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The Transformation, Challenges, and Reinvention of China's Design Education Model in the AIGC Era

Yifan Yang[1,*], **Ruoyu Fu**[1] **and Liqun Xiang**[2]

[1] School of Innovation Design, City University of Macau, Macau 999078, China
[2] School of Design, Art and Media, Qingdao Institute of Technology, Qingdao 266000, China

Abstract

With the paradigm shift driven by Artificial Intelligence Generated Content (AIGC) technology, the design industry is undergoing unprecedented transformation and reconstruction. China's traditional design education model faces severe challenges, as long-standing emphases on hand-drawing skills and mastery of classical software increasingly fail to meet the evolving demands of the AIGC era. This paper proposes that design education must undergo a comprehensive Four-Dimensional Reconstruction encompassing four key dimensions: educational objectives, curriculum system, assessment mechanisms, and pedagogical environments. Drawing on a systematic literature review, the study develops a conceptual model aimed at cultivating design talents equipped with AI literacy, critical thinking, and interdisciplinary integration capabilities. The findings indicate that design education in the AIGC era requires not merely technological updates, nor isolated reforms in educational philosophy, teaching methods, or evaluation systems, but rather a holistic, all-dimensional reconstruction to align with the profound changes in the field.

Keywords: AIGC, artificial intelligenc, design education, educational transformation, four-dimensional reconstruction model.

1 Introduction

The last few years have seen advancements in AIGC technology (Artificial Intelligence Generated Content), which now focuses on the Transformer architecture. The beginning of the AIGC era can now be marked with the launching of the large-scale generative models like DALL-E and GPT. These technologies are now poised to change the creative industries at an unprecedented rate due to their ability to generate content [1]. On the design side, the impact of AIGC tools, as illustrated in Figure 1, has facilitated a paradigm shift of drastic magnitude. The AIGC tool is no longer just an instrument of scalability but, rather, transforms the very basic characteristic of concept exploration and creative generation processes. The designers are no more bound by the drudgery of laborious routine operations and are able to focus even more on higher-order strategic thinking and concept creativity [2]. But, while such technology accords such a great design productivity advantage, it has, in fact, generated considerable debate regarding design ethics,

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***Corresponding author:**
Yifan Yang
qq1376901275@163.com

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authorship ownership, and the "de-skilling" of the designer.

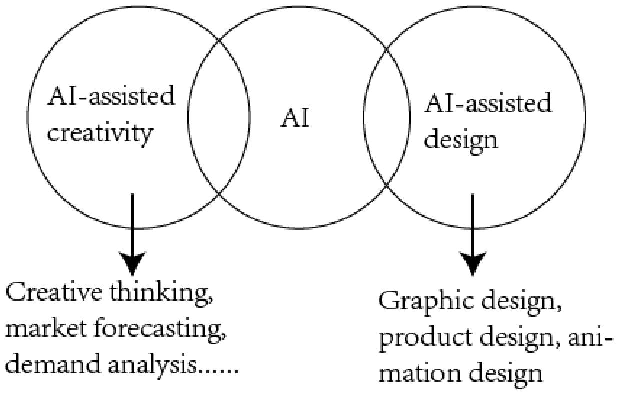

Figure 1. Application of AIGC in Design.

Literature reviews by recent research have already developed foundation discussions of the way design processes have been influenced by AIGC and the work of the designer, with general agreement that design education models of the day must be redesigned. Yet, most of the literature reporting are macro-level appeals or application-driven case studies with technology application-centricity, and no systematic and practicable theoretical framework has emerged with applicability in directing the overall redesign of design education models [3]. Thus, such a diffused body of research has generated ambiguity regarding the direction of reforms to be undertaken with reference to design education. Under China's existing design education, the paradigm is still one that is controlled by traditional pedagogy, with attention given to imparting basic theory knowledge and practical skill. But students are basically found ill-prepared when they are confronted by the rapid digital and intelligence shift of the design industry and converging skill demands of the AIGC market placed on the designer. Today, traditional training programs are increasingly falling short of marketplace requirements [4].

Thus, in the face of the power and impact of the AIGC technology, this research tries to answer the key question of how China's traditional design talent education system can develop systematically and cultivate design talents to address the challenges of the future with sustainable competitiveness.The belief of this research is that an in-depth investigation into the transformation process of Chinese design education, apart from resolving the dilemma of imbalance of supply and demand of talents, possesses special theoretical values to integrate AI with design education. To answer the above research question, this paper proposes a theoretical model called the "Four-Dimensional Reconstruction Model" as the systematic model of China's modernization of design education. The model attempts to implement overall reform on four basic dimensions: education goals, course system, examination mechanisms, and teaching facilities. Its ultimate goal points at changing the education of design talent from the traditional role of "executors" to "innovation leaders" who are able to control technology and exercise strategic creativity.

The paper begins with an analysis of the challenge and opportunity brought by the AIGC to the design industry and education. Next, it explores the theoretical basis and special connotations of the "Four-Dimensional Reconstruction Model" based on the case studies with the goal to illustrate its effectiveness. Finally, conclusions and future directions are made, suggesting an available theoretical model and reference for renewing design education in the context of the AIGC era.

2 Literature Review and Theoretical Framework

2.1 Current Research on the Integration of AIGC and Design Education

Over the past few years, technologies based on Artificial Intelligence Generated Content (AIGC) have progressed rapidly. In particular, deep-learning-derived generative models like OpenAI's GPT series, DALL·E, and Midjourney, have significantly influenced the design world. The technologies have given designers new creative tools, which largely boost the productivity of design work while extending the range of creative design expression. The application of AIGC is increasingly becoming part of mainstream design disciplines, both creating new challenges and potential opportunities for design education's frameworks.

Current literature largely focuses on the application of AIGC technology, especially with respect to creative design, image production, artistic visualization, and marketing approaches. Various researchers argue that AIGC technology has the potential to substitute traditional design approaches partially, thus freeing up designers from routine chores and providing greater leeway for them to focus on complex creative activities and innovation strategy. Additionally, AIGC significantly enhances design efficiency and enables designers to explore a massive array of innovative design potential. The application of AIGC enables designers to overcome routine chores, thus accelerating the design process and making design activities more innovative and effective.

However, the extensive application of AIGC has brought substantial challenges deserving of full consideration. Many studies have been initiated to investigate the effects of AIGC technology on designers' work processes. As we witness rapid advancements in AIGC technology, designers are transforming in their roles from mere "craftsmen" to "creativity guides." A shift in emphasis has occurred from performing manual tasks to overseeing and fine-tuning AI-generated designs. However, the AIGC phenomenon has also triggered "de-skilling," the decreasing relevance of fundamental skills. A growing number of educators seek to find sustainable solutions aimed at mitigating designers' skills erosion by integrating AI technologies into the framework of design education while still preserving traditional design skills [1].

The extension of the responsibilities of designers has run parallel with the development of AIGC technology, which has raised considerable debate regarding the ethics of design and related matters of copyright ownership. The products of AIGC pose complexities with respect to attributing copyright, especially with reference to the controversial view that holders of design rights have the right to claim intellectual property rights over AI-generated content. Researchers like Chen et al. [5] have pointed out that the consequences of copyright with respect to AIGC products, including the conditions of determining ownership, are topics of great dispute. This debate includes questions regarding whether the AI-generated work has a possibility of becoming original, its qualifications for copyright protection, and the identification of the rightful owner of the copyright. The inclusion of ethical concerns, studies of copyright, and the effects of AIGC technology upon design practice into design studies has therefore become an area of great focus among current scholarship.

2.2 Research on the Integration of the TPACK Framework and Design Thinking

In design education, attention has been given to two foundational theories, the TPACK (Technological Pedagogical Content Knowledge) framework and design thinking, but very little focus has been placed on one of the most cutting-edge areas of research—the integration of both frameworks in response to the challenges presented by the AIGC epoch. This study seeks to address that issue by explaining the integration of both theories and developing the conceptual framework of this study. The TPACK framework, which Koehler et al. [6] proposed, aims to comprehend the knowledge frameworks described in technology-enhanced instruction by teachers. It identifies three core components, which are Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK). Moreover, TPACK underscores the overlap of these domains, which form four types of integrated knowledge: TCK, TPK, PCK, and, at the apex, TPACK (Technological Pedagogical Content Knowledge). Numerous studies have confirmed that TPACK helps educators foster technology adoption and integration in instruction to develop 21st-century competencies in their students. Its use has spread from only the STEM fields to include the humanities and social sciences.

Design thinking has emerged in pedagogy as a crucial part of modern design instruction and adopts a human-centered approach to innovation. Its five stages—empathy, definition, ideation, prototyping, and testing—develop students' critical and creative thinking skills to solve complicated problems. Instructional methods utilized in teaching design thinking are clearly project-centered; participants are trained to solve users' problems in an incremental manner. Design thinking as an educational approach has been known to foster innovation, and its impacts have been documented favorably by numerous researchers [7].

A research gap exploring the intersection of TPACK with design thinking principles has recently emerged. As an example, Koh et al. [8] in 2015 wrote TPACK and Design Thinking in a Framework for ICT Curriculum Design for 21st Century Learning. In this study, the authors sought to investigate the potential of design thinking to help teachers overcome various instructional challenges related to ICT curriculum and collaboratively nurture problem-solving skills. In a more recent publication, Felix et al. [9] argue that design thinking serves as a vital approach to enhance TPACK for teachers. The findings showed that with a design thinking approach, teachers were able to resolve ICT integration challenges and improve teaching performance.

While the influence of AIGC on design education has been researched, the attempts have been too simplistic—mostly centered on tool use without a cohesive theoretical structure. Moreover, AIGC's impact on the conceptual merger of TPACK and design thinking has not been addressed, along with the burgeoning technological and ethical concerns. Within the scope of China, this gap is particularly pronounced. Thus, this study attempts to address this gap with the introduction of a "Four-Dimensional Reconstruction Model," which simultaneously incorporates TPACK and design thinking with the aim of studying China's design education transformation in the AIGC context.

2.3 Theoretical Framework: Deep Integration of TPACK and Design Thinking

To address the research gap established above, in this study, we introduce a conceptual model that synergizes TPACK with design thinking, and this serves as the theoretical framework for the upcoming "Four-Dimensional Reconstruction Model." Design thinking in this model acts as an innovation philosophy and methodology that is user-centered, while TPACK outlines the way technology, pedagogy, and content knowledge are integrated to facilitate the practice of this approach.In AI design courses, the TPACK framework and design thinking do not exist as separate entities but rather as an organically integrated whole. Design thinking offers the user-centered methodology and mindset, whereas the TPACK framework supplies the specific integration of technological, pedagogical, and content knowledge required to actualize it. This integration runs through all stages of the curriculum: TPACK guides teachers in leveraging big data tools to conduct efficient user research during the "empathy" and "define" stages of design thinking; during the "ideation" and "prototype" stages, AIGC technologies act as core tools, accelerating idea generation and prototype iteration under the guidance of pedagogical strategies; at the same time, the evaluation system shifts toward a process-oriented approach, assessing how students apply TPACK knowledge throughout the design thinking process.

Ultimately, this integration not only enhances design efficiency but also aims to cultivate a new generation of designers who are not only capable of mastering AI technologies but also equipped with critical thinking and innovative capabilities.

3 The Real Challenges Facing Chinese Design Education in the AIGC Era

3.1 Traditional Education Models Struggle to Meet Market Demand for Talent

Within design education, the pedagogy is strictly linear, starting from introductory courses to advanced classes focusing on a combination of theory and practice, emphasizing theory on design history, drawing, color theory, aesthetics, and literacy, among others. With teaching practice, there is a predominant reliance on hand drawing and basic software [10]. Students must toil tirelessly on sketches, models, and iterative processes on products. In the past, the education model focusing on operational procedures and tools, barebones construction, sufficed. This pattern, though, is lagging terribly behind the AIGC technology leap.

Combined with the new tools, the design work processes are structured differently. AIGC's rapid output of a variety of solutions all but establishes the "time costs" to be obsolete, and most painstaking processes are losing relevance quickly. AIGC technology has yet to be fully adopted, and in China, design education largely operates on the "3 learn, 1 do" model. This leads to an unprepared workforce in the wake of a digitally and intelligently integrated industry. AIGC's multidisciplinary skillset designed to challenge the education sphere is also a byproduct of the eagerness for AIGC technology and the model's relentless pursuit of examination grades.

3.2 The Changing Skill Structure Requirements for Design Talents Driven by Technological Progress

The rapid development of AIGC has prompted considerable shifts of the educational structures that control design pedagogy. Design pedagogy's focus has moved increasingly from that of emphasizing manual individual capabilities and proficient knowledge of software applications to the embracing of an innovative design approach that makes optimum use of the human-computational system interface. This requires design professionals whose knowledge goes beyond core artistic and aesthetic principles, including competent interactions with computer systems. These interactions are no longer based simply on natural language communication but require the combination of design-specific vocabulary with programming languages, leading to a coherent, systematic, and ordered manner of engagement [11].

Today, the role of designers is changing dramatically;

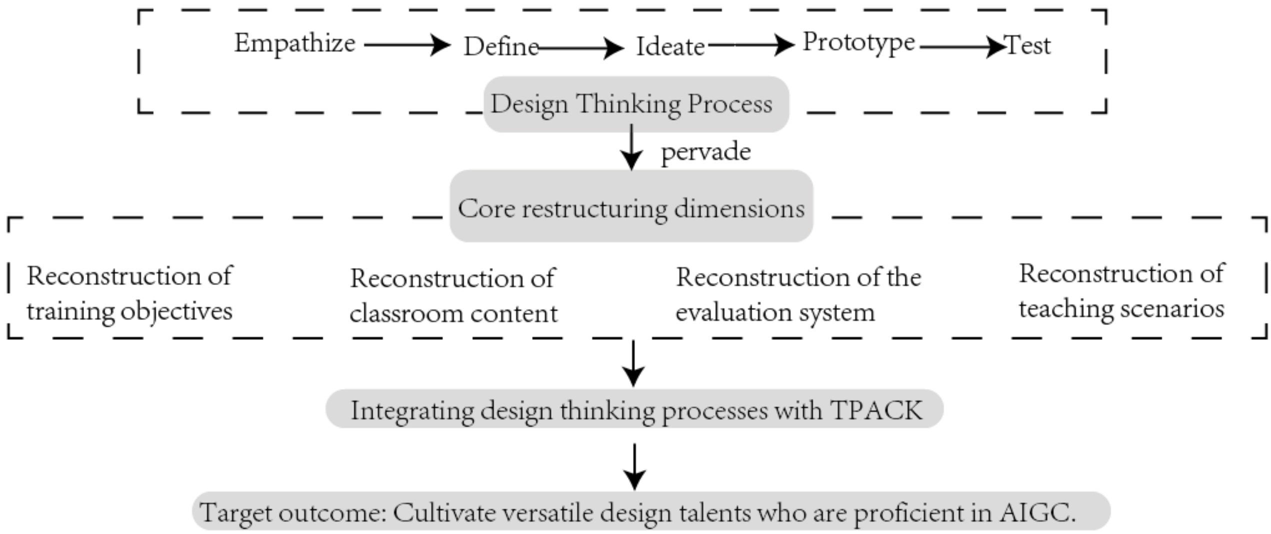

Figure 2. Schematic diagram of the "four-dimensional reconstruction" model of design education in the AIGC era.

they are no longer mere users of traditional tools but are becoming "intelligent collaborators" with skills in programming, algorithms, and basic principles of artificial intelligence. In artificial intelligence systems, designers must express their design requirements, aesthetic judgments, and emotional perceptions in terms that will be understandable to the system, thus placing additional demands on their analytical reasoning and professional communication skills.This implies that, for students, the range of educational needs has to cover not just design competencies but also interdisciplinary studies. As such, with environmental design, students should move from basic knowledge of material qualities and structural principles to synthesizing techniques of light-shadow simulation and narrative visualization, among other things, and utilize AIGC to further guarantee design results' efficacy and quality.

In education, it is necessary that universities take a proactive approach to mentoring by aligning their talent development goals with the needs of the industry. Design education needs not just to update its curriculum material but to revolutionize the structure of the curriculum itself so that it creates a talent development paradigm that integrates art, technology, and innovation [12]. These are critical steps necessary to ensure that future designers have not only knowledge of AI technologies but also the competitive advantage of creativity and strategic thinking and develop into the next-generation design practitioners needed with the advent of AIGC.

4 Building a "Four-Dimensional Reconstruction Model" for Design Education in the AIGC Era

In the AIGC era, design education faces unprecedented challenges and opportunities. This study proposes a "four-dimensional reconstruction model," as visualized in Figure 2. The model starts from four dimensions: educational objectives, curriculum system, evaluation mechanism, and teaching scenarios. Its core theoretical basis lies in the deep integration of the TPACK framework and design thinking, providing a theoretical foundation and practical path for the reform of design education. In this integrated model, design thinking provides a user-centered methodology and core mindset, while the TPACK framework provides a technology-instruction-content integration path to implement this methodology.

4.1 Reconstruction of Training Objectives

Along with the rise of AIGC technology, the goals of design education, specifically talent training, are undergoing a paradigm shift. Most design education frameworks focus on teaching drawing techniques, manual sketching, and relevant software tools. Such an approach is obsolete, given the advancement of AIGC technology. With the AIGC tools permeating the design space, mere skill mastery is not sufficient for designers to remain competitive in the context of AIGC technology. Design education must shift to emphasize the cultivation of comprehensive literacy, innovative spirit, and interdisciplinary thinking. The new training objectives should form a systematic talent training path through the integration of the entire process of design thinking and the knowledge of the TPACK framework.

In the "empathy" stage, the talent cultivation goal emphasizes students' humanistic literacy and user sensitivity. Teachers can use CK to guide students in understanding social culture and design contexts, leverage AIGC data analysis and user profiling tools in TK to help them grasp user needs, and use scenario simulation and research methods in PK to guide students in people-centered observation and thinking. In the "problem definition" stage, the cultivation goal focuses on critical and logical thinking.Students should identify core issues with the support of CK's disciplinary theories, use TK's data modeling and algorithm analysis tools to structure issues, and form systematic problem statements under the guidance of PK.

During the "conceptualization" phase, the main concern of educational outcomes shifts towards developing creativity and non-linear thinking processes. By participating in collaborative ideation sessions and workshops conducted by PK, students are given the opportunity to share their ideas with others. Utilizing TK's artificial intelligence generation platform allows them to quickly generate a set of solutions; at the same time, they are tasked with rigorously critiquing these systematically generated solutions in the context of CK's design theory and aesthetic standards. During the "prototyping" phase, the concern shifts to developing practical skills and experimental reasoning. Students are tasked with effectively utilizing TK's 3D modeling, virtual simulation, and AI-facilitated iteration tools, using CK's expert knowledge to translate concepts into concrete prototypes while continually refining their solutions through PK's project-based learning approach. Lastly, during the "testing" phase, the key aim of talent development centers is the development of students' iterative refinement and evidence-based skills. Using TK's feedback analysis and AIGC modeling tools, combined with CK's professional standards and PK's iterative frameworks, learners are able to continue refining their solutions based on feedback, developing design logic that is needs-centered, scientifically based, and rational.

In the era of AIGC, the objectives of cultivating talent should move beyond covering only a training session. Furthermore, they should be accomplished via a holistic merging of the five stages of design thinking and the three categories of TPACK knowledge, systematically developing students' innovative spirit, critical thinking, interdisciplinary competencies, and the ability to work alongside machines. These professionals will not only command the necessary technical tools but will also be able to drive innovation in sophisticated design situations, enabling a shift from mere 'executors' to 'leaders of innovation.'

4.2 Reconstruction of Course Content

The design education curriculum has a pressing need for systematic changes due to the AIGC technologies. In the context of AIGC, the focus on manual and software skills in traditional education is quickly falling behind the core requirements of talent competitiveness. A thorough redesign of the curriculum must incorporate the design thinking framework's five stages while also integrating the three knowledge categories from the TPACK framework to establish a comprehensive structure that is centered on users, fosters innovation, and synergizes humans and machines in a collaborative manner. This would usher in a holistic change in design education. A good illustration is the "Information Design 1" course, where Associate Professor Zhang Mangmang of Tsinghua University's Academy of Arts and Design collaborates with Luckin Coffee to co-create "lucky scenes" and design related practices using AIGC tools. Offering more tailored learning and course options, Guangzhou Academy of Fine Arts collaborates with Ming Manga on an elective AI-assisted drawing course. An additional case features Changzhou University's DMllab Interaction Design Laboratory, which started offering the course 'AIGC Artificial Intelligence Creative Design and Application' with the purpose of keeping up with the rapid shift of technology in the world.This course integrates the most recent AIGC (Artificial Intelligence Graphics Computing) developments into teaching design, therefore, providing students with the necessary competencies and expertise to succeed in a technology-driven environment. This approach and all of the courses draw from the amalgamation of design thinking and the TPACK framework.

In the "empathy" stage, courses should guide students to focus on user needs and social issues. Through CK, students can master design anthropology, cultural studies, and user experience theory to provide theoretical support for understanding the design context; through TK, students can use AIGC-driven data analysis and natural language processing tools to conduct large-scale user behavior mining and emotional analysis; and through PK, teachers can design teaching activities such as scenario simulations, user interviews, and field research to help students form a people-centered design concept. The goal of this stage of the course is not only to teach research methods but also to cultivate students' sensitivity to society and users.

In the "problem definition" stage, the course needs to strengthen students' problem refinement and logical construction abilities. CK provides a professional knowledge analysis framework at this stage, enabling students to clarify the essence of problems from the perspectives of design theory, market trends, and technological development; TK supports students in sorting and reconstructing complex information through AIGC modeling and visualization tools; and PK guides students to form structured problem statements and design directions through problem-oriented learning and case analysis. The course design should avoid students getting stuck on superficial issues and instead push them to learn how to define profound challenges in an interdisciplinary context.

During the 'conceptualization' stage, the emphasis is on 'creative thinking' and on 'divergent thinking,' where students' creativity is richly appreciated. An improved creativity climate can be achieved with PK design workshops, collaborative brainstorming, and interdisciplinary team collaborations. At this stage, TK is important, as with AIGC generation tools, students can rapidly produce a wide array of design concepts and their visual representations. CK mystically makes certain that with AIGC the ideas are integrated with appropriate disciplinary theories, aesthetic benchmarks, and industry standards to prevent creative chaos. Such courses should balance idea generosity with rigorous interdisciplinary refinement to enhance their quality and feasibility.

At the "prototyping" stage, the focus on courses should be on practical experience. Through TK, students should learn to model, 3D print, and interact with virtual and real models, changing theory into working prototypes. They should learn materials science and structural and aesthetic norms through CK to make the prototypes practical and worthwhile. Finally, in project-based and industry-academia collaborations, they should iterate, optimize, and refine through PK. The objective for this stage is the development of the selected advanced practical skills and technologies, which include AIGC-assisted rapid design hypothesis validation. This is facilitated through AIGC.

In the "testing" phase, the primary goal is to improve in relation to the data and metrics. In TK, user feedback and protocol results analysis relative to the test goals, affective computing, and data visualization frameworks are presented. The CK domain of the test case is expected to provide evaluation frameworks, professional benchmarks, and validation benchmarks. In PK, participating students are scaffolded to continuously improve the design solutions produced through the collaborative mechanisms of the evaluative frameworks and structured peer feedback. Students' attention should move from primarily focusing on the presentation of outcomes to iterative reflection and revision grounded in peer feedback.

4.3 Reconstruction of the Evaluation System

Within the realm of AIGC, a redesign of the evaluation system for design education requires more than the simple tweaking of the evaluation criteria; it calls for an overall reconceptualization of the assessment framework. The traditional method of "summative evaluation" overemphasizes the ultimate presentation of results. With the prevalence and widespread use of AI-generated content, evaluations based on individual outcomes do justice neither to the learning paths of the students nor to their contributions toward innovation. Therefore, the new evaluation system must shift from being "results-oriented" to a process-oriented one, from "single standards" to "multidimensional criteria." It should also embed the design thinking process as the core area of evaluation, using the three knowledge categories specified by the TPACK framework as assessment dimensions, thus providing a holistic and systematic system.

An assessment mechanism focusing on processes is necessary. At the "empathy" and "problem formulation" stages, this evaluation framework should examine students' knowledge of end-user needs and the accuracy of problem statements based on stage reports, research reports, and discussions by groups. The framework asserts that, apart from illustrating their conclusive research findings, students should present evidence of having interacted with artificial intelligence artifacts (TK), explain their personal contribution with data analysis and modeling of information, and illustrate sound logical thought in the identification of problems through application of conceptual knowledge (CK) and pedagogical knowledge (PK). This strategy ensures that students do not just rely on materials produced by artificial intelligence (AIGC) in making conclusions but instead exercise critical thinking and investigation qualities, which are part of the learning process.

A more effective evaluation framework that values diversity is needed. At the "conceptualization" and "prototyping" levels, it is critical that the process of evaluation does not depend exclusively upon the one-sided viewpoints of instructors but instead includes peer reviews, industry mentors' evaluation, and knowledge acquired through artificial intelligence. By participating in design workshops of PK and evaluation exercises, students are encouraged to collectively examine the potential of their ideas; they utilize CK and design parameters with verified professional theories to estimate the scholarly merit of proposed solutions; similarly, by applying TK, the AIGC platform independently suggests several ideas, while the collaborative analytical model enables the estimation of proposed solution quality. This complex operation integrates professionalism with pragmatism and thus enhances the objectivity and completeness of the process of evaluation.

An iterative evaluation framework needs to be put in place. In the "testing" stage, the testing needs to go beyond the evaluation of the ultimate results; it should additionally assess how students refine their designs through the integration of feedback. This framework requires students to keep iteration logs, which record a data set of user feedback, the use of AIGC tools during the optimization process, and changes to professional design based on CK, as well as learning reflections based on PK. Teachers should incorporate both "formative evaluation and summative evaluation" in order to effectively guide students' efforts and progress throughout different phases of the learning continuum while being mindful of the social aspects and human-related dimensions of the culminating design.

Improvements are warranted for mechanisms regarding standardization and assurance. The difficulty brought up by copyright controversies and the "deskilling" phenomenon due to AIGC requires the combination of scholarly standards with ethical consideration within the framework of evaluation. Students are required to clearly distinguish between artifacts produced by artificial intelligence and independently produced ones, thus incorporating a double requirement of "originality statements + technical usage explanations" within the framework. At the same time, assessments of conventional hand-drawing and construction of models should be carried out so that students' basic capabilities are retained. The proposed framework, through this, tries to maintain scholarly integrity while at the same time developing students' professional ethics and understanding of originality.

4.4 Extension of Teaching Methods and Scenarios

Design education is undergoing rapid transformation alongside the AIGC revolution. The long-standing approach, which is based on lecture and discussion, is no longer effective for students who learn in a technology-rich and interdisciplinary environment. The integration of AIGC technology has created an interdependent and synergistic bond between teachers, students, and virtual intelligent tutors, expanding the teaching scenario beyond physical classrooms to include intelligent laboratories, virtual spaces, and even cross-border collaborative teaching platforms. Innovation in education in this transformation necessitates the application of a design thinking approach as the logical framework backbone with the TPACK model to foster a flexible, diverse, and personalized instructional ecosystem. A case in point is the DigiLab at the Communication University of China. In partnership with Intel, the DigiLab created a generative AI art creation base, which allows students to apply AI technology as a step towards launching their careers. This platform has enabled the transformation of teaching with students exploring AI technology beyond the physical classroom. This case study has cultivated a diverse and interactive learning ecosystem, guided by design thinking and bolstered by the TPACK framework.

In the "empathy" and "problem definition" phases of design thinking, lessons should encourage guided discovery learning. They may also utilize sociocultural contexts, through their content knowledge (CK), to help learners construct design complications within the boundaries of the sociocultural framework. This stage may be followed by sociocultural framing, big data evaluation, user needs assessment on the AIGC platform, and TK (technological knowledge) within the WK scope of educational technology. Through workshops, virtual discussions, and scenario simulations, pedagogical knowledge (PK) is used to motivate student participation and active reflection, enabling them to understand design problems within a broader real-life framework. During this stage, virtual digital teaching assistants provide real-time feedback, allowing students to refine and deepen their understanding of the problems.

In the "conceptualization" and "prototyping" phases, the spatial-temporal extension of the teaching scenario is the most pronounced. With the aid of AIGC smart whiteboards, virtual modeling platforms, and collaborative design systems, students can generate and prototype their ideas in interdisciplinary teams much more rapidly. The TPACK framework clearly delineates the boundaries of the teaching objectives and outcomes: the technological component motivates the students to design AIGC as an appropriate technology to generate diverse design solutions, subject knowledge enables the students to observe scholarly and professional ethics while being creative, and pedagogical knowledge is evident in the use of collaborative, project based teaching which requires students to participate in many cycles of discussion and innovation within teams. In this case, students are immersed in smart 3D printing laboratories and virtual reality (VR) 3D spaces, helping them undergo both physically and virtually the design to reality transformation process.

In the "testing" phase, the teaching methodology focuses on reflection and on-planning based on evaluation and results. Utilizing the TPACK framework, teachers can employ technical knowledge to help learners analyze feedback and optimize solutions via AIGC. With subject knowledge, teachers can aid students to evaluate the solutions professionally, and through pedagogical knowledge, the teacher can inspire students to adhere to feedback cycles through robust learning mechanisms to refine their designs. In this phase, virtual teaching assistants can support educators by offering tailored Q&A sessions, resolving students' testing phase challenges, and suggesting ways to improve, thus increasing the coherence and precision of instruction delivery.

With the advent of the AIGC era, the process of teaching and learning is no longer confined to a solitary classroom. Now, it is holistically integrated as a full learning system incorporating the entire design process and the TPACK framework. Students are provided with appropriate scaffolding through the integration of AI, which allows the students to practice and reflect on learned concepts within various teaching contexts. With AI integration, educators are provided with accurate instructional pathways and efficient resource allocation. An example of such processes is the DigiLab laboratory, which is found at the Communication University of China.

This not only reinforces the role of design thinking in pedagogy but also increases the usefulness of the TPACK framework, thereby helping to provide a basis for nurturing innovative interdisciplinary engineering design talent with human-machine collaboration intelligence in design education in the future.

5 Conclusion

The development of AIGC is changing the framework of design education in China. The "four-dimensional reconstruction model" in this paper aims to holistically transform the traditional reconstruction model in the areas of design objectives, curriculum system, design evaluation, and teaching scenarios through the integration of the TPACK framework and design thinking.Its theoretical contribution addresses prior fragmented issues by systematically creating, for the first time in the Chinese context, an educational transformation framework that addresses both the technical and ethical concerns AIGC poses on design education and broadens the application boundaries of TPACK and design thinking, thus offering a new theoretical perspective for design education. Its policies imply that these institutions and the educational administrative bodies must more proactively foster AI literacy and interdisciplinary competencies as AIGC demands redefined core competencies. AIGC courses, formative assessments, and virtual laboratories need to be integrated as part of institutional design to foster alignment between talent cultivation and industrial needs.This "four-dimensional restructuring model" needs more empirical research across various types of institutions and disciplines for its applicability to be fully confirmed. Additionally, more work needs to be done on the ethics of AIGC education, its intellectual properties, and its academic frameworks. This research would create the essential structural protections needed to make governance more effective. Moreover, pathways of integrating AIGC with industry, interdisciplinary education, and lifelong learning should be explored to develop strategies for design education that foster openness and sustainability amidst rapid technological advancement. AIGC isn't just a technological transformation; it goes further by rewriting the very essence of education. In order to effect the transformation concerning the design education, it has to advance at the same time on the theoretical, policy, and practical education levels.

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Data will be made available on request.

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Conflicts of Interest

The authors declare no conflicts of interest.

AI Use Statement

The authors declare that no generative AI was used in the preparation of this manuscript.

Ethical Approval and Consent to Participate

Not applicable.

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Yifan Yang, Obtained a Master of Design degree from Macau City University in 2023, and is currently pursuing a PhD in Design at Macau City University. (Email: qq1376901275@163.com)

Ruoyu Fu, Obtained a Master of Design degree from Macau City University in 2024. (Email: U22091110974@cityu.edu.mo)

Liqun Xiang, Obtained a Master of Design degree from Macau City University in 2024. Currently employed at Qingdao Institute of Technology, School of Design, Art, and Media. (Email: liqliqun@163.com)