DOI: 10.23977/curtm.2026.090215
ISSN 2616-2261 Vol. 9 Num. 2

Innovation and Practice of Competition-Driven Analog Electronic Technology Course and Course Design of Fundamentals of Electronic Technology

Xiaodong Zhang[1,a], Lianrong Zhang[1,b], Haixia Xie[1,c,*], Xixi Fu[1,d,*], Linlin Zhang[2,e,*]

[1]*School of Ocean Information Engineering, Hainan Tropical Ocean University, Sanya, China*
[2]*Key Laboratory of Agro-Forestry Environmental Processes and Ecological Regulation of Hainan Province, School of Environmental Science and Engineering, Hainan University, Haikou, China*
[a]*zxdlab@163.com*, [b]*zlr0308@163.com*, [c]*86725673@qq.com*, [d]*xixifu@hntou.edu.cn*, [e]*6962zhanglinlin@163.com*
**Corresponding author*

Keywords: Electronic technology, Practical teaching, Competition, Marine characteristics, Test bank

Abstract: Against the backdrop of the maritime power strategy and in response to the local demand of Hainan Province, marine-related electronic and information disciplines are required to strengthen the cultivation of talents with distinctive marine characteristics. Analog Electronic Technology and the Curriculum Design of Fundamentals of Electronic Technology are core courses for electronic and information majors, yet the disconnection between theory and practice still restricts students' competitiveness in discipline competitions. Taking competition-driven education as the core goal, this study constructs a trinity integrated teaching model of "Theory-Practice-Competition". Combined with the knowledge popularization function of the marine characteristic test bank, it focuses on exploring new paths for professional talent cultivation. Adhering to the Outcome-Based Education (OBE) concept, this research enriches the theory of curriculum integration in engineering education, provides practical references for carrying out marine-characteristic and competency-oriented teaching reforms, and improves the training quality of engineering and practical talents in the field of marine information engineering.

1. Introduction

Electronic information disciplines in Hainan Province are deeply intertwined with marine engineering, creating an increasingly urgent demand for high-caliber professionals in this field who possess both industrial application expertise and marine-related knowledge. Analog/digital Electronics serves as the foundational course for electronic information disciplines, while Electronic Information Course Design functions as the practical implementation vehicle. Together, they form the core curriculum for electronic information programs at universities. However, three major challenges persist in teaching practice that require resolution: First, students exhibit weak foundations in analog/digital electronics, with no design-oriented open experiments following verification-based experiments. Second, the curriculum lacks strong alignment with competitions, resulting in insufficient capacity to obtain competition certifications. Third, there is a shortage of specialized resources integrating marine engineering, making it difficult to meet the demand for cultivating marine information engineering talent under the national strategy of building a maritime power. Therefore, based on the BOPPPS and OBE philosophy, researching how to drive innovation and implementation in the design systems of analog/digital electronics courses and electronic information courses through competitions is an urgent requirement for reforming the teaching system in higher education institutions[1-2].

The integration of courses within the curriculum framework is a key principle in engineering education reform. Against the backdrop of applied undergraduate education, we strategically integrate and align the numerous courses within the curriculum system to form a locally distinctive course structure. However, course integration exhibits a piecemeal approach. While combining several related courses creates an apparent overarching framework, it lacks progressive development in content. Competition-driven approaches represent one effective solution to this problem. By introducing competitions, students enhance their practical skills in engineering project design, decomposition, and optimization, while simultaneously improving their understanding and application of theoretical knowledge. Given the marine engineering context, integrating marine knowledge into the question banks for electronic information courses is also a crucial means of achieving curriculum convergence.

In summary, the competition-driven curriculum system exhibits significant shortcomings in organically integrating marine engineering specialization, developing question banks that blend marine knowledge with professional content, and establishing a closed-loop connection between competitions and courses.

2. Results and Analysis

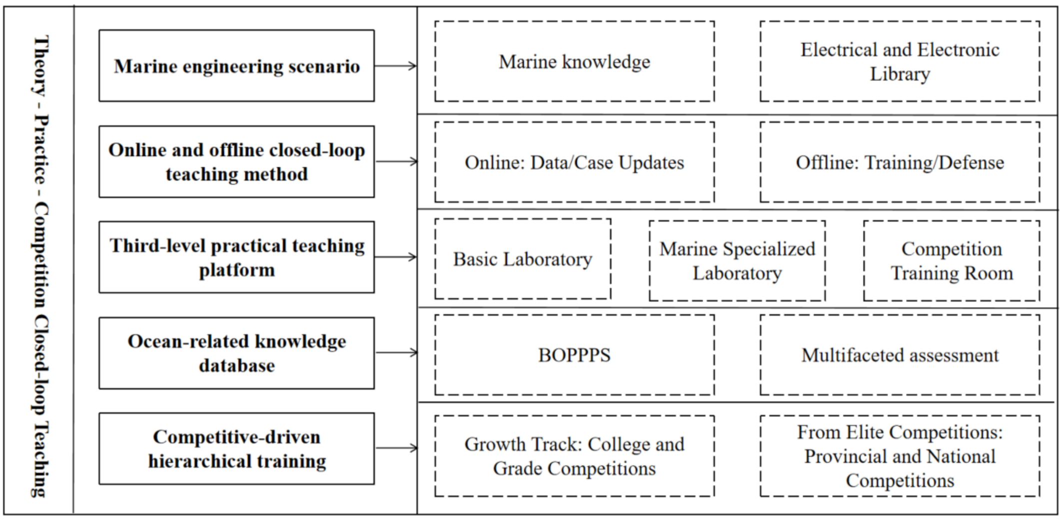

Figure 1: A competition-driven teaching model.

Figure 1 shows the competition-driven teaching model used in this paper. Based on the OBE philosophy, a trinity-integrated teaching model combining theory, practice, and competitions has been established. Its core logic centers on obtaining competition certifications as the training objective, leveraging marine engineering as the disciplinary specialty. By integrating simulation/digital electronics technology with electronic information course design as the vehicle, it bridges theoretical instruction, practical training and competition preparation to form a closed-loop system.

2.1. Integrating Teaching Content into Marine Engineering Scenarios

By integrating analog/digital electronics question banks and employing AI retrieval methods, we organically combine popular science marine knowledge with the question repository[3-4]. First, integrate operational amplifier problems with signal amplification circuits for marine environmental monitoring, and combine power supply circuit problems with marine equipment power system design. Second, implement electronic information course design projects in marine equipment applications, such as developing an underwater temperature-salinity-depth detection system based on the STM32 microcontroller. Third, competition-driven approaches align theoretical and practical course content with contest requirements. This involves analyzing past competition problems, deconstructing them, and integrating the insights into the teaching process.

2.2. Closed-Loop Teaching Method

A closed-loop system is formed by adopting traditional blended learning, project-based learning, goal-driven learning and flipped classroom mode. Online, supplementary learning materials, practical case studies of varying difficulty levels, and a question bank integrating marine knowledge are distributed via platforms such as WeChat groups. Offline, project briefings, hands-on training, seminars and defense sessions are conducted. Students are organized to independently study the contents of the experiment manuals, complete the experiments, and then participate in Q&A sessions before tackling more complex projects.

2.3. Establish a Practical Platform

Establish a three-tier practical teaching platform comprising foundational laboratories, marine specialty laboratories, and competition training labs. Basic laboratories continue to rely primarily on analog/digital electronics experiment kits to ensure the orderly conduct of foundational experiments. Marine specialty laboratories feature water tanks that simulate both surface and underwater environments, supporting experiments related to marine equipment. The competition training lab provides resources such as underwater robots, tracked vehicles, robotic arms, LiDAR systems, cameras, and Raspberry Pi devices, along with competition consumables, to enhance competition guidance.

2.4. Developing a Marine Knowledge Question Bank

The constructed question bank draws from midterm and final exam questions of the Analog/Digital Electronics course. Through AI-driven material expansion and manual curation, it organically integrates the exercises with marine knowledge.

2.4.1. Principles for Building a Question Bank

The question bank must first cover the core knowledge points of the Analog/Digital Electronics course, then integrate marine-specific knowledge to avoid generic questions. The question formats should adhere to tradition, ensuring an equal distribution between subjective and objective questions. The difficulty level should follow a normal distribution curve, progressively introducing problems from foundational exercises to competitive applications.

2.4.2. Core Content

The question bank comprises four major modules: multiple-choice questions, fill-in-the-blank questions, true/false questions, and calculation questions. Other question types (such as diagram-drawing questions and short-answer questions) are not required. The content of the question bank should cover fundamental electronic circuit analysis, such as “Operational Amplifier Design in Marine Sensor Interface Circuits” and “Design of Marine Environment Monitoring and Control Circuits.”

2.4.3. Application Mode

Employing the BOPPPS model, the comprehensive process—comprising pre-class introduction, goal clarification, pre-test, participatory learning, post-class assessment, and summary—seamlessly integrates pre-class, in-class, and post-class activities to ensure effective course evaluation. Implementing this plan requires using student self-assessment data as the primary analytical focus, supplemented by periodic assessments and final exam scores. It should also minimize disruption to students' extracurricular time to avoid generating subjective resistance that could hinder the plan's execution.

2.5. Competition-Driven Matching for Certificate Acquisition

This study implements the OBE philosophy through competition-driven education, establishing a teaching system comprising “tiered cultivation, specialized training, and competition participation”. Based on student self-assessments and scores from theoretical course periodic tests and final examinations, students are divided into two groups: the Growth Track (focusing on strengthening fundamental practical skills and participating in college-level and university-level competitions) and the Elite Track (focusing on enhancing advanced practical skills and striving for awards in provincial and national competitions). To assess the marine knowledge students have acquired from the question bank, this study proposes organizing an internal competition that simulates the real competition process and adheres to provincial competition standards for scoring. The scoring will be conducted by faculty members associated with the curriculum system, who will evaluate and summarize based on actual outcomes. Additionally, a designated competition period is required for the competition, ideally lasting 2 to 3 days, to facilitate intensive competition training.

3. Discussion

3.1. Innovative Features

The core innovations of this study are reflected in three aspects. First, it breaks through the traditional curriculum framework by integrating marine knowledge into the course system, aligning with policy directives while matching the cultivation of electronic information professionals with the talent needs of marine engineering. Second, it pioneers the development of an ocean knowledge question bank, filling a gap in specialized question repositories, enriching disciplinary distinctiveness, and establishing a tripartite teaching loop integrating “theory-experiment-competition”. Third, it establishes a tiered competition-oriented teaching system. When faculty resources permit, this enables tailored instruction, ensuring no student with learning difficulties is left behind, thereby enhancing the ability to obtain competition certifications.

3.2. Benefits of the Ocean-Themed Test Bank

The Ocean-Specific Question Bank serves as a distinctive resource for marine-focused universities, providing a replicable model for subsequent course development in related disciplines and programs. At the same time, marine knowledge from the specialized marine question bank serves as a vehicle to help students grasp theoretical concepts, deepen their understanding, and enhance their interest in learning.

4. Conclusions

The "theory-practice-competition" trinity teaching model developed in this study integrates fragmented courses into a cohesive whole. After mastering fundamental analog/digital electronics technology, students can acquire practical skills through electronic information course design, thereby enhancing their ability to obtain competition certifications. This study proposes integrating marine-specific knowledge with periodic assessments and final examinations in theoretical courses to establish a specialized marine question bank, thereby enhancing the marine focus of the curriculum. This approach provides a reference for teaching reforms in other related disciplines. Future applications may extend to similar programs to validate the feasibility of this research framework. Additionally, the question bank can be further developed by incorporating the latest artificial intelligence systems to support teaching. Strengthening existing industry-academia collaborations could also explore effective mechanisms and pathways for joint talent cultivation.

Acknowledgements

Project supported by the Education Department of Hainan Province, project number: Hnjg2025ZD-49, Hnjg2026-121. Funded by Education Reform Research Project of Hainan Tropical Ocean University, project number: RHYjg2025-10, RHYxgnw2026-03.

References

[1] Yanlin Z. and Yun M. (2021) On the Practice of Online Participatory Teaching based on BOPPPS Model. Higher Education Exploration, 10, 5-9.

[2] Wei, Y. (2025) Application of the OBE-BOPPPS Model in the Course Overview of Spanish-Speaking Countries at Dalian. Porta Linguarum, 14, 187-209.

[3] Li, K.X., Wang, P.J. and Chen, G.W. (2025) How can AI be Integrated into Teacher Professional Development Programs? A Systematic Review based on An Adapted Technology-Based Learning Model. Teaching and Teacher Education, 168, 105219.

[4] Chen, P., Xi, Y., Jin, X.F., Sun, D.S., Chen, Q. and Guo, J. (2026) Exploration and Practice of a Generative AI-assisted Four-dimensional Integration Platform of "Teaching, Learning, Evaluation, and Research" for The Biochemistry and Molecular Biology Courses. Progress in Biochemistry and Biophysics, 53, 789-800.