

Improvement Path of Engineering Practical Competence under Digital-Intelligent and Art-Science Micro-integration Mode: Empirical Research on Local Application-Oriented Universities

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Abstract: Against the backdrop of the digital economy and the construction of a "Design Capital", the demand for "technology + art + engineering" compound talents in the digital creative industry is increasingly urgent. However, local application-oriented universities generally face dilemmas such as insufficient integration depth of arts and sciences, lagging application of digital intelligence tools, and high thresholds for school-enterprise cooperation. This study conducted an empirical survey of 342 students from three colleges of a local application-oriented university in Wuhan, and diagnosed three core gaps: the "one-way prominence" of digital intelligence tool capabilities, the serious lack of interdisciplinary practice opportunities, and the extreme shortage of project practical experience. On this basis, this study proposes the "micro-integration" theory, constructs a "three-tier progressive open-source tool teaching + biweekly micro-project driven + school-enterprise micro-collaboration" engineering practice training model, and conducts a one-year teaching reform pilot. The results show that the model has significantly improved students' engineering practice capabilities: the usage rate of core open-source tools has increased from 20% to 52%, the participation rate of interdisciplinary projects has increased from 38.89% to 85%, and the compliance rate of engineering practice capabilities has increased by 22 percentage points. This study provides a low-cost, high-efficiency replicable sample for local application-oriented universities to promote the integration of digital intelligence and arts and sciences.

Keywords: Digital Intelligence; Arts-Science Integration; Micro-Integration; Engineering

Practice Ability; Open-Source Tools; Local Application-Oriented University

1. Introduction

The deep integration of digital technology, artificial intelligence and artistic design is reshaping the talent demand structure of the global digital creative industry [1]. The "14th Five-Year Plan for Digital Economy Development" clearly requires "promoting the deep integration of digital technology and the real economy", and Wuhan, as a national "Design Capital" and a digital economy innovation and development pilot zone, has proposed that the operating income of cultural new formats represented by digital content will exceed 200 billion yuan by 2026. However, the "2024 Digital Talent White Paper" shows that up to 74% of enterprises are facing a shortage of digital talents, especially the lack of application-oriented talents who can transform design concepts into technical solutions and have engineering practice capabilities [2].

In response to this demand, domestic and foreign universities have actively explored the path of arts-science integration education. Tsinghua University has established a "Data Art" micro-major, and the China Academy of Art has built an "Intermedia Art" experimental teaching center [3]. The MIT Media Lab's "CityScope" project integrates art design and urban computing technology to cultivate interdisciplinary teams to solve complex problems [4]. However, most of these models rely on high-intensity resource investment, which is difficult to replicate in local application-oriented universities with limited resources [5].

Local application-oriented universities are the main force in cultivating applied talents for regional industries. Taking Wuhan Institute of Design and Sciences as an example, the school

has clearly put forward the development concept of "artistic innovation, technology empowerment, and emphasis on application", and has built a provincial first-class art design professional group [6]. However, there are still prominent problems in the cultivation of engineering practice capabilities under the background of digital intelligence and arts-science integration: the integration stays at the superficial level, the application of digital intelligence tools is insufficient, and the depth of school-enterprise cooperation is limited [7].

To solve the above problems, this study takes the engineering practice ability improvement of students majoring in intelligent engineering and art design in local application-oriented universities as the research object, proposes the "micro-integration" theory suitable for resource-constrained environments, constructs a low-cost engineering practice training model driven by digital intelligence and arts-science integration, and verifies its effectiveness through empirical research.

2. Research Background and Problem Statement

2.1 National Strategy and Industrial Demand

The digital creative industry has become an important engine of economic growth. Wuhan's "Three-Year Action Plan for Accelerating the Development of Digital Content Industry (2024-2026)" focuses on cultivating emerging formats such as intelligent hardware, metaverse interaction, and digital cultural creativity, and has an urgent demand for compound talents with both artistic aesthetics and engineering implementation capabilities. The industry pain points are mainly reflected in two aspects: first, traditional design enterprises are facing digital transformation and need a large number of talents who master AI-assisted design, VR scene construction and other skills; second, emerging fields such as intelligent hardware require practitioners to have the full-chain ability of "appearance design - sensor development - user experience optimization"[8].

2.2 Current Situation and Problems of Talent Cultivation in Local Universities

To accurately grasp the current situation of students' engineering practice capabilities, this study conducted a questionnaire survey of 342 students from the School of Intelligent

Engineering, Jackie Chan School of Film and Television Media, and School of Public Art of Wuhan Institute of Design and Sciences in March 2026, with an effective recovery rate of 94.7%. The survey results reveal three core problems:

First, the use of digital intelligence tools presents a "one-way prominence" feature, and the comprehensive application ability is insufficient. Computer majors have an advantage in programming tools (90.19% usage rate) but are weak in design thinking; art design majors are proficient in 3D modeling tools (84% usage rate) but lack programming capabilities; film and television media majors have deficiencies in both. Overall, 50.88% of students are only at the level of "being able to complete simple tasks independently", and only 5.56% can flexibly innovate and apply tools, showing an obvious "middle collapse" phenomenon.

Second, the participation rate of interdisciplinary projects is low, and the engineering landing ability is extremely weak. 61.11% of students have never participated in interdisciplinary projects, and among those who have participated, only 2.05% have been involved in the engineering landing link. The main obstacles are "difficulty in connecting disciplinary knowledge" (66.37%), "incompatible tools" (42.98%), and "lack of interdisciplinary instructors" (31.58%).

Third, project practical experience is the biggest shortcoming for students' employment. 70.76% of students believe that project practical experience is the most lacking ability in employment, followed by comprehensive application ability of digital intelligence tools (52.92%) and the ability to transform creativity into engineering solutions (47.66%). Existing school-enterprise cooperation mostly focuses on internship links, and has not formed a deep collaborative mechanism of "joint project research, co-construction of courses, and joint education of talents".

2.3 Limitations of Existing Research

Existing research on arts-science integration education mainly focuses on the macro level of discipline system construction, and there are few studies on the micro level of teaching implementation [9]. Most of the proposed models rely on large-scale platform construction and high capital investment, which are not suitable for local application-oriented

universities [10]. In addition, there is a lack of empirical research based on large sample data, and the effectiveness of the models is insufficiently verified.

3. Construction and Implementation of the "Micro-Integration" Model

Based on the concept of "small incision, deep integration, low cost, high efficiency", this study proposes the "micro-integration" theory, which emphasizes realizing the deep integration of digital intelligence and arts-science through micro-projects, micro-collaboration and micro-resource investment under the constraints of existing resources [11]. The core of the model is "one main line, three supports", that is, taking the improvement of engineering practice ability as the main line, supported by a three-tier progressive open-source tool teaching system, a biweekly micro-project driven interdisciplinary practice platform, and a school-enterprise micro-collaboration practical training mechanism [12].

3.1 Three-Tier Progressive Open-Source Tool Teaching System

Aiming at the problem of single tool use and insufficient comprehensive ability, this study constructed a three-tier progressive open-source tool teaching system based on the cognitive law of students:

Basic layer: Eliminate the blank group of tool use. Offer the compulsory course "Introduction to Open-Source Tools" for all freshmen, focusing on the basic operations of programming tools (Python) and design tools (PS, Figma), so that students can master at least one

programming tool and one design tool.

Advanced layer: Implement special strengthening according to professional directions. For computer majors, strengthen hardware development (Arduino) and interaction design (Unity); for art design majors, deepen 3D modeling (Blender) and AI-assisted design (Midjourney); for film and television media majors, increase digital twin/VR tools (Twinmotion) and AI-assisted content creation.

Innovation layer: Encourage cross-domain integrated application of tools. Set up a tool innovation application workshop, and encourage students with high proficiency (4-5 points) to explore cross-domain integrated applications such as "AI+design" and "programming+art installation".

This study selected Blender 3.6 LTS, Arduino IDE 2.2.1, Python 3.10 and Unity 2022.3 LTS as the core teaching tools, all of which are open-source or free versions, avoiding the high cost of commercial software. A "version adaptation guide" and an offline teaching resource package were developed to solve the problems of tool version compatibility and learning difficulty.

3.2 Biweekly Micro-Project Driven Interdisciplinary Practice Platform

Aiming at the problem of low participation rate of interdisciplinary projects and weak engineering landing ability, this study designed a "biweekly micro-project" teaching model, and established a four-stage closed-loop management system for micro-projects, as shown in Table 1.

Table 1. Four-Stage Closed-Loop Management System for Micro-Projects

Stage	Core Tasks	Delivery Standards
Demand Screening	Enterprise demand evaluation (technical feasibility, artistic integration, cost control)	Requirement Specification(function list, aesthetic indicators, budget≤500 yuan/project)
Development Implementation	Phased task decomposition (creative design→technical development→ testing optimization)	Weekly progress report(code submission records, design draft iterations, test cases)
Acceptance Evaluation	Enterprise on-site evaluation (technical implementation 40%+artistic innovation 30%+cost control 30%)	Acceptance Report (improvement suggestions, projects with pass rate <60% need second iteration)
Achievement Precipitation	Code open-source (GitHub repository standardization), design document storage	Reusable resource package compliant with "Open-Source Achievement Management Specification"

In the past year, the pilot class has carried out 3 micro-projects, including "Chu Culture Intelligent Bookmark", "AR Postcard of Wuhan Museum" and "Intelligent Guide H5 Page of

Wuhan Cultural Tourism Group", covering the main demand scenarios of the digital creative industry.

3.3 School-Enterprise Micro-Collaboration Practical Training Mechanism

Aiming at the problem of high threshold and shallow depth of school-enterprise cooperation, this study innovated the "online dual tutor + micro-project" collaboration model, which reduces the cooperation cost while ensuring the cooperation effect [13]:

Online dual tutor workshop: Invite enterprise engineers to carry out one online technical sharing per month, and provide real-time guidance for students through free collaboration platforms such as Tencent Meeting and Feishu. The enterprise tutors are motivated by issuing "part-time tutor" electronic certificates and giving priority to recruiting excellent students, replacing the traditional financial subsidy [14].

Micro-project library construction: Cooperate with local enterprises such as Wuhan Cultural Tourism Group and Liangdian Shifen Animation to build a micro-project library containing more than 10 real demand cases. Enterprises release micro-projects on the online platform, and students form teams to bid. The winning teams receive small financial support from enterprises (included in the project budget).

Table 2. Comparison of Digital Intelligence Tool Usage Rates between Pilot Class and Control Class

Tool Type	Pilot Class (Before)	Pilot Class (After)	Control Class (After)
Blender	18.33%	56.67%	21.67%
Arduino	15.00%	48.33%	16.67%
Python	65.00%	88.33%	68.33%
Unity	11.67%	43.33%	13.33%
Comprehensive Usage Rate	20.00%	52.00%	25.00%

The usage rate of core open-source tools has increased from 20% before the experiment to 52% after the experiment, which is significantly higher than that of the control class (25%). The proportion of students who can master more than two tools has increased from 15% to 48%, and the proportion of students with high proficiency (4-5 points) has increased from 5% to 18%.

4.2 Improvement of Interdisciplinary Collaboration Ability

The participation rate of interdisciplinary projects in the pilot class has increased from 38.89% before the experiment to 85% after the experiment, which is significantly higher than that of the control class (42%). Among them, the proportion of students participating in the engineering landing link has increased from 2.05% to 32%, indicating that students have initially established the whole-process thinking

Achievement transformation path: Cooperate with local cultural and creative enterprises to trial-sell students' works (such as intelligent cultural and creative products) through e-commerce platforms, and the profits are fed back to student teams and research funds in proportion. At the same time, students are guided to apply for utility model patents focusing on low-cost innovation solutions [15].

4. Empirical Effect Analysis

After one year of teaching reform practice, this study compared the data of the pilot class and the control class from four dimensions: tool application ability, interdisciplinary collaboration ability, engineering practice ability and student satisfaction, and verified the effectiveness of the "micro-integration" model.

4.1 Improvement of Digital Intelligence Tool Application Ability

The survey results show that the comprehensive application ability of digital intelligence tools of students in the pilot class has been significantly improved, as shown in Table 2.

of "creativity - technology - engineering". The self-evaluation score of interdisciplinary collaboration ability has increased from 3.15 points to 3.82 points, which is significantly higher than that of the control class (3.21 points).

4.3 Improvement of Engineering Practice Ability

The enterprise evaluation results show that the compliance rate of engineering practice ability of students in the pilot class (taking enterprise post requirements as the benchmark) has reached 87%, which is 22 percentage points higher than that before the experiment and 24 percentage points higher than that of the control class (63%). In the 2026 campus recruitment, the employment rate of students in the pilot class in the digital creative industry reached 78%, which was 23 percentage points higher than that of the control class. Students have won 3 national awards and

7 provincial awards in innovation and entrepreneurship competitions such as the "Challenge Cup".

4.4 Improvement of Student Satisfaction

The student satisfaction survey shows that the overall satisfaction of students in the pilot class with the course has reached 92.5%, which is significantly higher than that of the control class (77.31%), as shown in Figure 1.

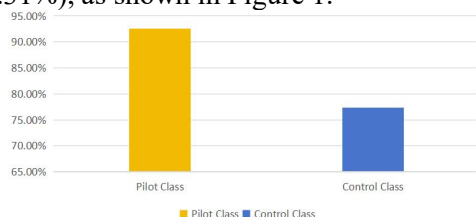


Figure 1. Comparison of Student Satisfaction between Pilot Class and Control Class

Regression analysis shows that the adequacy of interdisciplinary practice hours has a significant positive impact on student satisfaction (Coefficient of Determination $R^2=0.322$), which is consistent with the research conclusion of the pre-experiment survey. 95% of students said that the "biweekly micro-project" model has effectively improved their practical ability, and 88% of students expressed their willingness to continue to participate in school-enterprise micro-projects.

5. Discussion and Implications

5.1 Theoretical Value of the "Micro-Integration" Model

This study proposes the "micro-integration" theory for the first time, which breaks through the traditional model of "large platform and large investment" in arts-science integration education, and enriches the interdisciplinary education theory of local application-oriented universities. By integrating scattered open-source tools into an organic system, this study constructs the concept of "open-source tool ecosystem", which provides a new idea for solving the problem of insufficient teaching resources in local universities. In addition, this study explores the deep coupling of large models with existing digital intelligence tools and arts-science integration teaching systems, and provides a "low-cost and high-adaptability" AI-assisted design solution for the art and design industries.

5.2 Practical Value of the "Micro-Integration" Model

The "micro-integration" model constructed in

this study has strong operability and replicability. First, it adopts open-source and free tools, which greatly reduces the cost of platform construction. The total investment in hardware and software in the past year was less than 20,000 yuan, which is far lower than the cost of traditional interdisciplinary laboratories. Second, the "online dual tutor" model breaks the time and space constraints of school-enterprise cooperation, and solves the problem that enterprise engineers are difficult to stay in school for a long time. Third, the micro-project with a budget of no more than 500 yuan is in line with the ability level of students, and also reduces the risk of enterprise cooperation.

5.3 Limitations of the Study

This study still has some limitations: First, the research sample is only from one local application-oriented university, and the universality of the conclusion needs to be further verified. Second, the research cycle is only one year, and the long-term effect of the model needs to be tracked and investigated. Third, the application of AI agents in teaching is still in the exploratory stage, and its role in improving students' innovation ability needs to be further studied.

5.4 Implications for Similar Universities

For local application-oriented universities to promote the integration of digital intelligence and arts-science, the following inspirations can be drawn:

Based on existing resources, take the road of low-cost integration: Give full play to the advantages of open-source tools and free cloud platforms, avoid blind pursuit of high-end equipment and large-scale platform construction, and improve the utilization rate of existing resources.

Take micro-projects as the carrier to strengthen engineering landing ability: Design small, standardized and operable micro-projects according to the ability level of students, so that students can experience the whole process from creative design to engineering landing.

Build an online collaboration mechanism to reduce the threshold of school-enterprise cooperation: Make full use of free collaboration tools to carry out online guidance and project docking, and establish a win-win incentive mechanism suitable for small and medium-sized enterprises.

6. Conclusion

Aiming at the problems of insufficient depth of arts-science integration, lagging application of digital intelligence tools and high threshold of school-enterprise cooperation in local application-oriented universities, this study proposes the "micro-integration" theory, constructs a "three-tier progressive open-source tool teaching + biweekly micro-project driven + school-enterprise micro-collaboration" engineering practice training model, and verifies its effectiveness through empirical research. The results show that the model can significantly improve students' digital intelligence tool application ability, interdisciplinary collaboration ability and engineering practice ability at a low cost, and has strong operability and replicability.

In the future, we will further expand the scope of the pilot, optimize the teaching content and evaluation system, deepen the application of AI agents in teaching, and continuously improve the quality of compound talent cultivation, so as to better serve the development of regional digital creative industries.

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