Exploration and Practice of Comprehensive Practical Teaching in Electronic Information Engineering

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Abstract. With the rapid advancement of high-tech industries, electronic information technology plays an increasingly significant role in societal production. Practical teaching has become essential for higher education to cultivate electronic information engineering professionals who meet contemporary demands. This paper examines the necessity, current status, challenges, and reform strategies of comprehensive practical teaching in electronic information engineering. The objective is to enhance students' comprehensive and innovative capabilities by optimizing the practical teaching framework. Key measures include the development of a task- and student-centered practical teaching model, the strengthening of faculty development, and the improvement of laboratory teaching management. These initiatives provide robust support for training skilled professionals in electronic information engineering.

Keywords: Electronic Information Technology; Engineering Education; Practical Teaching; Teaching Reform

1 Introduction

With the rapid advancement of information technology, the demand for professionals in Electronic Information Engineering is increasingly urgent[1-3]. As crucial centers for talent cultivation, higher education institutions are responsible for training high-quality engineering and technical professionals with solid theoretical foundations and practical skills[4][5]. However, significant issues exist in the current teaching of Electronic Information Engineering programs, such as outdated theoretical course content, weak practical components, and insufficient faculty strength. These problems severely restrict the quality of talent cultivation[6][7]. Therefore, strengthening comprehensive practical teaching in Electronic Information Engineering and reforming traditional teaching models have become key to enhancing the quality of talent development.

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2 The Necessity of Comprehensive Practical Teaching in Electronic Information Engineering

2.1 Adapting to Industry Needs and Cultivating High-Quality Talent

As a strategic emerging sector of the national economy, the electronic information industry is characterized by rapid development and extensive influence. This growth has led to a diversified and multi-level demand for talent. Higher education institutions, serving as the cradle for talent cultivation, must closely follow industry development trends and continuously adjust and refine their talent training programs to meet the industry's demand for high-quality professionals. By strengthening comprehensive practical teaching, institutions can cultivate students' practical and innovative abilities, equipping them with the skills to solve real-world problems. This approach ensures that graduates are better prepared to adapt to the evolving needs of the industry.

2.2 Enhancing Teaching Quality and Promoting Educational Reform

Practical teaching is an essential component of higher education and an effective means of enhancing teaching quality. Through comprehensive practical teaching, educators can assess students' mastery of theoretical knowledge, identify instructional process shortcomings, and promote educational reforms. Additionally, practical teaching can stimulate students' interest and enthusiasm for learning, foster their autonomous and lifelong learning ability, and lay a solid foundation for their future career development.

2.3 Advancing Academic Disciplines and Fostering Research Innovation

Electronic Information Technology is a highly applied discipline whose level of development directly influences national technological advancement and economic growth. Comprehensive practical teaching can advance the discipline's development and promote research innovation. During practical activities, students are exposed to cutting-edge scientific technologies and research achievements, enabling them to understand industry development trends, stimulating their research interests, and enhancing their innovative capacities. Furthermore, practical teaching can provide experimental data and validation platforms for research endeavors, facilitating the translation and application of research outcomes.

3 Current Status of Comprehensive Practical Teaching in Electronic Information Engineering

3.1 Inadequacies in the Practical Teaching System

Many higher education institutions continue to emphasize theoretical instruction over practical training in Electronic Information Engineering programs. The practical teaching system is underdeveloped, with poorly designed practical components that lack systematization and coherence. This results in students struggling to establish a comprehensive knowledge base and practical skills during their training, failing to meet industry development's evolving demands. In top universities such as Harvard University in the United States, practical teaching has become equally important as theoretical teaching and has become a source of innovation for students.

3.2 Outdated Laboratory Equipment and Insufficient Teaching Resources

With the continuous advancement of electronic information technology, the rate of laboratory equipment updates has been accelerating. However, many higher education institutions face challenges such as outdated laboratory equipment due to insufficient funding or poor management, rendering them incapable of meeting the demands of practical teaching. Additionally, teaching resources, including textbooks, courseware, and laboratory manuals, are inadequate and lack timely updates and improvements. This deficiency adversely impacts the effectiveness of practical teaching.

3.3 Weak Faculty Strength and Inconsistent Teaching Quality

Teachers are the primary agents of practical teaching, and their teaching proficiency and practical abilities directly impact the quality of practical education. However, many higher education institutions face challenges in their Electronic Information Engineering programs, characterized by weak faculty strength and inconsistent teaching quality. Some instructors lack practical experience and skills, rendering them ineffective in guiding students through practical learning. Additionally, certain teachers employ outdated teaching methods that lack innovation and specificity, failing to meet the demands of modern practical teaching.

4 Reform Measures for Comprehensive Practical Teaching in Electronic Information Engineering

4.1 Developing a Task-Centered Practical Teaching Model

A task-centered practical teaching model can be developed to enhance students' practical and innovative abilities. This model decomposes practical teaching tasks into several specific projects or assignments, allowing students to learn and master relevant knowledge and skills by completing these tasks. By adopting a project-driven and task-oriented approach, students' interest and enthusiasm for learning are stimulated, fostering their abilities for autonomous learning and teamwork. Additionally, by engaging in real-world projects or tasks, students are exposed to the latest scientific technologies and research achievements, enabling them to understand industry development trends and broaden their perspectives and thinking.

Establishing Clear Task Objectives.

In practical teaching, instructors should establish clear task objectives to help students understand the purpose and significance of their practical activities. These objectives must be operational and measurable, enabling students to comprehend their learning tasks and track their progress. Additionally, task objectives should possess a certain level of challenge and innovation to stimulate students' interest in learning and enhance their innovative capabilities.

Task Decomposition and Implementation Planning.

Instructors should decompose these tasks into several specific sub-tasks and develop detailed implementation plans to complete practical tasks. The implementation plan should encompass task decomposition, time scheduling, personnel distribution, and resource requirements. By formulating an implementation plan, the smooth execution and effective completion of practical tasks can be ensured.

Encouraging Autonomous Learning and Teamwork Among Students.

Instructors should guide students in autonomous learning and team collaboration in the practical teaching process. By providing relevant resources such as textbooks, courseware, and laboratory manuals, instructors can help students acquire the necessary knowledge and skills. Additionally, organizing group discussions and team collaboration activities fosters students' abilities in teamwork and communication. Through autonomous learning and team collaboration, students can learn from one another, assist each other, and collectively enhance their practical and innovative capabilities.

Assessing Task Completion and Providing Feedback for Improvement.

Upon completing practical tasks, instructors should evaluate the task performance and offer feedback for improvement. The evaluation should encompass aspects such as the quality of task completion, progress, and innovation. Through this evaluative feedback, students can identify their areas of weakness and promptly make improvements to enhance their practical abilities. Concurrently, instructors can adjust the content and methods of practical teaching based on the evaluation results, thereby enhancing the quality and effectiveness of practical education.

4.2 Strengthening Faculty Development and Enhancing Teaching Quality

Teachers are the primary agents of practical teaching, and their pedagogical competence and practical abilities directly influence the quality of practical education. Therefore, strengthening faculty development and enhancing teaching quality is crucial for reforming practical teaching.

Recruiting Outstanding Talent to Enrich the Faculty Team.
Higher education institutions should actively recruit outstanding talent to strengthen the faculty team within the Electronic Information Engineering program. By hiring professional instructors with extensive practical experience and innovative capabilities, the faculty's overall quality and teaching standards can be enhanced. Additionally, by incorporating external resources such as industry experts and scholars, students can have broader learning perspectives and enhanced practical opportunities.

Enhancing Teacher Training and Improving Teaching Quality.
Higher education institutions should strengthen the training of faculty members in Electronic Information Engineering programs to enhance their teaching quality and practical abilities. By organizing faculty participation in academic conferences, seminars, training workshops, and other activities, institutions can stay informed about industry development trends and the latest research achievements, thereby updating educational philosophies and teaching methods. Additionally, conducting teaching observations, teaching competitions, and other activities can promote communication and learning among faculty members, thereby improving teaching quality.

Establishing Incentive Mechanisms to Encourage Active Participation in Practical Teaching.
Higher education institutions should establish incentive mechanisms to encourage teachers to engage actively in practical teaching. By setting up practical teaching reward funds and selecting outstanding practical teaching educators, teachers are motivated to dedicate themselves to practical teaching work. Additionally, by collaborating with enterprises to conduct research projects and jointly establishing practical training bases, institutions can provide teachers with more practical opportunities and platforms, thereby enhancing their teaching quality.

4.3 Optimizing Experimental Teaching Management and Boosting Experimental Teaching Quality

Experimental teaching is a crucial component of practical teaching, and its quality directly impacts students' practical and innovative abilities. Therefore, optimizing experimental teaching management and improving the quality of experimental teaching are necessary measures for reforming practical teaching.

Enhancing the Development and Management of Experimental Equipment. Support for constructing and managing practical teaching conditions is also an important aspect that requires focused attention. Higher education institutions should strengthen the development and management of experimental equipment to ensure its operational integrity and availability. By increasing financial investment and updating experimental equipment, experimental equipment performance and standards can be improved. Additionally, institutions should establish and improve experimental equipment management systems and maintenance mechanisms to ensure the regular operation and effective use of experimental equipment.

Optimizing the Content and Methods of Experimental Teaching. Higher education institutions should optimize the content and laboratory teaching methods to align with industry development demands and students' needs. This can be achieved by updating laboratory textbooks, improving laboratory manuals, and implementing other measures to ensure the timeliness and accuracy of laboratory teaching content. Additionally, various teaching approaches and techniques, such as case-based teaching, project-based learning, and virtual simulations, should enhance students' practical skills and innovative capabilities.

Enhancing the Assessment and Evaluation of Laboratory Teaching. Higher education institutions should strengthen the assessment and evaluation of laboratory teaching to ensure practical improvements in instructional quality. Establishing standardized assessment criteria and a well-defined set of evaluation metrics can facilitate a comprehensive and objective review. Additionally, institutions should implement a feedback mechanism to promptly gather and address student opinions and suggestions, thereby continuously refining and enhancing laboratory teaching.

In addition, the evaluation of these reform measures is also an important issue to consider, which is related to whether these reform measures can be maintained on the right path, and can be specifically studied in the future.

5 Case Studies of Comprehensive Practical Teaching in Electronic Information Engineering

The Electronic Information Engineering Comprehensive Practice Teaching Team, part of the Information Confrontation Technology major at the Electronic Countermeasures Institute of the National University of Defense Technology, adopts the CDIO (Conceive, Design, Implement, Operate) engineering education philosophy. Centered on students and guided by the goal of enhancing electronic information system design capabilities, the team designs sub-projects for comprehensive practice in Electronic Information Engineering. Students fulfill project requirements while integrating knowledge and strengthening their engineering practice skills through overall system design, detailed design, software and hardware design and simulation, actual development and fabrication, and system debugging. This approach continuously cultivates students' engineering thinking, scientific thinking, and systems thinking and develops their teamwork and communication abilities through hands-on practice. The primary teaching strategies are as follows:

5.1 Promoting Interdisciplinary Integration to Enhance the Substance of Practical Teaching

The electronic countermeasure emphasizes cross-disciplinary integration by breaking down barriers between subfields such as communication, radar, and optoelectronics. Through the design of comprehensive practical projects, the focus is placed on the integrated application of knowledge from various specialized domains. At the same time, the integration of research and teaching is prioritized by regularly reviewing research outcomes to identify their alignment with course-based practical teaching. The latest scientific advancements are seamlessly incorporated into classroom instruction, dynamically updating teaching content to ensure students are exposed to cutting-edge theories and professional knowledge in electronic information. This approach fosters interdisciplinary collaboration and ensures that students grasp the latest advancements in the field, bridging the gap between theoretical learning and real-world application.

5.2 Strengthening Support to Establish World-Class Engineering Practice Teaching Conditions

The course implementation involves all engineering laboratories within the college, with the construction of practical teaching facilities as a key course development focus. Anchored in the "14th Five-Year Plan" key construction projects, the course is supported by three platforms: foundational technical training, professional skill practice, and system engineering application. These platforms enable full coverage of engineering practice education, progressing from "basic knowledge → professional knowledge → integrated knowledge." The practical teaching content evolves stepwise, advancing from "demonstration and verification → comprehensive design → innovation" in a low-to-high progression. Additionally, the communication, radar, and optoelectronics fields transition from "independent development" to "cross-disciplinary integration," achieving the design philosophy of "full coverage, progressive advancement, and interdisciplinary integration."

5.3 Fully Considering Students' Backgrounds and Allowing Self-Selection of Practice Projects

Since participating students come from various majors within the electronic information domain, their prerequisite coursework may differ slightly. Multiple open-ended projects are provided to leverage each student's strengths and align with their future career paths. Before the course begins, students form teams of their own choosing, with strong encouragement for cross-disciplinary collaboration—facilitating integration among diverse academic backgrounds. Under a self-selection model for practical projects, each team independently chooses a project of interest and conducts research based on its specific expertise and needs.

5.4 Learner-Centered, Outcome-Oriented Teaching Model Reform

The course emphasizes differentiated talent cultivation by accommodating students' varying abilities, recognizing that a single standard is insufficient for all learners. Practical projects are designed with progressive levels of difficulty, ranging from essential to advanced tasks. The more challenging stages are set as optional components, meeting the "two principles and one degree" requirement while catering to students' diverse capabilities and preferences for different difficulty levels. Additionally, the course promotes flipped classroom teaching reform. In alignment with the course's characteristics, theoretical knowledge is distributed to students online prior to class. During practical sessions, students are encouraged to actively engage by explaining and demonstrating theoretical and technical problems encountered during practice, thoroughly stimulating their initiative and participation. Furthermore, the course introduces reforms to process-oriented assessments, focusing on evaluating students' progress throughout the project. This includes designing tailored assessment methods, standardizing the format of practical reports, and enhancing students' project management skills and abilities.

5.5 Emphasizing Students' Central Role and Encouraging Innovation and Adaptability

Regarding teaching methods, the course underscores its practical nature, placing students at the center while instructors serve primarily as guides. For each practice project, the instructor leads students in a concise review of the necessary professional knowledge to establish a fundamental technical approach. Driven by clear task objectives, students independently consult reference materials, engage in group discussions to brainstorm, and design their experimental plans autonomously. To ensure ongoing progress, each group presents daily during the first class session, reporting on their understanding of the project, current progress, encountered challenges, and problem-solving processes. Instructors address questions and correct misconceptions as needed. From the perspective of practice implementation, the expected outcomes have been achieved. Sometimes, the instructor only briefly introduces specific methods, prompting students to broaden their thinking. Under proactive guidance, students consult relevant materials and undertake autonomous project design. This approach has enhanced their capabilities and demonstrates a "student-centered" reform in teaching methodology.

5.6 Adhering to the Principles of Knowledge and Competence Formation, and Reinforcing the Integration of Theory and Practice

By varying project requirements, experimental teaching has shifted from the traditional, step-by-step format to a model in which students design their experimental plans, control the experimental process, independently analyze the outcomes, and compose thorough experimental reports. During this practical process, learners construct knowledge, acquire new skills, and develop competencies. Throughout the course, instructors emphasize guiding students to consider the theoretical underpinnings behind experimental designs, strengthening the integration of theory and practice by using theoretical foundations to inform experimental plan development.

6 Conclusion

Comprehensive practical teaching in Electronic Information Engineering is key to cultivating high-caliber engineering and technical talents. Students' practical skills and innovative capabilities can be effectively enhanced by constructing a task-centered practical teaching model, reinforcing faculty development, and refining experimental teaching management. Concurrently, higher education institutions should actively establish practical teaching platforms, granting students broader learning perspectives and opportunities for hands-on practice. We can only cultivate high-quality engineering professionals who meet industry development requirements and significantly contribute to the nation's technological progress and economic growth through such efforts.

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