Teaching-Learning-Practicing-Competing: Research and Practice of the Peking Opera 'Four Skills' Inspired Integrated Cultivation Model

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Abstract. Research indicates that the talent cultivation process in application-oriented universities often suffers from a passive transfer of knowledge within a single engineering discipline. Common issues among students include a lack of innovation, weak hands-on skills, and a disconnection be-tween acquired competencies and the practical needs of industry. Drawing inspiration from the time-honored Peking Opera training system characterized by "singing, reciting, acting, and martial arts" (Chang, Nian, Zuo, Da), this study explores and implements an integrated, sustainable, and closed-loop cultivation model of "Teaching-Learning-Practicing-Competing" tailored to application-oriented undergraduate education. Anchored in project- and case-based practices, this model redefines teaching approaches, enriches learning content, strengthens the role of experimentation and practical work, and stimulates students' creativity and problem-solving abilities. Ultimately, it aims to enhance the overall competencies of students and align educational outcomes with real-world industrial demands.

Keywords: Application-oriented undergraduate, New teaching mode of "Teaching-Learning-Practicing-Competing", Sense of innovation, Practice ability.

1 Introduction

With the rapid advancement of social economy and the ongoing optimization of its industrial structure, the demand for high-level application-oriented talents has grown increasingly urgent. In response, a series of national policy documents have been introduced in recent years, encouraging the transformation of traditional undergraduate institutions toward application-oriented universities. These policies emphasize the promotion of university-enterprise collaboration, the integration of industry and education, and the development of modern industrial colleges. The aim is to bridge the gap between educational supply and industrial demand, thereby fostering a deep integration between higher education and economic development [1][2].

Despite ongoing reforms, many application-oriented universities still rely heavily on theory-centered, linear teaching models, leading to weak innovation capacity, limited

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practical skills, and poor alignment with real-world industry needs[3]. Exam-driven learning habits further reinforce passive knowledge acquisition, with insufficient emphasis on hands-on and experiential learning—ultimately impairing students' adaptability to the demands of modern workplaces. Addressing this requires a shift toward innovation-centered, practice-integrated pedagogy[4][5].

In response, this study draws conceptual inspiration from the traditional Chinese Peking Opera training system, which emphasizes four core skills7—singing, reciting, acting, and martial arts—as a holistic approach to performance education. Translating this philosophy into engineering education, we propose the Teaching–Learning–Practicing–Competing (TLPC) model, a closed-loop framework designed for undergraduate electronic information programs. TLPC integrates technical instruction with personal development and is grounded in well-established educational theory.

Specifically, the TLPC model integrates several well-established pedagogical frameworks: The Teaching–Learning phase reflects the core tenets of constructivist learning theory, which views knowledge not as something transmitted by instructors but as actively constructed by learners through contextual engagement, task participation, and social interaction. This stage emphasizes deep learning through problem-based and situated instructional design. The Learning–Practicing linkage aligns with experiential learning theory, which posits that learning is a cyclical process involving concrete experience, reflective observation, abstract conceptualization, and active experimentation. This structure facilitates the transformation of knowledge into applied competence. The Practicing–Competing phase is informed by situated learning theory, which holds that learning is most effective when it occurs in authentic, socially embedded contexts. By engaging students in real-world tasks, project-based collaborations, and competitive challenges, this phase fosters the integration of knowledge and action "knowing in practice". In addition, the TLPC model draws upon Bloom's Taxonomy of Educational Objectives, particularly its emphasis on higher-order cognitive processes such as application, analysis, synthesis, and creation. By embedding these objectives across all stages of learning, the model cultivates students' critical thinking and innovation capacities.

Anchored in these theoretical perspectives, the TLPC model establishes a coherent and progressive learning loop that transitions students from theoretical understanding to practical application, from classroom instruction to real-world engagement, and from passive knowledge reception to active knowledge construction. It promotes not only cognitive development but also skill integration and identity formation within professional contexts. Through the systematic development and iterative refinement of the TLPC model, this study contributes a pedagogically grounded and contextually relevant framework for cultivating application-oriented talent in engineering education.

2 Innovation and Practice-Oriented Talent Training Model

The term "application-oriented" in undergraduate education emphasizes practical skills and competency development. Ideally, this approach prioritizes hands-on, practice-based learning. However, many institutions still rely heavily on theoretical instruction. In an era marked by rapid technological advances and accelerating knowledge turnover—particularly in electronic information—traditional methods increasingly fall short of industry needs. With innovation cycles shortening and knowledge expanding rapidly, it is essential that application-oriented undergraduate programs evolve in step with regional economic and industrial changes[6].

To cultivate versatile professionals capable of contributing meaningfully to the forefront of emerging industries, universities must reform not only their teaching methods and curriculum content but also their educational philosophies and learning environments. Practice-oriented exploration and innovation-focused teaching should be strengthened to stimulate students' creativity, enhance their ability to apply knowledge in real-world settings, and foster a mindset of lifelong learning. Such reforms aim to produce graduates who can tackle complex engineering problems and adapt to dynamic technological contexts[7]. The high emphasis on practical competence within application-oriented universities requires a top-down institutional design that integrates theoretical instruction with hands-on application. This calls for the establishment of a practice-driven education system centered around contemporary technological trends. Strategic planning, flexible management frameworks, and diversified talent development pathways must be developed to support this vision.

In light of these challenges, this study introduces a novel, cyclic, and closed-loop model—referred to as "Teaching–Learning–Practicing–Competing"—inspired by the traditional Peking Opera training system of "singing, reciting, acting, and martial arts." This model is designed to systematically develop students' innovation capacity and practical abilities, as illustrated in Figure 1.

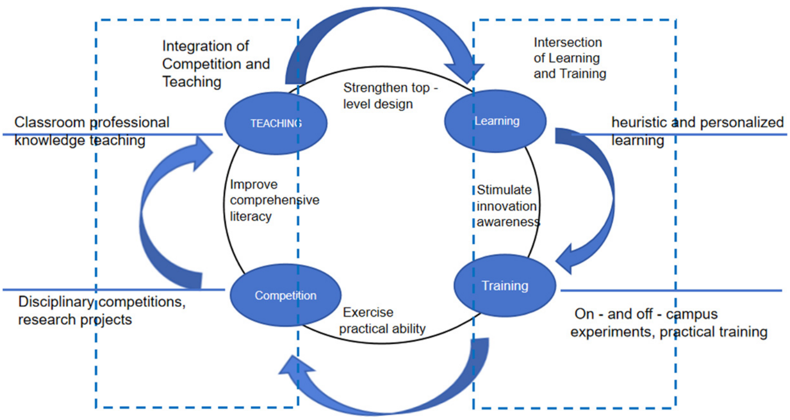

Fig. 1. A Closed-Loop Model for Innovation and Practice Ability Cultivation Based on the "Teaching–Learning–Practicing–Competing" Framework.

This model illustrates an integrated and iterative approach to talent development. Beginning with knowledge acquisition through structured teaching ("Teaching"), it progresses to self-directed learning that stimulates innovation awareness ("Learning"), followed by hands-on practice through in-campus and off-campus activities

("Practicing"), and culminates in academic competitions and research engagement to consolidate comprehensive capabilities ("Competing"). The cycle is reinforced by mechanisms such as interdisciplinary project design, personalized learning, practical training, and curriculum-competition integration, forming a sustainable and scalable system for cultivating innovation-driven, practice-oriented talents.

Using the Department of Electronic Information Engineering as a case study, this paper elaborates on the theoretical foundation, implementation strategies, and practical outcomes of this model. The objective is to address the limitations of conventional instruction in electronic information programs, which tend to rely on passive knowledge transmission. Through this integrated model, the emphasis shifts toward cultivating students' ability to apply knowledge creatively and effectively in practical scenarios.

3 Research and Practice of the Training Model

The electronic information industry is a pillar sector of national economic development. In application-oriented universities, programs in electronic information primarily focus on production-oriented practices and engineering technology applications, aiming to cultivate high-caliber engineering talents with strong innovative and practical capabilities[8]. For students in the Department of Electronic Information Engineering, systematic foundational and integrative training is essential. Only through mastering the equivalent of "singing, reciting, acting, and martial arts" can students develop into well-rounded professionals in the field. This concept is mapped onto a closed-loop model of "Teaching–Learning–Practicing–Competing" as the core educational strategy. The specific pedagogical implications of this model are elaborated as below.

3.1 "Singing" and "Reciting": Stimulating Innovation Awareness through Teaching and Learning

In this model, "Singing" and "Reciting" correspond to "Teaching" and "Learning", respectively, with the aim of fostering innovative thinking. A university's mission is not only to deliver instruction but also to inspire meaningful and productive learning. To this end, it is essential to construct dynamic, student-centered learning environments that awaken curiosity and creativity, while also nurturing multiple intelligences.

"Singing" emphasizes the creation of high-quality teaching resources and the adoption of advanced, student-centered instructional approaches. This reflects the broader trend in engineering education—shifting from traditional teaching paradigms toward learning-centered models. The learning paradigm encourages synergy between in-class and out-of-class experiences. Teaching strategies incorporate online micro-courses and MOOCs for professional knowledge delivery, and combine flipped classroom models with traditional lectures to promote inquiry-based, personalized learning. Through thoughtfully designed hybrid content, this approach transitions the focus from teacher-led instruction to student-led exploration, effectively cultivating students' capacity for innovation.

3.2 "Acting": Developing Practical Skills through Project-Based Training

"Acting" represents the "Practicing" component of the model, which is centered on strengthening students' technical competencies through project-based and hands-on training. This shift reflects a broader educational transition—from instruction-focused to learner-driven approaches—in the construction of a robust practical training system. The goal is to develop students who are proficient in electronic technology, information processing, and modern system design; who possess interdisciplinary design skills and innovation awareness; and who are well-prepared for real-world engineering challenges.

Practical training covers areas such as embedded systems, DSP applications, electronic product testing and production, equipping students to engage in the analysis, design, and development of various electronic devices and systems. Within the talent cultivation framework, this model is anchored in both discipline-specific and professional practical skill requirements. It features a three-tier practice-based teaching system: fundamental technical training, specialized lab-based practice, and integrated application-based projects. In alignment with the goal of cultivating innovation and engineering practice competence[9][10], this model embraces project-based teaching methods and promotes reforms in both teaching content and curriculum structure. It expands practical learning opportunities by embedding engineering thinking, gradually progressing from initial exposure to industry-style problem-solving, to measurable performance outcomes. The integrated framework that connects curriculum content, experimentation, and practical training is illustrated in Figure 2.

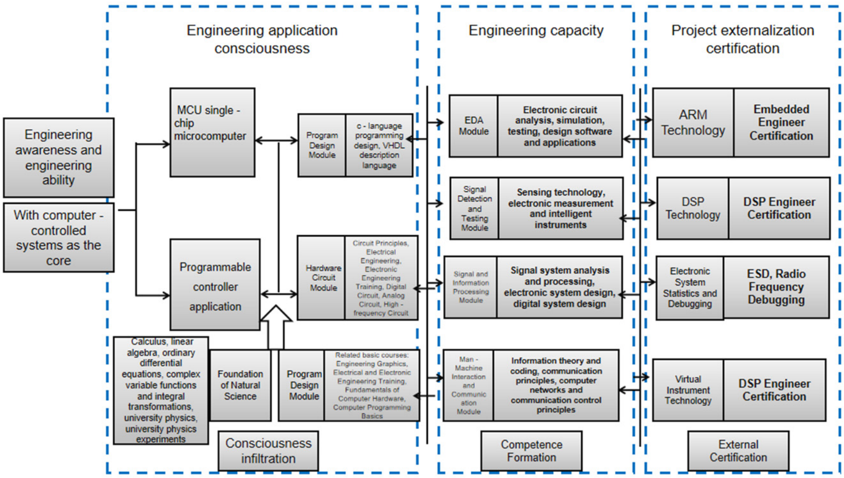

Fig. 2. Integrated Framework of Curriculum Instruction and Experimental-Practical Training.

The objective of specialized experimental and practical teaching is to develop students' foundational technical competencies and prepare them for more advanced, integrative practice activities. These components are closely aligned with core curricular requirements and include course-based experiments and project-oriented training related to compulsory professional modules. Representative courses include "C Programming", "Circuit Theory", "Fundamentals of Electronic Experimentation", "Analog Circuits", "Signals and Systems Laboratory", "Digital Circuits", and "High-Frequency Circuit Design Techniques". This teaching structure is developed in accordance with the overall practice teaching system, the characteristics of the program, talent cultivation objectives, and the specifications outlined in course syllabi. Instructional content is periodically reviewed and adapted based on the academic progression of each cohort to ensure both the effectiveness and quality of experimental instruction.

In contrast, "comprehensive practice teaching" is aimed at cultivating students' preliminary research ability, practical application competence, and innovative thinking. It primarily corresponds to graduation projects (theses), selected elective courses, and extracurricular activities with strong interdisciplinary and design-oriented components. Examples include "Electronic System Design", "IC Layout Design", "Wireless Sensor Network Prototyping", and "Embedded System Integration using ARM Technology". Experimental and practical instruction is tightly integrated with theoretical teaching throughout the undergraduate education cycle and across core courses. Each phase of practical training builds upon the previous one in a scaffolded, progressively deepening structure.

As an institution committed to training high-level applied talents, the college places significant emphasis on the construction and enhancement of practice-based teaching infrastructure. Leveraging the industrial advantages of the southern Jiangsu region, the school has established and co-developed several innovation and entrepreneurship (I&E) platforms—most notably the "Three Innovation Academy"—and a network of stable on-campus and off-campus training bases. These bases support a wide range of practical activities including site-based instruction, production internships, capstone project placements, summer practice programs, and extracurricular student research initiatives, all of which have shown positive outcomes. Supervision at these internship bases is typically provided by seasoned industry professionals with rich practical experience, ensuring that university-industry collaboration in training yields effective results. In addition, the college regularly hosts "Laboratory Teaching Coordination Meetings", organizes "Summer Academic Weeks", and offers "Project Practice" courses focused on enhancing students' applied and project-execution capabilities. Collectively, these initiatives contribute meaningfully to improving students' innovative thinking and hands-on skills in a scalable and adaptable manner.

3.3 "Martial Arts" — Enhancing Holistic Competence Through Competition

In the "Singing, Reciting, Doing, and Martial arts" pedagogical framework, "Martial arts" refers to the development of students' capabilities in professional design and implementation through participation in discipline-related competitions, especially in the context of emerging engineering education. The Ministry of Education has formally incorporated academic competitions into practical education, advocating the principle of "promoting teaching and learning through competitions." This approach effectively motivates broad student engagement in extracurricular contests and serves as a powerful mechanism for strengthening engineering practice skills, team collaboration, and overall professional competence[11].

For programs in electronic information engineering, which focus on training students to solve complex engineering problems in the field, competitions often reflect cutting-edge technological trends and are increasingly aligned with authentic engineering practices[12]. The implementation of a competition-integrated teaching model encourages instructors to innovate their pedagogical approaches and contributes to the development of dual-qualified teaching teams, thereby enhancing instructional quality.

At the department level, provincial and national competitions are systematically reviewed and structured. Each year, selected students participate in prestigious events such as the National Undergraduate Electronic Design Contest and the Smart Car Competition. Additionally, the student union hosts internal design contests every semester, such as the Electronic Design and Development Competition, offering all students an accessible platform to enhance their practical skills. These competitions typically attract over 200 student participants and focus on real-world, application-oriented problems. Students who excel in internal competitions receive project-based training under faculty supervision and are subsequently prepared for national-level contests. Within the defined competition period, students independently select project topics, engage in group discussions to develop design concepts and solutions, gather technical references, conduct feasibility analyses, and proceed with system design and integration—including hardware/software co-design, component procurement, circuit assembly, debugging, and final product development—followed by comprehensive report writing. This process is intellectually and technically demanding, but it provides students with meaningful opportunities to construct knowledge, strengthen practical competencies, and enhance collaborative problem-solving skills.

4 Outcomes of the Integrated Model

The implementation of the integrated "Teaching–Learning–Practicing–Competing" (TLPC) model has significantly enhanced students' innovation awareness and practical competencies within the Electronic Information Engineering discipline. The following sections evaluate the outcomes over the past three academic years, aligned with the four pillars of the TLPC approach. Under the proposed TLPC integrated model, the cultivation of students' innovation awareness and practical ability has achieved significant outcomes.

From the perspective of "Learning" in the TLPC (Teaching–Learning–Practicing–Competing) model, student engagement has significantly improved. The pass rates for fundamental and professional core courses have steadily increased over consecutive academic years. Students have also demonstrated noticeable improvements in both autonomous learning and practical application capabilities. Notably, the postgraduate enrollment rate has risen consistently, reaching an average admission rate of approximately 20% over the past three years. To assess the effectiveness and reception of this instructional model, we conducted an anonymous online survey targeting students enrolled in the“Analog Electronic Technology”course, with a total of 130 valid responses collected from the 2021 cohort. The results indicate that while most students acknowledge the importance of this course and exhibit enthusiasm for the subject matter. Among the respondents, 82.3% agreed that experimental components were helpful in reinforcing theoretical knowledge. Furthermore, 67.7% suggested increasing the proportion of practical content in the course, and 71.5% expressed a desire to verify newly learned concepts through experiments. Notably, 96.9% believed that the course’s practical and innovative activities significantly contributed to their comprehensive skill development, particularly in contexts such as academic competitions and job interviews which as shown in table 1.

Table 1. Summary of Survey Results for Analog Electronic Technology Course

Survey Item	Yes (n/%)	No (n/%)
(1) Do you find learning Analog Electronic Technology difficult?	122 (93.8%)	8 (6.2%)
(2) Have you used external resources (e.g., online videos, books) to support learning?	102 (78.5%)	28 (21.5%)
(3) Do you think more hands-on experimental content should be added to the course?	88 (67.7%)	42 (32.3%)
(4) When learning a new concept, do you want to verify it through hands-on experiments?	93 (71.5%)	37 (28.5%)
(5) Do you find that experimental content helps you understand theoretical knowledge?	107 (82.3%)	23 (17.7%)
(6) Do you think the innovative and practical components of the course help in competitions or job interviews?	126 (96.9%)	4 (3.1%)

These findings confirm that integrating experimental and practical teaching not only enhances students’ conceptual understanding and initiative but also contributes to improved employment readiness. The increasing recognition from employers regarding students’ competencies further validates the effectiveness of the model.

On the practice side, the department has maintained full implementation of experimental and practical teaching, establishing over 20 internal and external practice bases and launching the Innovation and Entrepreneurship Academy. These platforms are equipped with adequate experimental resources to support innovation-driven training. Students are encouraged to participate in project-based modules under faculty guidance, conducting lab experiments, developing entrepreneurship projects, and implementing technical solutions. This has led to notable improvements in their practical abilities, creative thinking, and real-world problem-solving skills.

In terms of academic competition, students have achieved remarkable success in high-level national contests over the past three years. From 2022 to 2024, students from the department received 665 awards in total, including 346 in 2024 alone, with 86 being national-level recognitions which as shown in Figure 3. These competitions align with current technological trends and serve as valuable platforms for students to demonstrate their engineering design capabilities and collaborative skills.

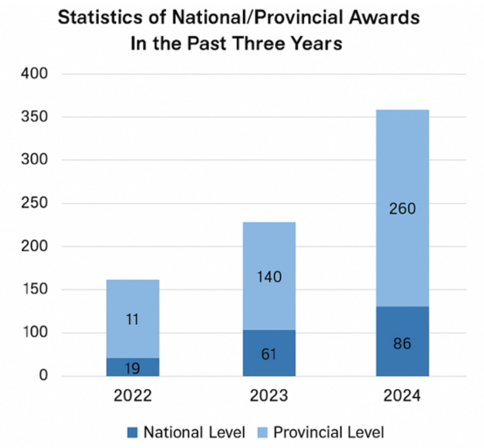

Fig. 3. Summary of Student Achievements in Professional and Innovation Competitions (2022–2024).

Students who participate in academic competitions tend to achieve higher employment rates and report greater career satisfaction. Their demonstrated technical competence and strong sense of collaboration are frequently recognized by both employers and graduate admissions committees. In recent years, the overall employment rate for these students has consistently exceeded 95%. Feedback from participants indicates that such experiences significantly enhance their hands-on skills and teamwork capabilities. More critically, competition-based learning has become a key driver for the continuous refinement of electronic information curricula, prompting substantive updates in course content and instructional strategies. This process has fostered a virtuous cycle in which theoretical knowledge and practical application reinforce one another.

5 Conclusion

This research draws on the core idea of the "Chanting, Recitation, Acting, and Martial arts" (commonly referred to as Chang-Nian-Zuo-Da) training and performance system from traditional Chinese opera and adapts it into a four-component educational model: "Teaching, Learning, Practicing, and Competing." This model emphasizes a closed-loop training mechanism designed to cultivate applied undergraduate students' learning approaches, innovation awareness, and practical abilities. Based on problem-, case-, and project-oriented learning paradigms, the model incorporates the characteristics of students in application-oriented programs. It emphasizes integrated curriculum design that combines theoretical instruction with laboratory experiments, project-based training, and course-related practical activities. This approach actively engages students and develops their innovative thinking and hands-on skills through comprehensive guidance in growth, knowledge acquisition, experimentation, and creative exploration.Students are encouraged to participate in extracurricular competitions and research-based activities during their spare time, enabling them to develop technical competencies and multiple skills, including independent learning, teamwork, communication, design innovation, and practical problem-solving.

In addition, the institution adopts a flexible, student-centered teaching strategy through multiple supportive policies such as skill certificate recognition, early graduation pathways, major transfers, merit-based rewards for standardized examinations, and dual-degree programs. These initiatives help support diverse student development trajectories and improve training outcomes.

Overall, this educational model prepares students for more professional and specialized learning in their future academic or career paths. It lays a solid foundation for solving complex engineering problems and contributing effectively to regional economic and technological development.

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