

Cultivating Design Educators' AIGC Technological Feedback Capacity under Industry–Education Integration 3.0: Constructing a University–Enterprise Collaborative Mechanism Based on the Dynamic Capabilities Model

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Abstract: Industry–education integration has gradually shifted from resource linkage and project-based cooperation toward multi-actor co-creation, capacity synergy, and value symbiosis. Meanwhile, artificial intelligence-generated content (AIGC) is reshaping the knowledge production modes, creative generation mechanisms, and talent competency structures of the design industry. Focusing on how design educators can effectively transform AIGC technological experience generated on the industry side into capacities for teaching, research, and service to society, this study adopts dynamic capabilities theory as its analytical framework and integrates the TPACK model to construct the developmental logic of design educators' AIGC technological feedback capacity. By combining literature analysis, questionnaire survey, and case analysis, this study examines the policy evolution of industry–education integration, the competency requirements generated by the incorporation of AIGC into design education, and the operational pathways of university–enterprise collaborative mechanisms. The findings indicate that the transformation of design educators' competencies is reflected not only in improved tool-use proficiency but also in the systemic formation of technological sensing, pedagogical transformation, project integration, ethical judgment, and continuous reconfiguration capacities. Accordingly, this study proposes a university–enterprise collaborative mechanism composed of “opportunity sensing–resource integration–pedagogical transformation–outcome feedback–feedback-based reconfiguration,” and further advances supporting strategies in terms of resource sharing, incentive mechanisms, communication and

coordination, and risk prevention and control. This study contributes to shifting the development of design educators' competencies from experience-based individual improvement toward organized, institutionalized, and continuously iterative cultivation.

Keywords: Industry–Education Integration 3.0; AIGC Technology; Design Educators; Dynamic Capabilities; TPACK; University–Enterprise Collaboration

1. Introduction

Since the 1980s, the relationship between education and industry has gradually shifted from one-way adaptation to reciprocal interaction. In vocational education and applied higher education, concepts such as “industry–education integration” and “work–study integration” have been continuously deepened, while university–enterprise cooperation has evolved from relatively simple arrangements for internships and practical training into diversified forms, including order-based talent cultivation, co-constructed training bases, collaboratively developed curricula, and jointly implemented project-based practices. With the continuous advancement of educational system reform and industrial restructuring, industry–education integration has increasingly been positioned at the intersection of educational supply optimization, talent cultivation model reconstruction, and industrial innovation. Its core function is no longer limited to enabling universities to supply skilled talent to enterprises; rather, it emphasizes the organic alignment among the education chain, talent chain, industrial chain, and innovation chain, thereby fostering closer coordination among educational resource allocation, talent cultivation objectives,

and industrial development needs [1].

In recent years, institutional arrangements surrounding the high-quality development of vocational education and applied higher education have been continuously improved, further highlighting the strategic importance of industry–education integration within the talent cultivation system. Relevant policy orientations have consistently emphasized that cities, industries, enterprises, and universities should serve as important carriers for embedding industrial needs, technical standards, occupational competencies, and authentic projects into the entire process of talent cultivation. Through the construction of practical training bases, university–enterprise collaborative education, industry–university–research cooperation platforms, and enterprises’ in-depth participation in curriculum development and practical teaching, a more stable and profound interactive mechanism between the educational system and the industrial system can be established [2]. In this process, the practical focus of industry–education integration has gradually shifted from external forms of collaboration, such as cooperative education, internships and training, and job-position matching, toward deeper collaborative relationships characterized by resource co-construction, process co-management, technological co-creation, outcome sharing, and value feedback.

It can therefore be argued that industry–education integration is no longer merely a means of addressing students’ insufficient practical opportunities or enterprises’ demands for talent matching. Instead, it has progressively evolved into an important mechanism for promoting educational innovation, industrial upgrading, and the reconstruction of talent competencies. Its developmental stage has also moved beyond the foundational cooperation model, which was mainly characterized by internships, practical training, and order-based cultivation, and has entered the 3.0 stage, marked by multi-actor collaboration, resource co-construction, technological co-creation, and value feedback. At this stage, the relationships among universities, enterprises, industry organizations, and research platforms have become more closely interconnected, the content of collaboration has become more complex, and the objectives of cooperation have expanded from the single function of talent supply to the

comprehensive development of teacher capacity enhancement, curriculum system renewal, technology application transformation, and support for industrial innovation.

In the field of design, AIGC technology is transforming design processes, modes of creative generation, paradigms of visual expression, and models of industrial service. Technologies such as text-to-image generation, intelligent layout design, parametric modeling, virtual scene generation, and user profile analysis have been increasingly embedded in brand design, interaction design, digital media design, industrial design, and cultural and creative design. These developments have enabled design activities to demonstrate new characteristics of human–AI co-creation, data-driven decision-making, rapid iteration, and cross-domain integration. Accordingly, design educators should no longer be regarded merely as transmitters of traditional design knowledge; rather, they should also become sensors of industrial technologies, translators of teaching scenarios, integrators of university–enterprise projects, and facilitators of students’ innovation capacity.

However, the current cultivation of design educators’ AIGC-related capacities still faces three major challenges. First, technology training often remains at the level of tool operation, lacking systematic alignment with design curricula, project-based practice, and teaching evaluation. Second, within university–enterprise cooperation, the transformation of enterprises’ technological experience into teaching content remains insufficient, making it difficult for educators to develop sustainable technological feedback capacity. Third, existing studies have largely focused on mechanisms of industry–education integration or the application of AIGC in teaching, while relatively limited attention has been paid to explaining how educators reconstruct their capacities in rapidly changing technological environments from the perspective of dynamic capabilities. Based on this, the present study introduces dynamic capabilities theory and the TPACK model to analyze the formation logic of design educators’ AIGC technological feedback capacity and further constructs a university–enterprise collaborative cultivation mechanism.

2. The Connotation and Dimensional Extension of Dynamic Capabilities and Their

Application in Design Teacher Education

The concept of dynamic capabilities was first proposed by Teece and Pisano (1994). Dynamic capabilities refer to an organization's ability to integrate, build, and reconfigure internal and external resources in response to rapidly changing environments [3]. At their core, dynamic capabilities emphasize an organization's proactive adaptation to changes in the external environment and its pursuit of sustainable development through the effective integration, reconfiguration, and innovation of existing resources and capabilities. In essence, dynamic capabilities represent a "capacity to change capabilities." They go beyond an organization's existing static capabilities and emphasize rapid response and adjustment in complex and volatile market environments. Dynamic capabilities mainly comprise three key dimensions. When analyzed from an educational perspective and integrated with the TPACK model, their role in design teacher education becomes clearer.

2.1 The Capability to Sense Opportunities and Threats: An Analysis Based on the TPACK Model

Teece, Pisano, and Shuen further defined dynamic capabilities as the processes through which organizations integrate, build, and reconfigure capabilities in order to adapt to environmental change, highlighting the continuity of "sensing opportunities–seizing opportunities–reconfiguring resources" [4]. This theory was originally used primarily to explain how enterprises maintain competitive advantage in uncertain market environments; however, its core logic is also applicable to teacher capacity development in the context of rapid technological iteration. For design educators, dynamic capabilities are not equivalent to the ability to operate a single software tool. Rather, they refer to educators' comprehensive capacity to sense industrial changes, understand pedagogical needs, integrate university–enterprise resources, transform technological experience, and continuously update curricula and research practices amid the ongoing development of AIGC technology.

The capability to sense opportunities and threats constitutes a foundational dimension of dynamic capabilities. In rapidly changing market environments, enterprises need to identify various external opportunities and threats,

including technological innovation, changes in market demand, and adjustments in policies and regulations. In the field of design, the rapid development of AIGC technology requires design educators not only to perceive the opportunities brought about by technological change, such as improving design efficiency and expanding design creativity through AIGC technology, but also to recognize potential challenges, such as its impact on designers' traditional skills and issues concerning intellectual property rights.

The TPACK model provides an educational framework for explaining teachers' capacity for technology integration. Mishra and Koehler argued that effective technology integration by teachers is not a simple addition of technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK). Instead, it requires the formation of technological pedagogical content knowledge through the interaction among these three domains [5]. Schmidt et al. further developed a TPACK assessment instrument, emphasizing that teachers' technology integration capacity can be identified and evaluated through a multidimensional knowledge structure [6].

When design educators sense opportunities and threats related to AIGC technology, they need to mobilize their own content knowledge (CK) to understand how AIGC technology affects the professional knowledge system of design, including how it changes design processes and design thinking. At the same time, with the support of pedagogical knowledge (PK), they need to consider how AIGC technology can be incorporated into teaching processes and how teaching methods can be innovated, for example, by using AIGC-generated design cases for classroom discussion or project-based learning. Technological knowledge (TK) enables educators to understand the basic principles of AIGC technology and the use of relevant tools. Only when teachers possess the ability to integrate these types of knowledge, that is, TPACK, can they more sensitively perceive the opportunities and threats associated with the pedagogical application of AIGC technology, such as whether AIGC technology can be used to address teaching difficulties or whether inappropriate technology use may undermine teaching effectiveness.

Compared with enterprises, teacher education differs theoretically in terms of sensing

capabilities. Enterprises sense opportunities and threats primarily on the basis of market competition and commercial interests, whereas teacher education places greater emphasis on the achievement of talent cultivation goals and the improvement of educational quality. For instance, enterprises may pay more attention to the short-term economic benefits brought about by AIGC technology, such as the rapid launch of profitable products. Teachers, by contrast, need to consider from a longer-term perspective how AIGC technology can be used to cultivate students' innovation capacity and future occupational competitiveness. Nevertheless, the two also demonstrate a certain degree of alignment. Enterprises' market-oriented perception of AIGC technology can provide teachers with information about industry trends, while teachers can transform such information into teaching content and cultivate design talent that meets market demands, thereby facilitating the alignment between education and industry.

2.2 The Capability to Seize Opportunities: Practical Transformation under the TPACK Model

Once enterprises perceive an opportunity, they need to take prompt action to transform that opportunity into an actual competitive advantage. This requires rapid decision-making, resource integration, and execution capability. In the field of design, when enterprises identify opportunities for applying AIGC technology in a particular design segment, they often rapidly assemble professional teams, integrate relevant technological and human resources, and develop design solutions. In teacher education, seizing the pedagogical opportunities brought by AIGC technology requires similar capabilities. Teachers need to make timely decisions, based on TPACK, regarding how to integrate AIGC technology into teaching practice.

For example, when teachers recognize that AIGC technology can be used to stimulate students' creativity, they need to integrate teaching resources, such as using the university's digital teaching platform and introducing relevant AIGC design tools. They must also combine their teaching experience with disciplinary knowledge to design teaching activities based on AIGC technology. During implementation, teachers should guide students in using AIGC technology for design practice, such as organizing AIGC-assisted design

projects in which students' design capacity and teamwork skills can be cultivated.

Compared with the process through which enterprises seize opportunities, the theoretical distinction in teacher education lies in differences in goal orientation. Enterprises pursue commercial success and market share, whereas teachers aim to promote students' holistic development and enhance their knowledge and skills. Enterprises may place greater emphasis on short-term product development and market promotion, while teachers need to guide students progressively in acquiring knowledge and skills over the course of long-term teaching processes. However, there is also alignment between the two. Enterprises' practical experience in applying AIGC technology can provide teachers with teaching cases, while teachers can draw on enterprises' project management experience to optimize the organization and implementation of teaching activities, thereby improving students' practical abilities.

2.3 The Capability to Maintain Sustained Competitiveness: The Dynamic Development of TPACK

Maintaining sustained competitiveness is the core objective of dynamic capabilities. In the field of design, with the continuous development and application of AIGC technology, both enterprises and educational institutions need to make ongoing investments in research and development as well as teaching resources. They must continuously enhance their capabilities in applying AIGC technology and cultivate design talent with innovation capacity and practical competence. From the perspective of the TPACK model, design educators who seek to maintain sustained competitiveness need to continuously update and develop their own TPACK.

As AIGC technology evolves, teachers' content knowledge (CK) needs to be continuously expanded so that they can understand the latest applications and development trends of AIGC technology in the field of design. Their pedagogical knowledge (PK) also needs to be continuously innovated in order to explore teaching methods for AIGC technology that are more suitable for students. Their technological knowledge (TK) must likewise be continuously improved so that they can master new AIGC tools and techniques for technological

application. Only in this way can teachers continuously cultivate design talent capable of adapting to market changes through their teaching practices.

Compared with the ways in which enterprises maintain sustained competitiveness, teacher education exhibits theoretical differences. Enterprises mainly maintain competitiveness by increasing research and development investment and optimizing products and services, whereas teachers achieve this by improving teaching capacities and updating educational concepts. For example, enterprises may invest substantial resources in AIGC technology research and development in order to launch more competitive products. Teachers, however, incorporate new AIGC-related technological knowledge into teaching by participating in training programs and conducting teaching research. Nevertheless, the two are mutually compatible. Enterprises' continuous investment in AIGC technology promotes industrial development and provides teachers with more teaching materials and practical cases. In turn, the high-quality design talent cultivated by teachers provides talent support for enterprise development.

The three dimensions of dynamic capabilities are interrelated and mutually reinforcing, jointly forming an organic whole. In the cultivation of design educators' AIGC technological feedback capacity under industry–education integration 3.0, analysis based on the TPACK model helps clarify how teachers continuously improve their AIGC technological feedback capacity through university–enterprise cooperation and adapt to the rapid development and transformation of the design field. At the same time, it also clarifies the theoretical differences and alignment between teacher education and enterprises in the application of dynamic capabilities, thereby providing a theoretical basis for constructing a more effective university–enterprise collaborative mechanism.

3. Demand Analysis of Design Education for Design Educators' AIGC Technological Feedback Capacity in the Context of Industry–Education Integration 3.0

3.1 New Requirements for Teachers' Competencies Brought by Changes in the Design Industry

AIGC technology is reshaping the landscape of

the design industry at an unprecedented speed. It has generated profound changes in key dimensions such as design tools, design processes, and creative generation, thereby promoting the development of the industry toward greater intelligence, digitalization, and diversification. Traditional design tools mainly rely on designers' manual operation and experiential judgment, whereas generative design tools can rapidly generate multiple solutions based on textual instructions, image samples, style parameters, and scenario constraints [7]. Taking image generation, intelligent retouching, assisted layout design, three-dimensional modeling, and virtual scene generation tools as examples, the focus of designers' work is shifting from “mere execution” to “prompt construction, solution selection, style control, and outcome redesign.” AIGC also demonstrates potential in industrial Internet-based training platforms and cultural and creative design courses by improving design efficiency, enriching teaching resources, and expanding practical scenarios [8].

To further understand the new requirements that this transformation places on teachers' competencies, this study conducted a questionnaire survey among 300 design educators and obtained 285 valid responses. The survey results show that as many as 85% of the respondents believe that AIGC technology has had a significant impact on the design industry, and that this impact is reflected in multiple dimensions.

In terms of design tools, traditional design tools rely largely on designers' manual operation, whereas tools empowered by AIGC technology have achieved a qualitative leap. Taking graphic design software as an example, Adobe Firefly integrates generative AI technology. Designers can input textual descriptions, and the software can rapidly generate corresponding graphics and make detailed adjustments according to subsequent instructions. In the field of industrial design, intelligent design software, based on the principles of parametric design, can automatically generate multiple design solutions according to product functional requirements, material properties, and other parameters, while also conducting performance simulation and optimization. This substantially improves design efficiency and quality. In interior design projects, with the support of AIGC technology, designers can use virtual reality (VR) and augmented

reality (AR) technologies to communicate with clients in an immersive manner, quickly obtain needs and feedback, and use 3D modeling software and AIGC algorithms to rapidly construct interior spatial models. These tools can present the effects of different decoration styles and layout schemes. After a design scheme is finalized, they can also automatically generate construction drawings and material lists, thereby enabling efficient coordination between design and construction. The survey data indicate that 78% of teachers perceive strong student demand for such intelligent design tools in teaching, yet only 35% of teachers believe that they can proficiently apply relevant tools in teaching practice.

AIGC technology has also stimulated the diversified development of design creativity. It provides designers with abundant sources of creative inspiration and can generate distinctive design concepts and creative directions through the learning and analysis of large volumes of design cases and data. In brand design, AIGC technology can analyze brand images and market trends across different industries, provide innovative brand visual elements and design concepts, support cross-domain and interdisciplinary creative integration, and promote deep integration among design, technology, culture, and art. It can also generate customized design solutions according to users' individualized needs. The survey further shows that 92% of teachers acknowledge the role of AIGC technology in promoting the diversification of design creativity, whereas only 42% report that they can effectively guide students in using this technology for creative design.

3.2 Transformation of Design Educators' Competency Structures under Emerging Trends

With the introduction of a series of policy initiatives concerning industry–education integration, the deep integration of education and industry has become an inevitable trend. This development has also placed new demands on the competency structures of design educators. In response to industrial transformation driven by AIGC technology, design educators need to undergo comprehensive and in-depth changes in their competency structures in order to cultivate design talent capable of meeting the needs of the new era.

In terms of knowledge structure, the survey results show that 70% of teachers believe they have deficiencies in foundational knowledge related to AIGC technology. Among them, the proportions of teachers who report relatively low levels of mastery of artificial intelligence principles, machine learning algorithms, and big data analysis are 55%, 62%, and 58%, respectively. Teachers therefore need to move beyond a single disciplinary knowledge structure in design and develop a multidisciplinary and interdisciplinary knowledge system. They should not only acquire a deeper understanding of the foundational knowledge of AIGC technology but also strengthen the integration of design with computer science, psychology, sociology, and other disciplines. For example, in user interface design, psychological knowledge can be used to optimize user experience, while computer science technologies can be employed to realize intelligent interaction design. At the same time, the transformation of teachers' knowledge structures also involves the dimension of educational ethics. In teaching practice, teachers need to guide students in the proper use of AIGC technology, prevent plagiarism and infringement, and cultivate students' awareness of intellectual property rights and ethical norms.

In terms of skill level, as shown in the competency gap matrix (Table 1), only 30% of teachers have proficient operational skills in AIGC design tools, 25% are capable of using AIGC technology for design project management and collaboration, and 18% possess a certain level of programming capability for extending the functions of AIGC design tools. Teachers therefore need to shift from traditional design skills toward digital and intelligent design skills. They should proficiently master various AIGC design tools, integrate them into teaching practice, and develop project management and collaboration capabilities, as well as a certain degree of programming ability.

Innovative thinking is a core element in the transformation of design educators' competency structures. The survey finds that only 38% of teachers believe they possess strong interdisciplinary innovative thinking and can guide students in using AIGC technology to conduct interdisciplinary design practice. Teachers need to cultivate their own interdisciplinary innovative thinking, encourage students to break through the limitations of traditional design thinking, and develop data-

driven innovative thinking. They should become skilled at using AIGC technology to analyze design data and identify points of innovation. At the same time, they need to cultivate students' critical thinking and independent innovation capacity, guiding students to rationally analyze and evaluate design solutions generated by AIGC technology and to engage in independent

innovation on the basis of informed reference. At the level of educational ethics, teachers must ensure that students follow ethical and legal norms in the innovation process and do not misuse AIGC technology for unfair competition or for infringing upon the rights and interests of others.

Table 1. Competency Gap Matrix of Design Educators' AIGC Technology-Related Skills

Competency Type	Proportion of Teachers Possessing This Competency	Degree of Competency Gap
Operational skills in AIGC design tools	30%	Relatively large
Project management and collaboration capability using AIGC technology	25%	Large
Programming capability for extending the functions of AIGC tools	18%	Extremely large

4. Construction of a University–Enterprise Collaborative Mechanism Based on the Dynamic Capabilities Model

4.1 Introduction and Adaptation of the Dynamic Capabilities Model

The dynamic capabilities model is highly compatible with industry–education integration and plays a key role in explaining university–enterprise collaborative innovation and enhancing teachers' AIGC technological feedback capacity. The core connotation of industry–education integration lies in realizing the deep integration of education and industry, building a bridge that organically connects the education chain, talent chain, industrial chain, and innovation chain, and cultivating high-quality and well-matched talent for industrial development. The dynamic capabilities model, by contrast, focuses on the dynamic regulation and optimization of organizational capabilities in response to changes in the external environment, thereby enabling sustainable development.

In the practical context of industry–education integration, both universities and enterprises face dynamic changes in market demand, technological innovation, and industrial upgrading. Taking the rapid development of AIGC technology in the field of design as an example, the dynamic capabilities model enables universities and enterprises to sensitively perceive the opportunities and challenges brought about by this technological transformation. For instance, AIGC technology creates opportunities for improving design efficiency and expanding creativity, while also generating challenges such as design style

homogenization and ambiguous copyright boundaries. On this basis, universities and enterprises can adjust their cooperation strategies in a timely manner, enhance teachers' AIGC technological feedback capacity, and meet the needs of design talent cultivation.

From the perspective of the developmental needs of industry–education integration, as this integration continues to deepen, universities and enterprises must possess the ability to respond flexibly and innovate continuously. The sensing, integration, and reconfiguration capabilities embedded in the dynamic capabilities model provide a solid theoretical foundation for this process. Sensing capability helps universities and enterprises capture market, technological, and policy-related information and provides a basis for cooperation-related decision-making. Integration capability promotes the integration of resources and capabilities between the two sides, realizes complementary advantages, and improves cooperation efficiency. Reconfiguration capability encourages universities and enterprises to adjust cooperation models and organizational structures in response to change, thereby ensuring the sustainable development of collaborative innovation. For the cultivation of design educators' AIGC technological feedback capacity, the application of this model enables universities and enterprises to effectively integrate educational and industrial resources, actively conduct teacher training, curriculum development, and research projects, and enhance teachers' technological application and pedagogical innovation capacities. Meanwhile, the model also provides a dynamic analytical framework for university–enterprise collaborative innovation and supports the

optimization of cooperative relationships and collaborative innovation capacity.

It should be clarified that enterprises and teachers differ significantly in terms of dynamic capabilities. Enterprises' dynamic capabilities are mainly oriented toward market performance, with the pursuit of profit maximization and competitive advantage as their core objectives [3]. Teachers' dynamic capabilities, however, must respond simultaneously to technological iteration and educational goals. Teachers not only need to keep pace with the development of AIGC technology but also need to ensure that it is reasonably incorporated into the teaching process in order to achieve the educational goal of cultivating innovative design talent. Compared with enterprises, teacher capability reconfiguration needs to be embedded within the TPACK framework [6]. Within the TPACK framework, teachers' technological knowledge (TK) enables them to master the principles, tools,

and application scenarios of AIGC technology; pedagogical knowledge (PK) helps them design scientifically sound teaching processes and integrate AIGC technology into teaching activities; and design content knowledge (CK) ensures that teachers transmit professional and systematic design knowledge in teaching. The interaction among these three types of knowledge, as shown in Figure 1, jointly supports teachers in enhancing their AIGC technological feedback capacity. For example, when teaching an AIGC-assisted graphic design course, teachers can rely on technological knowledge (TK) to proficiently operate AIGC design tools, use pedagogical knowledge (PK) to design teaching activities such as case-based learning and practical operation, and apply design content knowledge (CK) to explain the principles of graphic design and creative concepts, thereby guiding students to produce high-quality graphic design works.

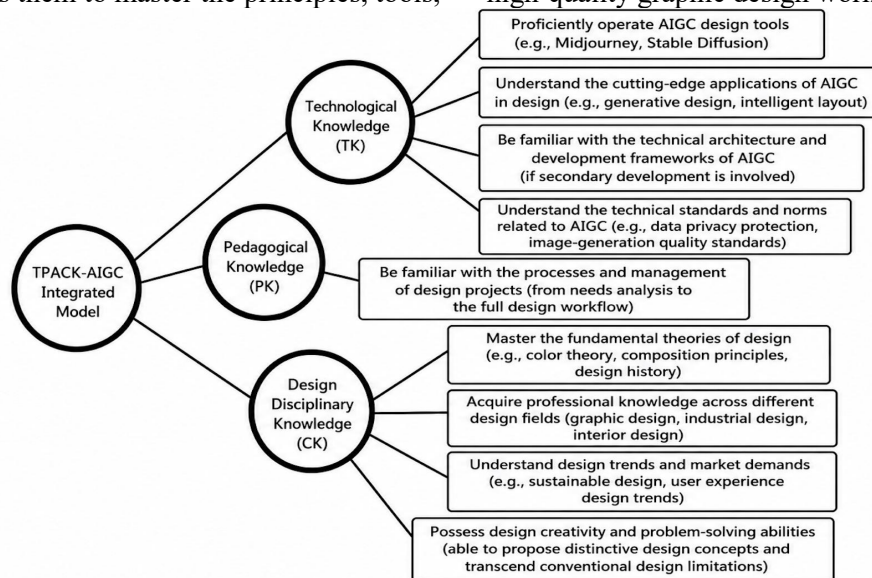


Figure 1. TPACK-AIGC Integrated Model

4.2 Framework Design of the University-Enterprise Collaborative Mechanism

4.2.1 Collaborative goal setting

In the broader context of industry-education integration 3.0, the overall goal of university-enterprise collaboration in cultivating design educators' AIGC technological feedback capacity is to comprehensively improve teachers' overall literacy in the field of AIGC technology and to realize the deep integration and coordinated development of education and industry. Specifically, through university-enterprise cooperation, teachers should be able to master the core principles and cutting-edge

applications of AIGC technology, organically integrate them into design teaching, research, and practice, and cultivate high-quality and innovative design talent that meets the needs of industrial development.

To achieve this overall goal, clear phased objectives need to be established. In the first stage, the primary objective is to enhance teachers' understanding and basic application ability regarding AIGC technology. By organizing teachers to participate in AIGC technology training courses, academic lectures, and related activities, they can comprehensively understand the developmental history, basic principles, and application scenarios of AIGC

technology. Teachers should master the operation of common AIGC design tools, such as intelligent graphic design software and generative AI design platforms, and be able to use these tools for basic design practice. At this stage, an initial communication and cooperation mechanism between universities and enterprises should also be established, clarifying the basic responsibilities and modes of cooperation of both parties in cultivating teachers' AIGC technological capacity.

In the second stage, the focus is on deepening teachers' understanding and application of AIGC technology and improving their capacity for pedagogical innovation. Teachers should be able to deeply integrate AIGC technology with design teaching content and innovate teaching methods and curriculum systems. They should develop design courses based on AIGC technology, introduce authentic enterprise project cases, and conduct project-based teaching to cultivate students' practical abilities and innovative thinking. Teachers should also actively participate in university-enterprise research projects, use AIGC technology to conduct frontier research, and explore new theories, methods, and technologies in the field of design. Universities and enterprises should strengthen resource sharing and collaborative innovation and jointly establish AIGC technology research and development centers or innovation laboratories to provide teachers with better research conditions and practical platforms [9].

In the third stage, the objective is to achieve a comprehensive enhancement of teachers' AIGC technological feedback capacity and to promote the transformation and application of research outcomes. Teachers should have the capacity to transform research outcomes into actual productive forces, collaborate with enterprises in technological research and development and product innovation, and apply AIGC technology to design practice in order to create value for enterprises. Teachers should also be able to guide students in participating in enterprises' actual design projects and cultivate students' abilities to solve practical problems and collaborate in teams. Universities and enterprises should establish a sound evaluation and feedback mechanism to comprehensively assess the cultivation effects of teachers' AIGC technological feedback capacity, adjust cultivation strategies and methods in a timely

manner, and continuously optimize the teacher capacity cultivation system [10].

4.2.2 Collaborative subjects and responsibility definition

In terms of educational cultivation, universities should formulate scientific and reasonable teacher training plans and organize teachers to participate in various AIGC technology training programs and academic exchange activities. By cooperating with professional training institutions, universities can offer specialized AIGC technology training courses and invite industry experts and technical specialists to teach teachers, thereby improving teachers' technical level and application capacity. Universities should also optimize curriculum design, incorporate AIGC-related courses into the design curriculum system, and provide platforms for teachers' teaching practice. Teachers should be encouraged to carry out teaching reform and innovation, explore teaching models and methods based on AIGC technology, and improve teaching quality.

In terms of resource support, universities should increase investment in teaching and research resources related to AIGC technology. They should build AIGC technology laboratories, equip them with advanced hardware devices and software tools, and provide a sound practical environment for teachers and students. They should also purchase relevant databases and academic resources to facilitate teachers' academic research and teaching preparation. In addition, universities should strengthen communication and cooperation with enterprises, actively seek enterprise support and collaboration, and provide teachers with more practical opportunities and project resources.

In terms of practical guidance, enterprises should select experienced technical personnel and managers to serve as teachers' practice mentors and provide teachers with on-site guidance and practical cases. In actual enterprise projects, these mentors can guide teachers in using AIGC technology to solve practical problems and improve teachers' practical capacity and project management capacity. Enterprises should provide internship and practice opportunities for teachers, enabling them to gain an in-depth understanding of enterprise production processes and technological applications and to enhance their understanding of industrial needs.

In terms of demand guidance, enterprises should promptly provide universities with feedback on

the latest development trends and technological needs of the design industry, thereby offering direction for universities' talent cultivation as well as teachers' teaching and research. Enterprises should participate in professional development and curriculum design, integrate practical enterprise needs and industry standards into teaching content, and ensure that the cultivated talent meets the needs of enterprises and the market. Enterprises should also cooperate with universities in research projects, jointly address key technological challenges in the application of AIGC technology in design, and promote the transformation and application of research outcomes.

As the core subjects of capacity cultivation, teachers should actively participate in the learning and application of AIGC technology. They should continuously improve their AIGC technology application capacity by participating in training, engaging in independent learning, and conducting practical exploration, so as to master the latest development trends and application techniques of AIGC technology. In the teaching process, teachers should organically integrate AIGC technology with design teaching, innovate teaching methods and approaches, and stimulate students' learning interest and innovative thinking. Teachers should also actively participate in university-enterprise research projects, leverage their professional strengths, and provide technical support and solutions for enterprises. In addition, teachers should strengthen communication and exchange with enterprise practice mentors and continuously improve their practical capacity and overall quality.

4.2.3 Design of the collaborative operation process

To collaboratively enhance design educators' AIGC technological feedback capacity, universities and enterprises need to establish a scientific, reasonable, and efficient operation process. This process covers several key links, including market research, resource integration, capacity cultivation, outcome transformation, and communication and feedback. These links are closely connected and mutually influential, jointly promoting the enhancement of teachers' capacities and the deep integration of education and industry.

(1) Market research and needs analysis

Universities and enterprises should jointly conduct comprehensive and in-depth market

research to accurately grasp the development trends of the design industry and enterprises' specific demands for design educators' AIGC technological feedback capacity. Through multiple methods such as questionnaire surveys, enterprise interviews, and industry analysis, relevant information can be widely collected to clarify teachers' competency gaps in AIGC technology application, pedagogical innovation, and research transformation, and to determine directions for capacity enhancement.

Taking the Central Academy of Fine Arts × Tencent CDC virtual design project as an example, before the project was launched, the two parties jointly conducted research on the virtual design market. Through questionnaire surveys, they collected a large amount of information on enterprises' skill requirements for virtual designers' application of AIGC technology, such as proficiency in AIGC-assisted modeling and scene generation. Through interviews with industry experts, they learned that the virtual design industry expected teachers to integrate interdisciplinary knowledge into teaching, such as combining design with computer science and psychology to cultivate students' comprehensive literacy. Based on these research results, the competency gaps of teachers in teaching that integrates AIGC technology and virtual design were identified, providing a strong basis for the subsequent formulation of cultivation plans.

Using Nvivo software for analysis, initial concepts such as "virtual design market demand," "requirements for AIGC technology application skills," and "expectations for interdisciplinary teaching" were extracted during open coding. During axial coding, relevant concepts were categorized into themes such as "industry demand insight" and "technical teaching competency gaps." Through selective coding, the pathway of "clarifying teachers' competency gaps and improvement directions based on market research" was summarized. In other words, multi-method research was used to identify the market demand for AIGC technology in virtual design talent and to determine teachers' deficiencies and improvement directions in teaching capacity.

(2) Cultivation plan formulation and resource integration

Based on the results of needs analysis, universities and enterprises should jointly formulate personalized cultivation plans for

teachers' AIGC technological feedback capacity to ensure that cultivation objectives are closely aligned with industrial needs. Universities should integrate internal teaching resources, such as allocating outstanding faculty, optimizing curriculum design, and opening laboratories, to provide strong support for teacher capacity cultivation. At the same time, universities should actively expand external resources and establish cooperative relationships with enterprises and research institutions to achieve resource sharing. Enterprises, in turn, should provide practical projects, advanced technical equipment, senior industry experts, and other resources to create practical opportunities for teachers and offer professional guidance. The two parties should build a resource-sharing platform to promote the optimal allocation and efficient use of resources.

In the Tongji University × Alibaba Cloud "Metaverse Exhibition Hall Design Course" project, the two parties formulated a detailed teacher cultivation plan based on market demand for metaverse exhibition hall design talent. The university integrated core faculty resources from the design major, offered courses such as "Fundamentals of Metaverse Design" and "Applications of AIGC in Exhibition Hall Design," and opened its digital design laboratory. Alibaba Cloud provided metaverse-related technical equipment and practical projects, such as participation in actual metaverse exhibition hall design projects. The two parties also established an online resource-sharing platform that allowed teachers to access the latest industry materials and technical documents.

Through Nvivo coding analysis, concepts such as "internal university resource integration," "enterprise resource support," and "shared platform construction" were identified during open coding. During axial coding, these concepts were summarized under the category of "cultivation resource integration strategies." Selective coding further identified the pathway of "integrating multi-party resources to formulate and implement cultivation plans." That is, universities and enterprises respectively integrate their internal resources and jointly build a shared platform, thereby providing comprehensive support for cultivating teachers' AIGC technological feedback capacity.

(3) Capacity cultivation and practice

In accordance with the cultivation plan, universities and enterprises should jointly

organize teachers to participate in AIGC technology training and practical activities. Universities can improve teachers' theoretical level and teaching capacity by offering specialized courses, organizing academic lectures, and conducting teaching seminars. Enterprises can enhance teachers' practical and application capacities by providing internship positions, arranging practice mentors, and conducting project cooperation. During the cultivation process, teachers' individual differences should be fully considered, and differentiated cultivation services should be provided.

In the Guangzhou Academy of Fine Arts × ByteDance "AIGC Copyright Management Training" project, the university offered courses such as "Interpretation of AIGC Copyright Regulations" and "Case Analysis of Copyright Management" and invited industry experts to give lectures. ByteDance provided internship opportunities for teachers and arranged senior legal professionals as practice mentors to guide teachers in participating in actual AIGC copyright management projects. Personalized learning plans were developed according to teachers' knowledge foundations and career development plans. For example, teachers with a certain legal foundation were assigned more in-depth study of copyright litigation cases, while teachers with a design background focused more on copyright issues concerning AIGC in the field of design.

Through Nvivo coding analysis, concepts such as "diversified training methods," "personalized cultivation services," and "enterprise-based practical training" were extracted during open coding. During axial coding, these concepts were grouped into the category of "teacher capacity cultivation pathways." Selective coding further generated the pathway of "university-enterprise collaboration in differentiated capacity cultivation." Specifically, universities and enterprises enhance teachers' AIGC technological feedback capacity through various training methods and practical activities, while providing cultivation services according to individual teacher differences.

(4) Outcome transformation and application

After mastering AIGC technology, teachers apply it to teaching and research practice and generate corresponding outcomes. In teaching, teachers innovate teaching methods, improve teaching quality, and cultivate students with

innovation capacity and practical competence. In research, teachers cooperate with enterprises in research projects, promote the transformation and application of research outcomes, and create value for enterprises. Universities and enterprises should establish outcome transformation mechanisms to evaluate and promote teachers' outcomes and facilitate their effective application.

In the Central Academy of Fine Arts × Tencent CDC virtual design project, teachers applied the AIGC technology they had learned to teaching and innovated teaching methods, such as adopting project-based learning and allowing students to use AIGC technology in actual virtual design projects. Students created a series of high-quality virtual design works and won multiple awards in industry competitions. At the same time, teachers collaborated with Tencent CDC on research projects and developed new virtual design algorithms, which were applied to Tencent's virtual product design, improving user experience and market competitiveness. The two parties established an outcome evaluation mechanism, quantitatively assessed teachers' teaching and research outcomes, and promoted them through industry exhibitions, academic exchanges, and other channels.

Through Nvivo coding analysis, concepts such as "teaching outcome production," "research outcome transformation," and "outcome evaluation and promotion" were extracted during open coding. During axial coding, these concepts were summarized under the category of "outcome transformation and application strategies." Selective coding further identified the pathway of "promoting teachers' outcome transformation and realizing educational and industrial value." That is, teachers generate outcomes through teaching and research, while universities and enterprises jointly evaluate and promote these outcomes, thereby realizing their educational and industrial value.

(5) Communication and feedback optimization
Throughout the collaborative operation process, establishing an effective communication and feedback mechanism is crucial. Universities and enterprises should hold regular communication meetings to exchange information on the progress of cultivating teachers' AIGC technological feedback capacity, jointly discuss existing problems, and adjust cultivation strategies and methods in a timely manner. Feedback from teachers, students, and

enterprises should be widely collected, and the collaborative operation process should be continuously optimized and improved to ensure the efficient operation of the university–enterprise collaborative mechanism.

In the three typical cases discussed above, both universities and enterprises established regular communication mechanisms. For example, in the Tongji University × Alibaba Cloud "Metaverse Exhibition Hall Design Course" project, the two parties held online communication meetings once a month and offline exchange activities once a quarter. During these meetings and activities, both sides shared course progress, teachers' capacity improvement, and problems encountered. Based on teacher feedback, course content and practical project arrangements were adjusted; based on student feedback, teaching methods were improved; and based on enterprise feedback, the focus and direction of cultivation plans were optimized. Through continuous communication and feedback, the collaborative operation process was constantly improved, and the effectiveness of cultivating teachers' AIGC technological feedback capacity was enhanced.

Through Nvivo coding analysis, concepts such as "regular communication mechanisms," "multi-subject feedback collection," and "process optimization and adjustment" were identified during open coding. During axial coding, these concepts were summarized under the category of "communication feedback and process optimization." Selective coding further identified the pathway of "establishing communication and feedback mechanisms and continuously optimizing collaborative processes." In other words, by establishing communication mechanisms, collecting feedback from various parties, and optimizing collaborative processes based on that feedback, the cultivation of teachers' AIGC technological feedback capacity can be effectively promoted.

4.3 Key Elements and Safeguard Measures of the University–Enterprise Collaborative Mechanism

4.3.1 Resource sharing and integration mechanism

In terms of university–enterprise talent resource sharing, universities and enterprises should establish a normalized talent exchange mechanism. Universities can assign teachers to enterprises for temporary posts and practical training, allowing them to participate in actual

enterprise projects, understand the latest industry technologies and development trends, and improve their practical capacities. Enterprises can dispatch technical specialists and managers to universities as part-time teachers, bringing practical work experience and cases into the classroom and enriching teaching content. Universities and enterprises should jointly conduct talent cultivation projects, jointly formulate talent cultivation plans, and achieve seamless alignment in talent cultivation. In AIGC technology talent cultivation, universities and enterprises can jointly formulate curriculum systems, with enterprises providing practical projects and internship positions and universities being responsible for theoretical teaching, thereby jointly cultivating design educators with AIGC technology application capacity.

Universities and enterprises should strengthen technological exchange and cooperation and jointly conduct research on the application of AIGC technology in the field of design. Enterprises can open their advanced technologies and research outcomes to universities, providing technical training and practical opportunities for teachers. Universities, in turn, can leverage their research strengths to provide technical support and innovative ideas for enterprises [11]. Universities and enterprises can jointly establish AIGC technology research and development centers or laboratories to address technological problems and promote the innovative application of AIGC technology in design. In terms of design creativity generation, they can jointly develop AIGC-based creative generation algorithms to improve design efficiency and creative quality.

Universities and enterprises should also share experimental equipment, production equipment, and other resources. Universities can use enterprises' advanced production equipment to provide practical teaching platforms for teachers and students, enabling them to engage with actual production environments and advanced equipment. Enterprises can use university laboratory equipment to conduct technological research and product testing. By jointly building practical training bases and integrating equipment resources from both sides, universities and enterprises can provide support for cultivating teachers' AIGC technology practice capacity. In the field of virtual reality design, for example, universities and enterprises can jointly build virtual reality laboratories and

share virtual reality equipment to support teachers' teaching and research. The two parties should also establish information-sharing platforms to exchange industry trends, technological development trends, talent demand, and other information in a timely manner. Through such platforms, universities can understand enterprises' demands for design educators' AIGC technological capacity and adjust teaching content and methods accordingly, while enterprises can obtain university research outcomes and talent information to support their own development. Information sharing can thus promote communication and cooperation between universities and enterprises and optimize resource allocation.

4.3.2 Benefit distribution and incentive mechanism

The benefit distribution and incentive mechanism is key to stimulating the enthusiasm of collaborative subjects. A reasonable mechanism can ensure that universities and enterprises achieve mutual benefits in cooperation and promote the smooth development of work related to cultivating design educators' AIGC technological feedback capacity. In terms of benefit distribution principles, fairness, rationality, and mutual benefit should be followed. The principle of fairness requires that universities and enterprises distribute benefits reasonably according to their respective inputs and contributions, ensuring that the interests of both parties are treated fairly. Universities invest educational resources in teacher cultivation and curriculum development, while enterprises contribute to practical guidance and project provision. Therefore, the benefits generated by cooperative outcomes should be distributed according to these inputs and contributions.

The principle of rationality emphasizes that benefit distribution should conform to market rules and industry standards and should not be excessively biased toward either party. For example, the distribution of economic benefits from university–enterprise cooperation outcomes should refer to the distribution ratios of similar cooperative projects in the market to ensure a reasonable distribution plan [12]. The principle of mutual benefit requires that benefit distribution promote the common development of both universities and enterprises and achieve a win–win situation. Through reasonable benefit distribution, universities can improve the quality

of talent cultivation, while enterprises can obtain talent and technical support that meet their needs, thereby realizing mutual benefits.

In terms of benefit distribution methods, diversified approaches should be adopted according to the different characteristics and needs of cooperative projects. For research cooperation projects, benefits can be distributed according to the transformation income of research outcomes. When universities and enterprises jointly invest research and development resources and research outcomes are transformed into actual products or services that generate economic benefits, income can be distributed according to a pre-agreed ratio. For talent cultivation projects, enterprises can benefit by giving priority to selecting outstanding graduates and receiving talent training services from universities. Universities, in turn, can obtain practical teaching resources, support from part-time enterprise teachers, and cooperation funding from enterprises. During cooperation, benefit distribution can also be implemented through intellectual property sharing and technology equity participation, thereby motivating both universities and enterprises to actively participate in cooperation.

To stimulate the enthusiasm of collaborative subjects, a sound incentive mechanism should also be established. For universities, policy support and financial rewards can encourage active participation in university–enterprise cooperation. Universities that actively participate in cooperation and achieve significant results in cultivating teachers' AIGC technological feedback capacity may receive rewards such as financial subsidies and tax preferences. Internally, universities should also establish incentive mechanisms that give priority and support to teachers participating in university–enterprise cooperation in terms of professional title evaluation, performance assessment, and research project application. For enterprises, policy measures such as tax reductions and project support can encourage participation in teacher cultivation and university–enterprise cooperation. Enterprises that perform well in cultivating teachers' AIGC technological feedback capacity may receive rewards such as tax reductions and priority in undertaking relevant projects. Enterprises should also establish internal incentive mechanisms to provide material rewards and career development opportunities for employees who

participate in university–enterprise cooperation, thereby enhancing employee motivation.

4.3.3 Communication coordination and risk prevention mechanism

The communication coordination and risk prevention mechanism is an important safeguard for the effective operation of the university–enterprise collaborative mechanism. By establishing regular communication and coordination mechanisms and improving risk prevention measures, problems arising during collaboration can be resolved in a timely manner, and cooperation risks can be reduced. Universities and enterprises should establish multi-level communication channels, including regular cooperation meetings, liaison officers, and communication platforms. Cooperation meetings should be held regularly to enable both parties to engage in in-depth discussions on cooperation progress, existing problems, and future plans. Liaison officers should be responsible for daily communication and information transmission to ensure timely and accurate communication between the two parties [13]. Communication platforms can be either online information exchange platforms or offline cooperation offices, providing convenient communication environments for both sides.

In the cultivation of AIGC technological feedback capacity, regular communication and coordination mechanisms can help resolve issues related to teacher training content, practical project arrangements, and teaching resource sharing, thereby ensuring the smooth implementation of cultivation work. The content of communication and coordination should cover all aspects of cooperation, including the adjustment and clarification of cooperation objectives, the formulation and implementation of cooperation plans, the allocation and use of resources, the distribution and coordination of benefits, and the problems that arise during cooperation and their solutions. When market demand changes, universities and enterprises should adjust cooperation objectives and talent cultivation plans in a timely manner through communication and coordination to ensure that the cultivated teachers can meet market needs. In terms of resource allocation, both parties should reasonably adjust resource allocation plans according to cooperation progress and actual needs, thereby improving resource utilization efficiency.

To reduce cooperation risks, sound risk

prevention measures should also be formulated. Before cooperation begins, universities and enterprises should conduct sufficient risk assessment and identify potential risk factors, including market risks, technological risks, management risks, and legal risks. With regard to market risks, attention should be paid to changes in market demand and competitors' developments, and cooperation strategies should be adjusted in a timely manner. In the context of the rapid development of AIGC technology, market demand for AIGC technology applications may change, and university-enterprise cooperation should closely monitor market dynamics and adjust cultivation directions and cooperative projects in a timely manner.

With regard to technological risks, the management of technological research, development, and application should be strengthened to ensure technological reliability and safety. In the application of AIGC technology, attention should be paid to technological accuracy and stability in order to avoid cooperation failure caused by technical problems. In terms of management risks, a sound management system for cooperative projects should be established, the responsibilities and rights of both parties should be clarified, and supervision and management of the cooperation process should be strengthened. In terms of legal risks, comprehensive cooperation agreements should be signed to clarify the legal responsibilities and obligations of both parties and to avoid legal disputes that may affect cooperation. For foreseeable risks, response plans should be formulated in advance. When facing risks caused by technological upgrading, universities and enterprises should plan research and development directions in advance and increase investment to ensure technological advancement. For unforeseeable risks, an emergency risk response mechanism should be established so that measures can be taken promptly to reduce losses. When sudden market changes or policy adjustments occur, the emergency mechanism should be activated quickly, cooperation strategies should be adjusted, and the impact of risks on cooperation should be reduced.

5. Conclusion

In summary, industry-education integration has undergone multiple stages of development and

has now entered the 3.0 stage, with policy support strongly promoting its movement toward deep integration and collaborative innovation. Dynamic capabilities theory, which includes the three dimensions of sensing, seizing opportunities, and maintaining competitiveness, provides a strong framework for analyzing university-enterprise collaborative mechanisms. Against the background of AIGC technology reshaping the landscape of the design industry, design educators need to transform their competency structures in order to meet new industrial demands. The university-enterprise collaborative mechanism constructed based on the dynamic capabilities model clarifies collaborative objectives, subject responsibilities, and operational processes. Through resource sharing, reasonable benefit distribution and incentives, as well as effective communication coordination and risk prevention, the mechanism aims to enhance teachers' AIGC technological feedback capacity, promote the deep integration of education and industry, and cultivate high-quality innovative design talent.

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