovative thinking [1].

B. STIMULATING STUDENTS' INTRINSIC INTEREST AND MOTIVATION IN ARTISTIC CREATION

AI tools have the feature of instant visual feedback, which can quickly turn students' abstract ideas into concrete and visible visual expressions. The intuitive sense of accomplishment greatly enhances students' enthusiasm for participating in art creation. Compared with traditional manual drawing, AI-assisted creation lowers the mechanical threshold for visual execution, allowing more students to focus on creativity. Crucially, this shift reallocates cognitive resources from manual drafting to the semantic deconstruction of design intent; thus, crafting AI prompts serves as a rigorous exercise in higher-order design thinking, compelling students to translate nebulous visual impressions into concrete design judgments anchored in language [2].

C. PROMOTING THE DEEP INTEGRATION OF ARTS EDUCATION WITH THE DEVELOPMENT OF THE TIMES

At present, the demand for art and design talents has shifted from single-skill type to compound innovation type. Design talents with AI tool application ability are increasingly valued by the industry. Incorporating AI technology system into the art curriculum system is beneficial for students to cope with the changes in the digital design ecosystem in advance, shape cross-border integration thinking, and enable art education to better fit the development trend of the times and achieve precise alignment between educational goals and social needs [3].

III. THE REAL-WORLD CHALLENGES OF CULTIVATING INNOVATIVE STYLING DESIGN CAPABILITIES SUPPORTED BY AI TECHNOLOGY

A. TEACHERS' AI TEACHING LITERACY AND APPLICATION ABILITY NEED TO BE IMPROVED

The rapid development of AI technology has put forward higher requirements for the comprehensive quality of art teachers. However, there are obvious shortcomings in the use of AI in teaching. According to a survey conducted by the author on some primary and secondary school art teachers in this region, more than 60% of the teachers have not systematically used AI design tools in the classroom, and nearly 80% of the teachers believe that they have not combined AI technology with modeling teaching well [4]. This presents a large gap between the current situation and the rapid development of AI technology in the field of art. There are two reasons for the above phenomenon. First, the current pre-service teacher training system lacks systematic courses on the application of AI in teaching, and teachers lack a solid technical foundation. Second, the content of in-service training is mostly limited to the tool operation level, without in-depth discussion on the teaching design logic of the deep integration of AI and art courses [5]. When teachers are afraid of the practical needs of integrating AI into teaching, they will avoid trying it, thus creating a negative cycle. The overall low level of teachers' AI literacy is the main obstacle to the effective implementation of AI technology in art classes. To address this, the implementation of the collaborative framework must be preceded by a tiered professional development program that focuses on 'Human-in-the-loop' pedagogy. This training enables teachers to transition from technical operators to facilitators who can effectively intervene promptly throughout the human-AI collaborative process to consistently reinforce the students' sense of agency.

TABLE 1. Survey on the Current Status of Art Teachers' AI Teaching Literacy

Survey Project	Proportion
I have never used AI design tools in the classroom system.	62%
They believe they lack the ability to integrate AI with art education.	78%
Participated in AI teaching training	21%
Willing to proactively learn AI teaching applications	45%

B. INSUFFICIENT INTEGRATION OF AI TOOLS WITH STYLING DESIGN COURSES

Although some schools have introduced AI tools into art classes, the level of integration is still relatively shallow. Most of them are only at the stage of tool display or auxiliary demonstration, and have not truly penetrated into the core links of modeling and design teaching. In my classroom observation, I found that about 70% of students use AI as an auxiliary tool for teaching, and only use it as an embellishment for classroom introduction or appreciation. AI has not penetrated into the students' modeling creation process [6]. The fundamental reason for the shallow integration is that the current art curriculum standards and teaching evaluation system have not included the application of AI tools in the scope of core competencies, and teachers lack systematic guidance on the integration design system. At the same time, there is a great lack of localized AI teaching resources adapted to primary and secondary school art courses, and teachers will encounter great difficulties when developing integrated courses independently. The state of AI tools being separated from modeling teaching makes it impossible to fully realize the potential of technology, and the educational value of integrated teaching is greatly reduced [7].

TABLE 2. Distribution of AI tools used in art classes

Application methods	Percentage
For classroom introduction or appreciation presentation only	69%
Occasionally assist students in creating presentations	18%
The system is integrated into the core aspects of styling design.	8%
Build a complete human-computer collaborative teaching process	5%

C. STUDENTS' OVER-RELIANCE ON AI-GENERATED CONTENT WEAKENS THEIR ORIGINAL CREATIVE ABILITIES

The high convenience of AI image generation tools has improved students' operational efficiency, but there are also negative impacts that cannot be ignored. After some students came into contact with AI tools, they gradually developed a lazy mindset of "direct generation instead of independent conception", and their aesthetic judgment and aesthetic creativity declined to varying degrees in modeling design [8]. According to the author's observation, after the introduction of AI-assisted design, the proportion of students who actively carried out sketching and conception in the class decreased, the homogenization of student works was serious, and the distinctiveness of personal style also decreased. The underlying logic of this problem is that the powerful generation ability of AI has, to some extent, covered up the process of students' perception, understanding and expression, causing students to bypass the process of generating modeling design ability. If there is a lack of effective teaching guidance and constraints, then AI tools will not enable students to generate new creative thinking [9].

TABLE 3. Comparison of students' creative behavior before and after the introduction of AI

Observation indicators	Before the introduction of AI	After introducing AI
The proportion of students who actively complete the sketching concept	73%	41%
The proportion of works with obviously similar styles	22%	58%
Proportions that clearly express personal styling intentions	65%	38%
The proportion of AI-generated results that are actively modified	—	19%

IV. STRATEGIES FOR CULTIVATING INNOVATIVE STYLING AND DESIGN CAPABILITIES EMPOWERED BY AI TECHNOLOGY

The above teaching process can be summarized into the following four progressive steps, which are interconnected and logically rigorous, as shown in Figure 1.

A. INSTRUCTION ON HUMAN-COMPUTER COLLABORATIVE GENERATION AND ITERATIVE OPTIMIZATION OF DESIGN CONCEPTS

In a human-AI collaborative teaching model for design, the respective roles played by humans and AI must first be clearly defined [10]. Educators should deconstruct the design task into four interconnected stages: independent conceptualization, AI-assisted generation, critical evaluation, and iterative optimization. This ensures that students remain in a state of creative leadership, rather than being dominated or swayed by the results produced by the AI. Before utilizing AI tools, students are required to independently complete initial heuristic sketches to articulate their primary design intent. This preserves the necessary space for original thought to flourish while providing a baseline for AI-driven divergent exploration, where the AI serves to provide alternative permutations of the student's core concept rather than replacing the conceptualization phase. Subsequently, students translate their design intentions into textual prompts that the AI can interpret, utilizing human-AI dialogue to transform abstract concepts into tangible visual imagery [11]. Furthermore, educators must guide students to meticulously observe and reflect upon the images generated by the AI in relation to their intended outcomes, subjecting them to critical evaluation. This iterative synergy—where students refine prompts through multiple cycles—aligns the final design with the project's objectives while fostering cognitive synergy. Within this framework, the students' own aesthetic judgment remains the pivotal variable guiding the machine's output toward a refined artistic vision. When designing instructional tasks, educators should deliberately incorporate specific design constraints—such as the requirement to "deviate from the AI's default aesthetic style"—to encourage students, through the inherent tension of their dialogue with the AI, to consciously forge their own distinct design language rather than being passively governed by the aesthetic inertia of the underlying algorithms [12].

Taking the IP derivative design as an example, students begin by creating a hand-drawn sketch to establish the morphological proportions and linear relationships of the structure. They then translate these conceptual ideas into specific textual prompts, which are fed into an AI image-generation tool to produce a preliminary visual proposal. Upon comparing the AI-generated images with their original sketches—and identifying discrepancies such as inaccurate massing relationships or decorative details that fail to align with their initial vision—students undertake targeted revisions to the descriptive vocabulary within their prompts. After undergoing three to four iterative adjustments, they arrive at a design solution that faithfully embodies their original creative concept. Finally, they present and share their results with the class, thereby completing a closed-loop creative cycle that spans the entire journey from independent conceptualization to final presentation. Furthermore, instructors should guide students to maintain a "design log," documenting every modification made to their prompts—and the corresponding changes in the results—thereby fostering a habit of evidence-based design iteration. This method of parallel textual and visual documentation facilitates the identification of underlying design principles during review; it transforms serendipitous, intuitive judgments into rational insights that can be applied to future projects, enabling students to engage in human-AI collaboration with greater intentionality and efficiency in their subsequent creative endeavors. Following this classroom practice, many students reported that the act of articulating their design intentions precisely through text deepened their understanding of fundamental design concepts—such as form, proportion, and materiality—far beyond their previous grasp. This demonstrates that the very process of crafting AI prompts serves as a rigorous exercise in higher-order design thinking, compelling students to translate nebulous visual impressions into concrete design judgments anchored in language, and thereby establishing a more robust cognitive foundation for design through the iterative dialogue between human and machine.

B. CONTEXTUALIZED STYLING DESIGN PRACTICE BASED ON AI IMAGE TOOLS

Contextualized teaching serves as a method for stimulating students' intrinsic motivation in form design. Integrating AI image tools into real-world or simulated design scenarios significantly enhances students' problem awareness and their capacity for visual expression. In terms of instructional

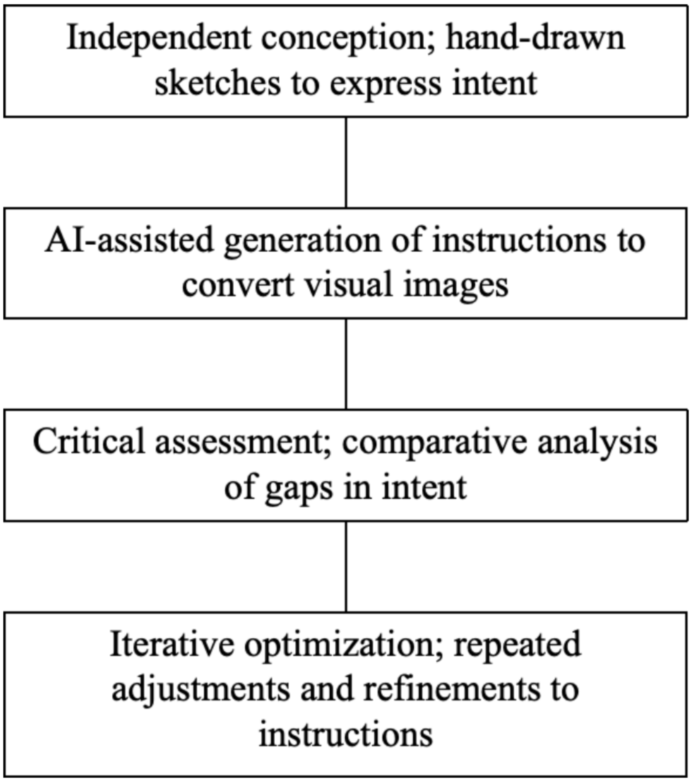

FIGURE 1. Flowchart of Human-Computer Collaborative Modeling Design Teaching

design, educators should anchor their approach in specific form design themes to create immersive learning environments, thereby prompting students to utilize AI tools comprehensively while executing practical design tasks within these contextualized scenarios. Driven by these contextual tasks, students must first analyze the functional requirements, cultural background, and aesthetic sensibilities of the target object to formulate a conceptual framework for their design. Subsequently, they employ AI image generation tools to rapidly visualize various design options, deepening their understanding of form through authentic comparison and critical discussion [13]. Contextualized practice effectively addresses the issue of technology being utilized without a clear purpose; by engaging in the process of solving real-world problems, students naturally cultivate a design-oriented mindset regarding form. Educators must prioritize the graduated sequencing of these contextual tasks, guiding students from AI-assisted exploration of individual design elements toward the comprehensive innovation of holistic design schemes, thereby ensuring the systematic and continuous development of their competencies. Furthermore, during the design of these contextual tasks, educators should emphasize the intrinsic connections between design language, regional culture, and material properties. This encourages students to integrate traditional design resources into the semantic structure of their AI prompts, thereby achieving an organic fusion of cultural heritage and technological innovation. Rooted in the local design context, such contextualized practice not only enriches students' repertoire of design resources but also encourages them—amidst the mounting pressures of global aesthetic convergence—to consciously cultivate a distinct personal design sensibility that possesses strong cultural identity [14].

In a teaching unit titled "Extraction of Hakka Cultural Elements and Apparel Design for Taihua Town IP Image, " students begin by conducting research and analysis regarding the target space's users, functional zoning, and regional cultural characteristics, culminating in the development of a conceptual design statement. Subsequently, students translate this conceptual statement into AI prompts to generate various spatial renderings reflecting diverse design styles; within their respective groups, they engage in discussions regarding the morphological logic, proportional relationships, and visual language of these different design options. During the class-wide presentation phase, each group refines its design direction based on the feedback received during discussions; they then modify their AI prompts to regenerate and optimize their design schemes, ultimately producing a comprehensive design proposal grounded in coherent formal logic. This process effectively cultivates students' ability to apply design language holistically to address real-world challenges. In addition to being task-driven, instructors should incorporate a comparative analysis component into the contextualized practice process. This involves guiding students to conduct cross-referential analyses of design precedents—specifically, similar formal examples drawn from diverse cultural backgrounds or historical periods—thereby enabling them to examine AI-generated proposals within a broader formal context. This cross-contextual comparative perspective serves to expand the boundaries of students' formal cognition and, through multifaceted referencing, facilitates the development of distinctive, personally identifiable design styles, thereby further enhancing the pedagogical value of contextualized practice. Following their project presentations, several student groups noted that the AI-generated renderings exhibited significant deficiencies in the rendering of fine details—particularly regarding the fidelity with which they reproduced the material textures characteristic of regional architecture—thereby creating a compelling need for students to supplement these outputs with hand-drawn illustrations. Consequently, they spontaneously presented the AI-generated images alongside their hand-drawn detail sketches, creating a hybrid representational format that combines digital generation with manual refinement. This approach effectively filled the informational gaps inherent in purely AI-generated formal outputs and, moreover, demonstrated the students' innate potential—stimulated by the contextualized learning environment—to proactively integrate a diverse array of expressive tools.

C. A DIVERSIFIED STYLING EVALUATION SYSTEM INTEGRATING AI FEEDBACK MECHANISMS

A scientific evaluation system serves simultaneously as a guide for pedagogical practice and a driving force for the continuous development of students' capabilities. Establishing a multifaceted design evaluation system—one that incorporates AI feedback—requires breaking free from the traditional, singular evaluation model that places sole emphasis on the final product. Instead, it must integrate the originality of creative conceptualization into a comprehensive evaluation framework. To counter the observed risks of homogenization, 'originality' is specifically defined within this metric as the degree of deviation from the AI's default algorithmic outputs, rewarding students who successfully impose unique personal styling intentions over the machine's latent patterns. Operationally, instructors can guide students to systematically compare their own creative works against AI-generated reference images, utilizing the visual analysis methods provided by the AI to identify deficiencies in formal composition and subsequently formulate targeted improvement strategies [15]. AI feedback functions as an auxiliary diagnostic tool, offering students immediate and objective technical responses. While current survey data indicates a significant literacy gap among educators, this AI-driven feedback serves as a standardized 'technical baseline' that assists less experienced instructors in identifying formal inconsistencies, thereby providing a bridge toward more objective assessment while teachers undergo parallel professional development. Furthermore, peer review and self-reflection components must not be overlooked, as they enable students to acquire a holistic understanding of the underlying principles of design. Only by organically integrating AI feedback, peer assessment, and instructor evaluation—thereby creating a dynamic, multi-dimensional evaluation ecosystem—can we effectively stimulate students to engage in continuous reflection and adjustment, ultimately fostering a spiral trajectory of growth in their innovative design capabilities. Additionally, the evaluation system must take into account students' critical literacy regarding AI-generated content. The ability to identify logical errors in formal composition, stylistic redundancies, or a lack of cultural depth within AI-generated images constitutes a sophisticated level of aesthetic judgment. Instructors can design specific evaluation tasks—such as "Diagnosing Flaws in AI-Generated Design Proposals"—to encourage students to heighten their sensitivity in making formal judgments while scrutinizing AI outputs, thereby embedding critical thinking deeply into every stage of the evaluation process.

Within the evaluation phase of a specific design module, instructors may require students to input their completed design proposals into specialized computer vision assessment algorithms or multimodal Large Language Models (LLMs) to generate automated diagnostic summaries regarding compositional balance, color schemes, and morphological proportions. By leveraging contrastive learning models to compare student work against established design principles, these tools provide a structured data layer for students to interpret. Based on these feedback reports, students are then required to draft self-reflection logs, identifying specific issues within their design proposals and outlining proposed directions for revision. This is followed by a peer review session, during which each student offers constructive suggestions regarding the formal language and expression of their peers' design proposals. Ultimately, drawing upon the AI feedback results, peer review comments, and students' self-assessments, the instructor conducts a summative evaluation of the student's entire intellectual development trajectory throughout the creative cycle. Rather than judging the merit of a work solely based on the technical proficiency of the final product, this approach objectively and authentically reflects the student's developmental journey in design proficiency. Furthermore, the design of the assessment framework must incorporate a mechanism for the dynamic updating of evaluation criteria. As the course progresses and students' proficiency levels evolve, instructors should periodically review and revise the assessment dimensions in collaboration with their students, thereby transforming the evaluation criteria into a medium for pedagogical dialogue. This open-ended, collaborative process of establishing standards enhances students' understanding of—and buy-in regarding—the underlying logic of assessment; it also fosters the metacognitive skills necessary for self-calibration and self-monitoring during independent creative endeavors. Tracking observations conducted over three consecutive instructional units revealed that the proportion of students who proactively modified AI-generated proposals rose from an initial 19% to 47%. While this suggests a positive trend, it should be noted that this increase reflects a combination of the assessment-oriented incentive and the students' natural iterative learning curve; however, the structured requirement for self-reflection logs indicates that the framework accelerated the shift from passive generation to active intervention. Additionally, the percentage of students capable of clearly articulating their specific design intentions also saw an increase. These findings demonstrate that when an assessment framework prioritizes process-based reflection and critical revision as core dimensions, students come to recognize that the proactive adjustment of AI outputs is a valued and encouraged learning behavior; driven by this assessment-oriented incentive, students spontaneously strengthen their sense of agency within the context of human-AI collaboration.

V. CONCLUSION

The deep integration of AI technology with IP derivative design teaching has provided new avenues for cultivating complex fiber modeling and structural design abilities. This synergy allows for the precise simulation of material properties, significantly expanding the creative scope of engineering pedagogy. Faced with the opportunities and threats that technological innovation brings to art education, art educators must both actively embrace the opportunities for teaching innovation brought about by AI tools and clearly recognize the educational risks inherent within them. Only within a system of human-machine collaboration, experiential learning, and multi-dimensional evaluation can AI technology truly be applied to students' innovative modeling and structural design abilities, enabling technical art education to exert a stronger educational function in the digital age. This integrated approach ensures that computational intelligence directly enhances the material experimentation required for modern industrial aesthetics.

AUTHOR CONTRIBUTIONS

Chen Li designed, collected and analyzed the data, and drafted the manuscript. Chen Li conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Chen Li participated fully in the work, take public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICTS OF INTEREST

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