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# TRIPLE INTEGRATION REFORM OF GRADUATION INTERNSHIP, DESIGN, AND THESIS FOR UNDERGRADUATES UNDER INDUSTRY-EDUCATION INTEGRATION IN THE DIGITAL INTELLIGENCE ERA

HaiBo Li, BoLin Li, Chen Pan*, JiaMing Guo*, JiaWei Wu
*Architecture and Civil Engineering Institute, Guangdong University of Petrochemical Technology, Maoming 525000, Guangdong, China.*
*Chen Pan and JiaMing Guo are both the corresponding authors.*
*Corresponding Authors: Chen Pan, JiaMing Guo*

**Abstract:** The digital intelligence era poses new challenges to the practical abilities and technological literacy of application-oriented design talents. To address the structural predicament identified in graduation practice of application-oriented undergraduate design programs—namely, "formalized internship, subjective design, and vague thesis"—this study takes the Environmental Design major of Guangdong University of Petrochemical Technology as a practical case. A reform model characterized by "digital intelligence technology empowerment, deep industry-education integration, and tripartite integration of internship, design, and thesis" (abbreviated as the "Three Integrations" model) is constructed and implemented. Specific measures include developing an AI teaching resource library, establishing a school-enterprise dual-tutor collaborative guidance mechanism, and creating an integrated teaching system that links the entire process of "internship-design-thesis." The results show significant improvements in students' comprehensive practical abilities and the quality of graduation design (thesis). Practice demonstrates that this model effectively enhances graduates' employment competitiveness and offers a reference framework paradigm for similar application-oriented undergraduate programs.
**Keywords:** Digital intelligence era; Industry-education integration; Application-oriented undergraduate; Graduation internship-design-thesis three integrations; Environmental design

## 1 INTRODUCTION

### 1.1 Research Background and Problem Statement

The digital intelligence era, characterized by artificial intelligence (AI) and big data, is reshaping the design industry, posing new challenges to the practical abilities, technical literacy, and innovative thinking of application-oriented design talents. The latest generation of information technologies—exemplified by big data and AI—is transforming global economic structures and industrial ecosystems at an unprecedented pace. AI is penetrating deeply into fields such as architectural and interior design, altering not only design tools and workflows but also profoundly influencing design thinking, design methodologies, and the future trajectory of the design industry. The advent of this "digital intelligence era" presents both a historic opportunity for leapfrog development in China’s design industry and a serious challenge to higher design education, which bears the critical responsibility of talent cultivation [1].

A series of national initiatives have been introduced to promote "AI+ education" and industry-education integration, such as *the Next Generation Artificial Intelligence Development Plan, the Action Plan for Artificial Intelligence Innovation in Colleges and Universities, and the Measures for the Sampling Inspection of Undergraduate Theses (Designs)* [2-4]. These policies explicitly call for strengthening the integration of technology into teaching and improving the quality of graduation practice. Nevertheless, graduation practice in application-oriented undergraduate design programs is currently plagued by the "three formalizations"—namely, formalized internship, subjective design, and vague thesis [5]. Specific problems include: (1) fragmented processes—internships are often superficial, designs rely on virtual topics, theses lack practical grounding, and the three components operate in isolation without progression; (2) shallow industry-education collaboration—university-industry cooperation remains at the level of nominal internships, with limited and intermittent participation of industry mentors; (3) inadequate digital intelligence empowerment—cutting-edge technologies such as AI and spatial quantitative analysis are insufficiently integrated into teaching, leaving students without systematic training in relevant tools; and (4) superficial quality control—management focuses on format review, with insufficient attention to topic value, practical depth, and innovation level.

### 1.2 Literature Review

Digital intelligence technologies are driving the design industry’s transition from "experience-driven" to "data and intelligence dual- driven." How to cultivate application-oriented talents who possess design fundamentals, technical application skills, and industrial adaptability has become a central issue [6].

#### *1.2.1 Transformation of design education under the background of digital intelligence technologies and industry- education integration*

Industry-education integration is the fundamental pathway for cultivating application-oriented design talents [6], yet traditional university- industry cooperation often falls into the trap of "shallow integration without depth." Li and Wang point out that reconstructing the industry-education integration model in the context of educational digitalization requires optimizing pathways along digital trends to better align talent cultivation with industrial needs [7]. Regarding digital intelligence empowerment, Han surveyed seven universities at home and abroad and proposed that empowering environmental design talent cultivation with artificial intelligence necessitates a comprehensive consideration of new course introduction, pedagogical reform, and assessment mechanism updates, designing an empowerment framework with six typical training models [8]. Shandong University of Art & Design has incorporated AI into its core strategy by establishing an AI Design Research Center and creating a required AI general education course, thereby building a new paradigm for empowering design education [9]. In the specific reform of the environmental design major, Zhi and Yu proposed the "three- stage and three- integration" practical teaching model, which explores an educational pathway that merges value guidance with digital technology through a progressive curriculum system and digital empowerment [10].

#### *1.2.2 The "three formalizations" predicament in graduation practice and explorations of integrated reform*

Graduation internship, design, and thesis are the core components of practical teaching in application- oriented undergraduate design programs. However, they have long suffered from the "three formalizations" predicament—fragmented processes, formalized internship, subjective design, and vague thesis [5]. In new engineering disciplines such as light chemical engineering, Mo et al. constructed a project- based teaching reform titled "real problem solving, dual- tutor co- education, three- real training" [11]. By introducing real technical challenges from enterprises and implementing collaborative guidance by both on- campus and industry supervisors, this reform provides replicable experience for industry- education integration in graduation design (thesis). Moreover, Rao also explored innovative practices in collaborative education for graduation design under the new engineering background [12].

#### *1.2.3 Research gap and positioning of this study*

In summary, the current research has the following shortcomings. First, there is a lack of an integrated reform scheme that truly connects the three components of "internship, design, and thesis"; existing explorations are mostly limited to dual- component integration such as "internship plus employment" or "design plus thesis." Second, the integration of digital intelligence technologies remains largely at the course teaching level, without forming a systematic empowerment framework covering the entire graduation practice process. Third, comprehensive solutions to the "three formalizations" predicament of design disciplines are relatively absent, and a synergistic mechanism between industry- education integration and digital intelligence empowerment remains underdeveloped. Based on this, this study takes the Environmental Design major of Guangdong University of Petrochemical Technology as a practical case, constructing and implementing a reform model of "digital intelligence technology empowerment, deep industry- education integration, and tripartite integration of internship, design, and thesis" (the "Three Integrations" model). By developing an AI teaching resource library, establishing a school- enterprise dual- tutor collaborative guidance mechanism, and creating an integrated teaching process that links internship, design, and thesis, this paper aims to provide a systematic reform solution and practical paradigm for application- oriented undergraduate design programs to resolve structural difficulties and respond to the new requirements of talent cultivation in the digital intelligence era.

### 1.3 Research Gap and Objectives

Based on the literature analysis above, the innovative orientation of this study is threefold: first, to break down the barriers among the three components—internship, design, and thesis—and build an integrated teaching system; second, to systematically embed digital intelligence technologies into the entire graduation practice process rather than integrating them only partially; third, to establish an institutionalized, full- process school- enterprise dual- tutor collaborative mechanism. To this end, this study takes the Environmental Design major of Guangdong University of Petrochemical Technology as a pilot, exploring and validating the "Three Integrations" reform model characterized by "digital intelligence technology empowerment, deep industry- education integration, and tripartite integration of internship, design, and thesis" [13].

## 2 THEORETICAL BASIS AND REFORM APPROACHES

### 2.1 Definition of Core Concepts

In this study, the "three integrations of graduation internship, design, and thesis" refers to breaking down the barriers in traditional teaching that treat graduation internship, graduation design, and graduation thesis as three independent and separate instructional components. By integrally designing teaching content, coordinating teaching schedules, and synergistically allocating guidance resources, a spiral, logically coherent practical teaching chain is constructed. This chain takes internship as the starting point (problem identification), design as the medium (analysis and attempted problem-solving), and thesis as the destination (method refinement and effectiveness validation).

### 2.2 Three Major Theoretical Foundations

The reform practice of this study is rooted in the intersection of three major theories. First, constructivist learning theory. This theory holds that knowledge is not passively received but actively constructed by learners through interaction with their environment. Authentic, complex situations are necessary conditions for effective learning to occur. This study places students in authentic industry project contexts (graduation internship), allowing them to actively explore, apply, and integrate knowledge (including new AI tools) while solving real-world problems (graduation design), and ultimately to organize and elevate their own cognition through thesis writing [14,15]. Second, outcome-based education (OBE) theory. OBE emphasizes a backward design of teaching systems and evaluation criteria guided by the final learning outcomes (knowledge, abilities, competencies) that students are expected to achieve. The reform in this study follows OBE logic: first, identify the core competencies that "application-oriented design talents in the digital intelligence era" should possess (e.g., AI tool application, complex problem solving, academic norm expression), then backward-reconstruct the teaching objectives, content, and methods for graduation internship, design, and thesis, and establish a corresponding multi-faceted evaluation system (e.g., process evaluation, university-industry joint evaluation) [16-18]. Third, collaborative education theory. The synergetics theory founded by German physicist Hermann Haken provides an important theoretical foundation for collaborative education [19], and the multi-party collaboration theory proposed by Barbara Gray further reveals the synergistic mechanisms of cross-organizational cooperation [20]. This theory emphasizes that different actors (e.g., schools, enterprises, society) form educational synergy through goal alignment, resource sharing, and process coordination, achieving an effect where "1+1>2." This study establishes a "dual-tutor" joint guidance mechanism involving on-campus and industry supervisors, thereby complementing theoretical advantages (on-campus supervisors) with practical advantages (industry supervisors). It also aligns technological resources with teaching needs through the construction and sharing of an AI teaching resource library.

### 2.3 Design of the Overall Framework for Reform

Based on the above background and guided by the intersection of constructivist learning, OBE, and collaborative education theories, this study constructs a "Three Integrations" teaching reform model characterized by "digital intelligence technology empowerment, deep industry-education integration, and tripartite integration of graduation internship, design, and thesis." The core logic of this model is "one core, two pillars, three links, four outcomes": taking the enhancement of comprehensive practical abilities of application-oriented design talents in the new digital intelligence era as the center; taking "deep industry-education integration" and "digital intelligence technology empowerment" as the two pillars; restructuring graduation internship, design, and thesis into three logically progressive stages—"internship for problem identification, design for analysis and solution, thesis for theoretical synthesis"; and finally producing four types of outcomes: enhanced student abilities, construction of teaching resources, tangible achievements, and a replicable reform model (Figure 1).

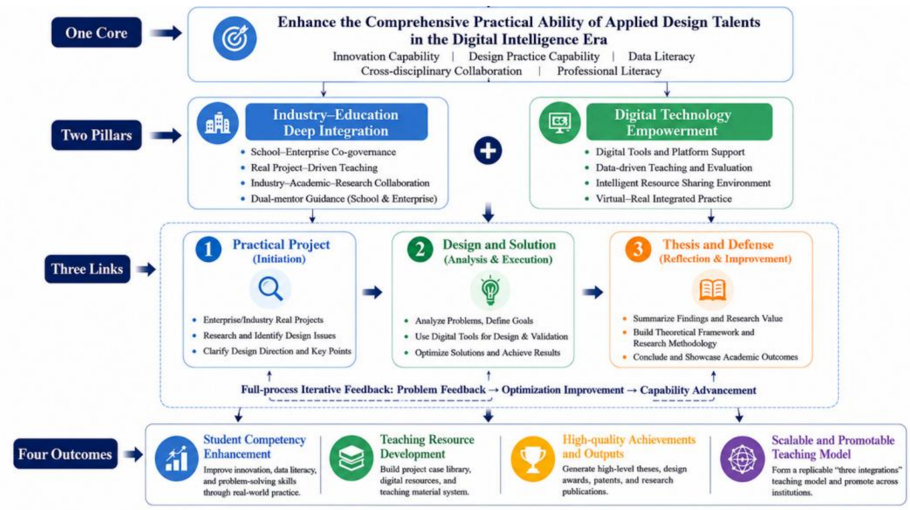


**Figure 1** "Three Integrations" Teaching Reform Model

## 3 REFORM DESIGN

Based on the "Three Integrations" reform model described above and its core logic of "one center, two pillars, three stages, four outputs," this study further refines the reform objectives into three dimensions: system construction, quality improvement, and mechanism development. An overall reform framework characterized by "dual-wheel drive, three-stage integration, and four-dimensional support" is established to comprehensively enhance the practical teaching system for graduation in the environmental design major.

### 3.1 Reform Objectives

(1) System construction objective: Break down the barriers among graduation internship, graduation design, and

graduation thesis, and build a tripartite graduation practice teaching system of "artificial intelligence + industry practice + theoretical methods," forming an integrated teaching model with aligned objectives, coherent content, synergistic processes, and connected evaluation.
(2) Quality improvement objective: Comprehensively solve the problems of "formalized internship, subjective design, and vague thesis," ensure that no less than 90% of students' graduation topics originate from real practice, steadily increase the excellence rate of graduation theses (designs) in spot checks, and significantly enhance students' ability to apply digital intelligence technologies.
(3) Mechanism development objective: Establish a stable and sustainable school-enterprise dual-tutor joint guidance mechanism, build a systematic artificial intelligence teaching resource library, and improve the full-process quality monitoring and feedback optimization mechanism.

### 3.2 Reform Framework

This study follows the logical path of "mechanism construction→resource development→teaching implementation→evaluation feedback→iterative optimization" to build the overall reform framework of "dual-wheel drive, three-stage integration, and four-dimensional support." "Dual-wheel drive" refers to digital intelligence technology empowerment and deep industry-education integration. "Three-stage integration" refers to the deep integration of the three components: graduation internship, graduation design, and graduation thesis. "Four-dimensional support" refers to institutional support, team support, resource support, and platform support.
During implementation, the environmental design major serves as a pilot, with three rounds of progressive teaching practice carried out consecutively. Each round is optimized and adjusted based on feedback from the previous round, gradually improving the teaching process, guidance mechanism, resource system, and evaluation criteria, ultimately forming a mature and stable integrated teaching model.

## 4 THE CORE CONTENT OF THE REFORM AND ITS IMPLEMENTATION PATHWAY

### 4.1 Establish a Dual-mentor Collaborative Guidance Mechanism that Promotes Deep Integration between Industry and Education

Industry-education integration is the core support of this reform, with the key being the establishment of an institutionalized, full-process, and deep school-enterprise collaborative guidance mechanism to change the previous situation of shallow enterprise involvement, intermittent guidance, and unclear division of responsibilities [6].
The project team visited quality design enterprises and institutes in the Guangdong Greater Bay Area and Maoming city, selecting partner organizations with good reputations, sufficient project resources, and a strong willingness to deeply engage in talent cultivation. Industry-education integration collaborative education agreements were signed, clarifying the rights, obligations, and collaboration content of both sides. On this basis, a school-enterprise joint supervisor resource library was established, recruiting enterprise designers, project managers, and technical directors with extensive project experience and high professional competence as industry supervisors, forming guidance groups together with on-campus supervisors. Regarding the division of labor, industry supervisors are primarily responsible for providing real projects, guiding on-site internships, controlling industry standards, and participating in topic selection and design defenses; on-campus supervisors are primarily responsible for theoretical guidance, academic norms, design deepening, thesis writing, process management, and quality monitoring. Through regular online and offline meetings, joint design critiques, collaborative guidance, and synchronized evaluation, the two sides achieve collaborative education throughout the entire graduation process. The school-enterprise dual-tutor collaborative guidance mechanism established in this section follows the institutionalized cooperation framework proposed in the cited work, achieving systematic collaboration between on-campus and industry supervisors in goal setting, responsibility division, process management, and joint evaluation [20]. At the same time, the program comprehensively revised teaching documents such as the Graduation Internship Teaching Syllabus, the Graduation Design (Thesis) Management Regulations, and the Detailed Rules for Dual-Tutor Guidance, integrating the three components into a unified teaching process, clarifying teaching objectives, learning tasks, outcome requirements, and evaluation criteria at each stage, thereby ensuring the implementation of integrated teaching from an institutional perspective.

### 4.2 Building an AI-based Teaching Resource Library that Supports Digital and Intelligent Education

To address the problems of insufficient integration of digital intelligence technologies, fragmented learning resources, and high barriers to application, the project team systematically built an AI teaching resource library suitable for the environmental design major, providing students with systematic, progressive, and actionable learning support. The resource library was developed under the principle of "practical, sufficient, and easy to use," integrating high-quality resources from platforms such as MOOC, XuetangX, Bilibili, and professional forums, forming three modules. The first module comprises foundational AI technology resources, including instructional videos, operation tutorials, and documentation on the application of computer vision, natural language processing, space syntax, geographic information systems, generative adversarial networks, and other technologies in the design field. Over 200 video resources have been collected. The second module consists of AI tool application resources, organizing AI-assisted design plugins, data analysis templates, quantitative analysis scripts, and intelligent rendering tools to lower the technical barriers for students. The third module offers integrated case resources, containing complete "internship- design- thesis" cases based on real projects, demonstrating the entire process from extracting practical problems, innovating design solutions, to theoretically synthesizing the thesis, providing students with intuitive models. The resource library adopts an open online sharing model, allowing students to learn independently anytime and anywhere. Meanwhile, the team faculty regularly conduct AI tool workshops, special lectures, and hands-on guidance, recording "step- by- step" introductory micro- courses to help students quickly master technical methods and apply them throughout the graduation practice process.

### 4.3 Implement a "Three-Stage" Integrated Teaching Process

This reform reintegrates graduation internship, graduation design, and graduation thesis into a coherent and unified teaching process, advancing through a three- stage flow of "semester 6 preparation – semester 7 internship and practice – semester 8 design and thesis," achieving seamless connection among the three components (Figure 2).
(1) The first stage is the semester 6 preparation stage – two- way selection and preliminary topic research. The program holds a graduation component information session, announcing the research directions, guidance topics, and student quotas of on- campus and industry supervisors. Students submit their preferences based on their interests and career plans. The college determines guidance groups based on mutual preferences between students and supervisors, forming stable guidance teams. On this basis, students conduct preliminary research and identify preliminary graduation design topics related to real projects.
(2) The second stage is the semester 7 internship and design deepening stage – immersive internship in design institutes and studio practice. The first nine weeks consist of immersive internship in design institutes: students enter partner enterprises, deeply participate in real projects under the guidance of industry supervisors, complete on- site surveys, user research, data collection, needs analysis, and other tasks, discovering real problems, mastering real processes, and accumulating real data in practice, ultimately determining authentic graduation design topics highly relevant to their internship content. The following ten weeks constitute the studio practice stage: students return to the on- campus "Zero" Creative Workshop and, under the leadership of on- campus supervisors with remote collaboration from industry supervisors, use AI technologies from the resource library to carry out scheme design, form optimization, rendering, spatial quantitative analysis, and other tasks, completing the transformation from practice to design.
(3) The third stage is the semester 8 graduation design and thesis synthesis stage. Students comprehensively refine their design outcomes, completing renderings, construction drawings, design presentations, and other deliverables. Based on internship data, the design process, and project problems, they write graduation theses, extracting design principles, methodological strategies, and theoretical perspectives, achieving the synthesis from design practice to theoretical research. During this stage, the dual supervisors jointly conduct mid- term reviews, progress tracking, evaluation guidance, and defense organization.
Through this three- stage integrated teaching, students fully experience the entire process of "practical cognition -design innovation-theoretical elevation," with abilities progressively developed and deepened at each level, effectively avoiding the problems of disconnected components and vague content under the traditional model.

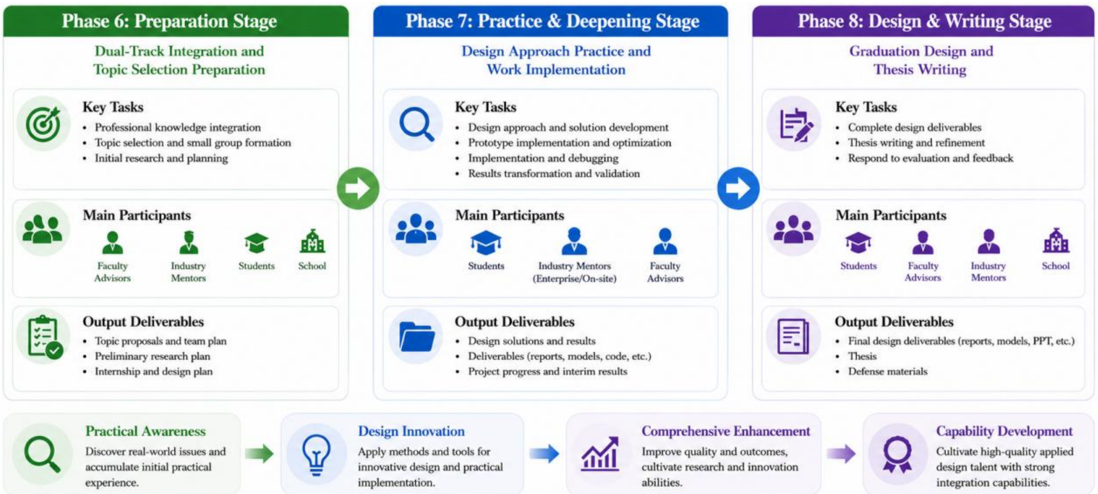

**Figure 2** "Three Integration" Teaching Full-Process Implementation Path

## 5 THE DEEP INTEGRATION AND APPLICATION OF ARTIFICIAL INTELLIGENCE TECHNOLOGY ACROSS ALL THREE STAGES

Artificial intelligence technologies run through the entire process of graduation internship, graduation design, and graduation thesis, providing strong support for improving the quality and efficiency of practical teaching [21].
(1) In the graduation internship stage, students apply technologies such as geographic information systems, space syntax, and computer vision to conduct site analysis, data collection, and quantitative assessment of current conditions.

(2) In the graduation design stage, students use technologies such as generative adversarial networks, convolutional neural networks, and AIGC to generate design schemes, optimize outcomes, simulate forms, and model performance [22].
(3) In the graduation thesis stage, students use tools such as natural language processing, machine learning, and statistical analysis to carry out literature review, data processing, and argumentation analysis.
The full integration of digital intelligence technologies not only improves the overall quality of the graduation components but also cultivates students' technological literacy and innovative thinking to adapt to the digital intelligence era (Table 1), narrows the gap between university teaching and industry frontiers, and enhances students' employment competitiveness.

**Table 1** Application Scenarios of AI Technologies in Graduation Internship-design-thesis

| Stage | Core application scenarios | Core technologies/methods | Applicable project types | Typical AI tools |
|---|---|---|---|---|
| Graduation internship | Quantitative assessment of site conditions, user behavior and needs analysis, environmental data collection and preprocessing | Space syntax, geographic information system (GIS), computer vision, natural language processing (NLP) | Spatial analysis, comprehensive application | DepthmapX, Space Syntax Toolkit, ArcGIS, QGIS, OpenCV, LabelImg, ChatGPT (for interview transcription). |
| Graduation design | Rapid concept generation, design rendering and video generation, form optimization and performance simulation, construction drawing assistance and detail deepening, interactive design and immersive experience | Diffusion models, AIGC, generative adversarial networks (GANs), semantic segmentation, convolutional neural networks (CNNs), parametric design. | Creative generation, comprehensive application, spatial analysis. | Midjourney, Stable Diffusion, ComfyUI, LoRA, Pix2Pix, StyleGAN, GPT Image-2, Nano Banana, Seedream, InteriorAI, SUAPP AI, EVAI Architecture Master, Runway Gen2, Unreal Engine, Photoshop, Arcadium 3D. |
| Graduation thesis | Literature review and knowledge graph analysis, research data statistics and modeling, argument visualization and academic polishing, innovation point extraction and logical verification. | Natural language processing (NLP), text mining, topic modeling, machine learning (regression, classification, clustering), scientific knowledge graphs, generative pre-trained models. | Theoretical research, comprehensive application | ChatGPT, Kimi, Claude, CiteSpace, VOSviewer, DeepSeek, Doubao, SPSS (SPSS-AI), Python (scikit-learn), R, Jupyter Notebook, Matplotlib, Zotero, Grammarly. |

Note: Based on the graduation theses (designs) of the past three cohorts, there are 18 spatial analysis-oriented topics (8.1%), 35 creative generation-oriented topics (15.8%), 145 theoretical research-oriented topics (65.6%), and 23 comprehensive application-oriented topics (10.4%).

## 6 QUALITY CONTROL AND THE OUTCOMES OF REFORMS

### 6.1 Establish a Comprehensive Quality Monitoring and Feedback Optimization Mechanism throughout the Entire Process

To ensure continuous advancement and improvement of the reform, the project team established a "full-process, diversified, closed-loop" quality monitoring and feedback optimization mechanism [23]. In process management, full-track tracking was implemented through internship logs, stage reports, mid-term inspections, and final defense, enabling timely identification and correction of deviations. In the evaluation system, diversified indicators were constructed, including practical performance, design quality, thesis level, technology application, innovation ability, and teamwork, with emphasis on process evaluation and competency assessment [24].
After each round of teaching practice, the project team comprehensively collected reform implementation effects through questionnaires, student interviews, supervisor discussions, and data analysis. Natural language processing, statistical analysis, and other methods were used to extract key issues, and targeted optimizations were made to teaching processes, resource content, guidance methods, and management mechanisms. Through three rounds of iterative optimization, the reform model has matured, and teaching effectiveness has continuously improved.

### 6.2 Outcomes of the Reform Practices

#### *6.2.1 Significant improvement in students' comprehensive abilities and training quality*

The quality of graduation theses (designs) has greatly improved. The most direct indicator is the grade data: for the 2023 cohort of environmental design majors after the reform, the excellence rate of graduation theses (designs) reached 14%, and the institutional spot-check excellence rate was 100%. Students' ability to apply digital intelligence technologies was enhanced. A questionnaire survey showed that over 90% of graduates reported being able to independently use at least one to two AI-related tools to assist their design research and scheme generation. Some outstanding students have already used ComfyUI and LoRA trainers to fine-tune their own models for specific design styles. The effectiveness of the reform is evidenced in specific student works. For example, in "Age-Friendly Renewal Design of Old Neighborhood Public Spaces Based on Space Syntax," the student used Depthmap to quantitatively analyze the integration of the neighborhood road network and proposed an acupuncture-style micro-renewal strategy, which won an institutional outstanding thesis award. In "Innovative Design Research on Lingnan Traditional Window Lattice Patterns Based on AIGC Technology," the student proactively studied advanced content on ComfyUI and LoRA training from the resource library. He systematically collected hundreds of images of window lattice patterns from traditional Lingnan architecture, annotated them, and used a LoRA trainer to fine-tune a base model, successfully training a LoRA model capable of generating novel window lattice patterns with Lingnan stylistic features, demonstrating the feasibility of digital intelligence technology in empowering design innovation. Fruitful results have been achieved in academic competitions. Using what they learned from the reform, students have repeatedly achieved good results in high-level disciplinary competitions. In the past three years, several students have received project approvals from the national university student innovation and entrepreneurship training program. Enhanced employment competitiveness and adaptability. Thanks to deep industry-education integration, partner enterprises have gained a deeper understanding of students, and students' practical abilities have been validated in advance. The job placement rate in related fields for the last two graduating cohorts increased by 15 percentage points, and several students directly joined the partner design enterprises.

#### *6.2.2 Bidirectional enhancement of teaching and research abilities of faculty*

The reform has also promoted the growth of the faculty team. The project team successfully led two provincial- and ministerial-level teaching reform projects and six university-level or higher teaching reform projects, covering cutting-edge directions such as "AI + design," "industry-education integration," and "curriculum ideology and value education."

#### *6.2.3 Substantial breakthroughs in industry-education integration mechanisms and resource development*

Through the reform, the college has established stable strategic partnerships with multiple design enterprises in the Pearl River Delta and western Guangdong region, forming actionable "dual-tutor" collaborative guidance processes and incentive-evaluation mechanisms. The on-campus "Zero" Creative Workshop has continuously undertaken more than ten real design projects, with all students participating in practice. A modest but continuously updated "AI + Design" teaching resource library (containing over 200 resources) and a dual-tutor pool (covering 15 industry supervisors from 10 enterprises) have been built.

## 7 CONCLUSION AND OUTLOOK

### 7.1 Conclusion

This study takes the Environmental Design major of Guangdong University of Petrochemical Technology as a practical case, directly confronting the "three formalizations" predicament faced by graduation practice in application-oriented undergraduate design programs in the digital intelligence era. Through three years of theoretical construction and action research, it has successfully constructed and validated a graduation practice reform model characterized by "digital intelligence technology empowerment, deep industry-education integration, and tripartite integration of internship, design, and thesis" (the "Three Integrations" model).

By reconstructing an integrated teaching process of "internship for problem identification – design for problem solving – thesis for theoretical synthesis," and building key supports such as an AI technology learning resource library and a school-enterprise "dual-tutor" joint guidance pool, this model has effectively enhanced students' practical innovation ability, digital intelligence technology application literacy, and academic norm compliance. These improvements are ultimately reflected in significantly higher quality of graduation theses (designs), continuous emergence of high-level competition achievements, and substantial enhancement of employment competitiveness. Rich case demonstrations and detailed data analysis strongly prove the scientific validity, effectiveness, and operability of the model. The contribution of this study lies not only in providing a systematic solution for the graduation teaching component of the design discipline but also in the core concepts behind it—"systematic design, technology empowerment, collaborative education"—and the action research paradigm of "problem orientation, practical verification, iterative optimization." These have important theoretical implications and practical reference value for practical teaching reforms in other engineering and art programs, and even broader humanities and social science programs, in similar application-oriented undergraduate institutions.

This study further distills four distinctive features and innovations.

(1) Model innovation: achieving deep integration of the three components to solve long-standing pain points. This reform breaks through the traditional model in which graduation internship, graduation design, and graduation thesis operate in separate, independent stages. It integrates the three into a unified teaching system with aligned objectives, coherent content, synergistic processes, and connected outcomes, truly realizing that "internship lays the foundation for design, design supports the thesis, and the thesis elevates practice." This fundamentally solves the long-standing pain points of "fragmented processes, formalized internship, subjective design, and vague thesis."

(2) Pathway innovation: full-course empowerment by digital intelligence technologies, narrowing the industry gap. The reform systematically integrates digital intelligence technologies such as artificial intelligence, big data, and spatial quantitative analysis into each stage of graduation practice, constructing a digital intelligence teaching pathway of "technology support, tool assistance, case demonstration." This enables students to master mainstream intelligent tools and research methods while still at university, quickly adapt to digital intelligence design workflows in the workplace, and effectively reduce the technological gap between university teaching and industry frontiers.

(3) Mechanism innovation: full-course collaborative education through industry-education integration, strengthening dual-tutor support. This study establishes an institutionalized, normalized, full-process school-enterprise dual-tutor joint guidance mechanism, promoting deep embedding of industry resources into graduation practice teaching. It changes the previous situation of "warm on campus, cold in enterprises, shallow cooperation without depth," forming an ecosystem where "on-campus supervisors focus on theory, industry supervisors focus on practice, and both sides collaborate in education," thereby improving the alignment between talent cultivation and industry needs.
(4) Outcome innovation: forming a replicable and extendable paradigm with universal value. Through three rounds of progressive practical verification, the reform has produced a complete set of teaching processes, resource systems, management mechanisms, evaluation criteria, and operation manuals. It is applicable not only to the environmental design major but also extendable to related programs such as architecture, industrial design, landscape design, and intelligent construction, offering strong universality and reference value for similar local application-oriented undergraduate institutions.

### 7.2 Shortcomings and Prospects

#### *7.2.1 Research shortcomings and limitations*

During the implementation of the reform, the project team identified several issues requiring continuous improvement. First, some AI tools are highly specialized and have steep learning curves; a number of students still lack sufficient depth in application, remaining at the basic operational level. Second, due to their daily work commitments, industry mentors cannot always guarantee stable guidance time and energy, leaving room for increasing the frequency of collaborative guidance. Third, when extending the reform model to other programs, adaptive adjustments must be made according to the specific characteristics of each program, and the precision of cross-program extension needs to be strengthened. Fourth, the digital intelligence teaching management platform has not yet been fully established, and there is still room for improvement in the efficiency of process data collection, analysis, and feedback.

#### *7.2.2 Research prospect*

In the future, the project team will continue to deepen the reform from four aspects. First, further optimize the AI teaching resource library by adding beginner-level tutorials, localized cases, and step-by-step hands-on videos, thereby lowering the learning threshold and enhancing students' depth of application. Second, improve the incentive, assessment, and support mechanisms for industry mentors, increasing their motivation and the stability of guidance, and enriching the forms of online and offline collaborative guidance. Third, customize personalized integrated reform plans according to the characteristics of different programs such as architecture, landscape design, industrial design, and intelligent construction, thereby improving the precision and adaptability of model extension. Fourth, accelerate the construction of a digital management platform for graduation practice, enabling online and intelligent control of the entire process—topic selection, internship, design, thesis, and evaluation—thus improving management efficiency and the level of quality monitoring.

## COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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