Article

Exploration and Practice of Marine Technology Talent Training Model from the Perspective of Maritime Power Strategy and Integration of Science and Education

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Abstract: Building a maritime power constitutes a core strategic arrangement for China's long-term development. As a key discipline supporting marine resource exploration, marine ecological management, marine equipment research and development as well as marine spatial governance, marine technology determines the core competitiveness of national marine science and technology and the development ceiling of marine industry. At present, domestic marine technology talent training generally suffers from insufficient integration of scientific research and teaching, separation between theoretical teaching and practical research, weak engineering innovation capacity of students and imperfect interdisciplinary education system, which can hardly meet the diversified and high-level talent demands in the marine industry in the new era. Supported by national key laboratories, accumulated research projects and the construction advantages of first-class discipline development in smart marine technology and engineering, this study takes in-depth integration of science and education as the core reform orientation to reconstruct the education and teaching system of marine technology majors. A four-in-one innovative talent training model integrating curriculum, scientific research, platforms and supervisors is established and implemented. A hierarchical and progressive case-based curriculum system is developed based on cutting-edge disciplinary progress and practical industrial demands, and a regular mechanism is set up to transform various research achievements into accessible resources for classroom teaching and practical training. Immersive full-process scientific research training is carried out relying on national major research projects and provincial and ministerial key platforms to cultivate students' comprehensive ability to judge, analyze and solve practical scientific and complex engineering problems independently. Meanwhile, a collaborative supervision system characterized by interdisciplinary integration and industry-university-research linkage is constructed to foster students' team awareness and cross-disciplinary innovative thinking. Adopting a steady implementation approach of pilot exploration, dynamic optimization based on multi-party evaluation and gradual promotion of mature models, a highly replicable and popularizable talent training system featuring science-education integration is finally formed, together with a standardized and systematic professional teaching resource library. The research findings can continuously deliver high-quality reserve talents for the self-reliance and self-improvement of domestic marine science and technology, and provide mature references and practical evidence for education reform of marine technology majors in similar domestic universities.

Keywords: maritime power strategy; integration of science and education; marine technology; talent training model; four-in-one framework; innovation ability

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1. Introduction

With the continuous expansion of the marine economy, the growing emphasis on maritime safety and security, and the gradual improvement of marine disaster prevention and mitigation systems, the marine technology industry is embracing unprecedented

development opportunities, which places stricter requirements on the comprehensive qualities of professional talents [1]. Marine technology integrates knowledge from marine science, electronic information, automatic control, computer big data, mechanical engineering and other disciplines. It is characterized by profound theoretical content, rapid technological iteration, strong engineering practicality and a prominent interdisciplinary nature. The industry urgently needs a large number of interdisciplinary, innovative and practical technical talents with a solid theoretical foundation, proficient operational skills, independent innovative thinking and an overall planning vision [2].

From the perspective of domestic undergraduate education, the traditional marine technology talent training mode is restricted by multiple inherent drawbacks. On one hand, classroom teaching content fails to keep pace with cutting-edge marine technology development, and textbook theories are greatly disconnected from current research hotspots and industrial production reality, resulting in outdated knowledge and limited vision among students [3]. On the other hand, distinct boundaries exist between teaching and scientific research. High-quality research resources such as research projects, experimental data, patented technologies and offshore test cases can hardly be incorporated into daily teaching, forming a long-standing separation between scientific research and classroom education [4]. In addition, practical teaching is dominated by basic verification experiments, lacking opportunities to participate in real research projects and offshore engineering scenarios, which leads to students' inadequate ability to tackle complex practical problems [5]. Furthermore, the fixed mode of single-discipline teaching and individual supervisor guidance breaks internal correlations among disciplines and fails to adapt to the cross-border integration trend of marine technology [6]. Students see slow progress in interdisciplinary innovation and team collaboration competence, making the overall talent training quality incapable of satisfying talent supply requirements for maritime power construction [7].

Marine powers in Europe, America and the Asia-Pacific region have developed mature and stable marine innovative talent training modes after decades of development, whose educational experience offers valuable references. Supported by world-class research institutions including Scripps Institution of Oceanography and Woods Hole Oceanographic Institution, the United States integrates undergraduate education into large-scale national and international marine scientific programs such as Ocean Observatories Initiative and Integrated Ocean Drilling Program [8]. Curriculum design closely focuses on technical essentials of research projects, realizing seamless connection between classroom learning and scientific practice. Marine research institutes affiliated to the Helmholtz Association in Germany and the National Oceanography Centre in the United Kingdom attach great importance to the interdisciplinary attributes of marine technology. They integrate knowledge of mathematics, physics, engineering and ecological environment during education to cultivate compound knowledge structure among students [9]. The European Marine and Maritime Research Consortium gathers educational resources from multiple countries including Vrije Universiteit Brussel and Nantes University, organizing transnational supervisor teams to deliver joint lectures and research guidance and broaden students' international academic horizons. Prestigious Japanese universities such as the University of Tokyo and Waseda University establish long-term cooperative education platforms with leading heavy industry enterprises including Mitsubishi Heavy Industries and Kawasaki Heavy Industries to cultivate targeted talents for marine equipment research and development [10]. Australian universities strengthen cooperation with government-affiliated research and administrative departments represented by the Australian Institute of Marine Science, implementing industry-university-research collaborative education based on practical demands of marine administration and ecological supervision [11]. Common characteristics of these mature training modes include high-level research platforms as fundamental support, research projects transformed into core teaching content, and standardized long-term industry-university-research cooperation systems to guarantee talent training conforms to industrial development reality.

Domestic higher education circles have long recognized the vital role of science-education integration in marine talent cultivation, and many key universities have carried out relevant explorations. Ocean University of China launches elite marine talent honor programs and optimizes curriculum structure relying on its comprehensive marine discipline system [12]. Shanghai Jiao Tong University sets up interdisciplinary joint supervisor teams based on its strengths in ship and marine disciplines to explore innovative educational paths [13]. The National Natural Science Foundation of China opens undergraduate research funding pilot projects nationwide to select outstanding students for fundamental scientific research. The Ministry of Education continuously approves special collaborative education programs to encourage undergraduates to participate in research work. Nevertheless, remarkable deficiencies still exist in domestic science-education integrated education. Firstly, integration remains superficial. Most universities simply combine classroom courses with extracurricular research projects without establishing long-term mechanisms for transforming research achievements into teaching resources. Secondly, professional characteristics are not prominent. Reforms fail to design whole-process training schemes in accordance with the interdisciplinary and practical nature of marine technology, leading to homogeneous educational modes. Thirdly, popularization faces great difficulties. High-quality existing training outcomes are mostly confined to small-scale elite classes relying on high-quality student sources and exclusive faculty resources, which cannot be widely promoted in ordinary universities.

Rooted in profound research accumulation of the Institute of Oceanographic Instrumentation, Shandong Academy of Sciences, the School of Marine Technology Science of Qilu University of Technology owns multiple national-level research platforms such as the National Engineering Research Center for Marine Monitoring Equipment and the National Joint Research Center for International Marine Instrumentation Equipment. It also undertakes the construction task of the first-class discipline of smart marine technology and engineering. The school has formed distinctive research and teaching advantages in subdivided fields including marine acoustic detection, marine optical monitoring, marine big data processing and intelligent marine instrument development. Since the implementation of integrated science-education schooling, the school has closely responded to talent demands of maritime power strategy and comprehensively promoted in-depth teaching reforms targeting existing difficulties in talent training [14]. Based on systematic reference to advanced international marine talent cultivation experience and objective analysis of defects in domestic educational modes, this paper constructs a practical, replicable and promotable in-depth science-education integrated collaborative training model combining school conditions, professional characteristics and student backgrounds, providing innovative and feasible practical schemes for cultivating high-quality interdisciplinary marine talents in China [15].

2. General Ideas and Framework of Talent Training Reform

2.1. Core Reform Objectives

Adhering to the fundamental task of fostering virtue through education, this reform accurately targets talent gaps in marine detection, marine equipment, marine information and marine ecology during maritime power construction, and addresses practical problems including separation between scientific research and teaching, insufficient innovative literacy, superficial industry-education integration and inadequate interdisciplinary education. The concept of science-education integration runs through the whole four-year undergraduate education process, coordinating four core educational elements: curriculum teaching, scientific research, platform utilization and supervisor guidance. The reform aims to synchronize teaching content with cutting-edge marine technology and industrial job requirements, realize mutual connection, full opening and shared utilization of internal research and practical training platforms, embed research projects into the whole process of daily learning, curriculum design and graduation design, and promote joint education by internal professional teachers, interdisciplinary

teachers and industrial experts. A distinctive, highly adaptable and versatile marine technology talent training system will be established to enhance graduates' comprehensive competitiveness and support independent innovation and sustainable development of domestic marine science and technology.

2.2. Overall Reform Ideas

Guided by national maritime strategy, disciplinary frontiers and practical industrial engineering problems, the reform fully mobilizes resources of national key laboratories, provincial and ministerial research platforms and first-class discipline construction, and establishes the four-in-one talent training model consisting of curriculum, scientific research, platforms and supervisors. The hierarchical progressive case-based curriculum system consolidates students' professional theoretical foundation and research cognition. Full-cycle practical research training improves students' engineering operation and problem-solving capacity. Large-scale professional research platforms build immersive practical scenarios. Diversified collaborative supervisor teams guarantee high-quality talent cultivation. Standardized procedures are formulated to regularly and systematically convert research papers, patented prototypes, experimental data and technical schemes into classroom courseware, practical training projects and teaching cases. Three core transformations are realized: from single textbook knowledge imparting to all-round comprehensive ability cultivation, from closed classroom learning to integrated study combining courses, research and industry, and from individual independent learning to team-based innovative exploration, fully conforming to the growth law of modern marine technology talents.

2.3. Framework of the Four-in-One Model

The four-in-one talent training model consists of four interrelated, mutually supportive and closed-loop core components, forming a complete science-education integrated educational system. The curriculum system serves as the basic carrier of talent training, building progressive case-based course groups adapting to marine technological development and industrial job demands. Scientific research acts as the core path for ability improvement, organizing students to participate in immersive practical research based on vertical national and provincial research projects and horizontal industrial cooperation programs. Research platforms function as crucial practical carriers, with laboratories, offshore test sites and instruments fully open to create authentic standard engineering practice environments. Supervisor teams are the key guarantee for education quality. Compound guidance groups composed of internal interdisciplinary teachers, external industrial experts and research institute researchers provide targeted all-round academic guidance according to individual student characteristics. The four elements empower and coordinate with each other to build a stable and efficient science-education integrated educational system.

2.4. Construction of Hierarchical Curriculum System and Transformation of Scientific Research Achievements into Teaching Resources

Objectives of Curriculum Reform: The reform breaks the long-term separation between theoretical and practical courses and abandons rigid textbook-based teaching modes. In-school research projects, real offshore engineering cases, cutting-edge technological achievements and practical industrial technical difficulties are fully decomposed into classroom cases, in-class operational tasks and extracurricular comprehensive training assignments. A progressive, case-rich and research-oriented professional curriculum system is constructed in line with knowledge accumulation rules. It gradually consolidates students' professional basic knowledge, broadens their industrial vision, and comprehensively improves their three core competencies: scientific thinking, engineering operation and technological innovation.

2.5. Hierarchical Case-Based Curriculum System

2.5.1. Basic Enlightenment Stage (Freshman and Sophomore Year)

This stage focuses on general education and professional introductory courses, including Fundamentals of Oceanography, Signals and Linear Systems, Basic Electronic Technology, Principles of Marine Acoustics and Fundamentals of Marine Optics. Teachers abandon pure theoretical indoctrination and incorporate classic research cases of offshore environmental monitoring, seabed terrain detection and marine meteorological observation conducted by school research teams into knowledge explanation. Close connections between textbook theories and practical research work are established combining real observation data, offshore experimental phenomena and basic technical problems. Vivid research examples help freshmen and sophomores quickly understand professional connotation, form preliminary scientific thinking, stimulate learning enthusiasm and research initiative, and achieve smooth transition from exam-oriented high school study to exploratory university study.

2.5.2. Professional Improvement Stage (Sophomore and Junior Year)

Core professional courses such as Marine Monitoring Technology, Marine Instrument Design, Marine Information Processing, Marine Big Data Analysis and Marine Remote Sensing Application are offered in this stage. Technical principles, research difficulties and innovative achievements of high-level research programs including national key research and development plans, National Natural Science Foundation projects and major provincial science and technology special projects are decomposed into modular teaching cases. Modern teaching methods including project-based learning, group case discussion and flipped classroom are widely adopted to enhance student participation. Elective frontier seminars on marine technology are arranged, delivered alternately by academic leaders and senior researchers to introduce the latest technological trends and industrial development prospects in marine detection equipment, intelligent marine perception and marine ecological big data, keeping students updated with disciplinary progress.

2.5.3. Comprehensive Practical Stage (Junior and Senior Year)

This stage focuses on comprehensive application ability and job adaptability training. Practical courses covering Integrated R&D of Marine Equipment, Comprehensive Marine Technology Training, Innovation Competition Guidance and Academic Thesis & Graduation Design Writing are set. Learning tasks are derived from entrusted industrial technical development projects and in-school vertical research programs rather than virtual exercises. Students work in teams to complete full-cycle work including scheme design, equipment assembly and commissioning, massive observation data analysis, system program optimization and achievement report summary, highly simulating daily working modes of marine technology enterprises and research institutes and shortening the adaptation period between campus study and professional employment.

2.6. Transformation Mechanism from Scientific Research Achievements to Teaching Resources

To sustain teaching content updating and resource enrichment, the school establishes standardized regular management systems for research achievement filing and teaching transformation. Researchers regularly sort ongoing projects, authorized invention patents, self-developed algorithm models, accumulated marine observation datasets, industrial technical specifications and engineering acceptance reports. These materials are classified and archived to continuously enrich three fundamental teaching resource libraries: case library, practical project library and examination question bank. Large-scale offshore observation buoys, high-precision acoustic and optical testing instruments and underwater detection equipment are integrated with digital technology to develop virtual simulation experimental courses, making up for limitations of high cost, high risk and restricted sites in offshore field practice. Binding rules for dynamic curriculum updating are formulated, requiring no less than 15% renewal of frontier research cases and emerging technical content in core professional courses every semester, ensuring teaching content synchronizes with cutting-edge and mainstream applied marine technologies.

2.7. Practical Scientific Research Training Supported by Major Platforms and Projects

2.7.1. Full-Coverage Hierarchical Research Training System

The school fully implements three early cultivation plans: early access to laboratories, research teams and research projects, breaking restrictions that research resources are only available to senior students. Starting from the sophomore year, all undergraduates are assigned to different research groups according to personal interests and academic performance. Students participate in complete research procedures including literature retrieval and reading, experimental scheme design and verification, instrument operation and sample testing, statistical data sorting, research report compilation, patent application preparation and academic exchanges. Training levels are divided into basic assistance, independent operation and innovative tackling based on grades and knowledge reserves. Systematic research literacy cultivation is carried out progressively to ensure comprehensive research experience for every student.

2.7.2. Empowerment by Major Research Platforms and Projects

National key laboratories, National Engineering Research Center for Marine Monitoring Equipment, Marine Acoustics Laboratory, Marine Big Data Processing Center and other high-level platforms are fully open to students with no access thresholds. Students are encouraged to participate in national and provincial major marine research special projects, engaging in practical engineering tasks such as marine buoy and submersible R&D, offshore field exploration tests, marine remote sensing information inversion, underwater intelligent perception equipment development and marine environmental early warning system construction. Equipped with high-precision research instruments, standardized test sites and authentic marine monitoring data, students confront practical difficulties in research and engineering construction, improving equipment operation, fault diagnosis and scheme adjustment capabilities and enhancing problem-solving competence for complex engineering issues.

2.7.3. In-Depth Integration of Scientific Research Training and Academic Development

All four-year undergraduate academic tasks are overall planned to integrate curriculum design, course papers, graduation design, disciplinary innovation and entrepreneurship competitions and university and national innovation training programs with research training. Sub-research topics and practical industrial technical difficulties are prioritized as themes of curriculum design and graduation theses to guarantee practical research value. Themes of marine technology innovation competitions and Challenge Cup closely focus on industrial technical bottlenecks, with competition works evaluated in accordance with research standards. Students' research participation duration, experimental contribution, paper and patent output and competition awards are incorporated into daily academic assessment, merit evaluation, postgraduate recommendation and employment evaluation systems, realizing coordinated development of research ability and long-term personal academic growth.

2.8. Interdisciplinary Industry-University-Research Collaborative Supervision Mechanism

2.8.1. Establishment of 1+N+X Diversified Supervisor Teams

In view of the interdisciplinary characteristics of marine technology, the school innovatively adopts a 1+N compound hierarchical guidance group mode. One full-time internal teacher serves as the core supervisor to coordinate four-year overall cultivation planning, academic progress control and ideological growth guidance. Several interdisciplinary internal teachers act as auxiliary supervisors to provide professional technical guidance in electronic information engineering, artificial intelligence algorithms, automatic control, mechanical material engineering and other fields. External supervisors consist of technical directors of marine instrument enterprises, senior researchers of marine research institutes and industrial administrative experts, responsible for connecting students with industrial production standards, engineering application scenarios and actual job demands. Three-level supervisors cooperate to realize all-round guidance supported by multidisciplinary knowledge and integrated industry-university-research education.

2.8.2. Operation and Management Specifications of Collaborative Supervision

Dual and multi-supervisor joint guidance systems are strictly implemented with clear division of responsibilities. Core and interdisciplinary internal supervisors focus on academic norms, professional theories and research methodology teaching to consolidate students' academic foundation. External enterprise and institute supervisors explain industrial production standards, field engineering skills and professional ethics to improve students' job adaptability. Regular group meetings, academic salons and phased achievement reports are institutionalized to exchange research progress and enhance students' expression, communication and teamwork abilities. A complete management system covering supervisor education performance evaluation, students' research process records and quantitative innovative achievement assessment is established to guarantee effective implementation of all guidance work.

2.8.3. Special Cultivation of Cross-Innovation Capacity

Interdisciplinary compound research topics are set focusing on popular cross-border marine research directions including intelligent marine detection equipment, artificial intelligence-based marine environmental perception, marine big data mining and comprehensive marine ecological monitoring. Students are guided to break the boundaries of single-discipline knowledge and integrate electronics, computer science, mechanics and marine science to design schemes and conduct technological innovation, eliminating rigid single-subject thinking. Students' cross-border thinking and multi-technology integration innovation capabilities are cultivated during interdisciplinary exploration, fostering compound innovative talents adapting to industrial development trends.

2.9. Phased Implementation Approaches

2.9.1. Preliminary Pilot Practice

The reform is steadily promoted with representative classes of marine technology major selected as initial pilot groups. Four core reform measures including case-based teaching, full research team admission, unrestricted platform access and diversified grouped supervision are fully implemented in pilot classes. Talent training procedures adapting to faculty resources, equipment conditions and student foundations are explored during the pilot period. Emerging problems are recorded to formulate practical operational modes suitable for school reality.

2.9.2. Dynamic Optimization Based on Multi-Party Evaluation

A four-dimensional comprehensive evaluation system is established after pilot implementation, collecting feedback from undergraduates, frontline teachers, cooperative enterprise experts and peer professionals from domestic universities. All-round assessment is conducted based on four core indicators: curriculum learning effect, students' research participation initiative, innovative practical achievement output and graduate employment quality. Teaching cases, practical training projects, platform opening rules and supervisor allocation modes are optimized pertinently according to feedback suggestions to refine the four-in-one talent training model.

2.9.3. Gradual Promotion of Mature Modes

Experience summarized from pilot reforms is refined and defects are revised to form standardized unified talent training schemes for marine technology majors. A complete teaching resource library containing courseware, virtual simulation experiments, examination papers and research case materials is built, together with reform management systems and operational manuals. The mature training model is gradually promoted to related engineering majors including Measurement and Control Technology and Instrumentation as well as Marine Information Engineering. Reform achievements and practical experience are shared through academic exchanges and teaching seminars to provide references for marine-related education reform in peer universities nationwide.

3. Practical Effects and Characteristic Values of the Reform

3.1. Steady Improvement of Talent Cultivation Quality

After years of systematic reform practice, all undergraduates can regularly participate in various research activities with a 100% participation rate. The number of students winning awards in university, provincial and national disciplinary competitions increases year by year. Output of academic papers, national invention patents and software copyrights grows substantially. Graduates possess solid theoretical knowledge, proficient engineering skills and independent problem-solving capacity, gaining wide recognition from marine instrument enterprises and research institutes. The number of admitted postgraduate students keeps rising, and the employment rate in high-quality state-owned enterprises and high-tech enterprises grows steadily. Cultivated talents fully meet practical employment standards of maritime power construction.

3.2. Fruitful Achievements in Curriculum and Teaching Resource Construction

Supported by the research achievement transformation mechanism, a complete hierarchical case-based curriculum cluster is formed. Multiple university-level excellent courses and provincial high-quality courses are developed based on independent research resources, along with dozens of virtual simulation experimental projects adapted to professional teaching requirements. Professional textbooks featuring school cultivation characteristics and industrial technological status are compiled combining teaching and research experience. Rich and high-quality hardware and software teaching resources fully satisfy multi-level teaching demands including basic undergraduate education, research training and innovative expansion.

3.3. Improved Science-Education Integrated Educational Ecosystem

The reform fundamentally eliminates the separation between scientific research and teaching, establishing a virtuous educational cycle where research feeds classroom teaching, teaching boosts research tackling, large-scale platforms support practical education and multi-party supervisors jointly cultivate talents. Disciplinary construction, research platform strength and undergraduate talent cultivation promote each other synchronously, greatly enhancing the school's comprehensive strength and social influence in science-education integrated education.

3.4. Strong Versatility and Popularization of the Training Model

The proposed talent training model requires no special high funding, elite small-class arrangement or top-quality student sources. Equal high-quality education for all students can be realized relying on institutional construction and systematic management. Adaptable to the schooling characteristics of local high-level universities and educational conditions of ordinary marine technology majors, the model is free from restrictions of regions and platform scales, possessing high versatility and wide popularization value.

4. Conclusion

Against the background of in-depth advancement of maritime power construction, targeting prominent problems including separated research and teaching, insufficient innovative practical ability and deficient interdisciplinary education prevailing in domestic marine technology undergraduate education, the School of Marine Technology Science of Qilu University of Technology constructs and implements the four-in-one science-education integrated talent training model supported by national-level research platforms and first-class discipline construction advantages. The hierarchical progressive case-based curriculum system bridges the gap between research achievements and teaching resources. Immersive practical research training is carried out based on national major research projects and professional platforms. Interdisciplinary industry-university-research collaborative supervisor teams enhance students' cross-border innovation and teamwork competence. Phased steady implementation guarantees stable advancement and continuous optimization of educational reforms.

Long-term practical verification proves that the model effectively remedies drawbacks of traditional education and comprehensively improves students' research

literacy, engineering operation capacity and overall innovation level, breaking barriers between theoretical teaching, scientific research and industrial application. The complete and standardized training scheme forms a replicable and widely promotable marine technology talent cultivation paradigm. It continuously delivers high-quality professional reserve talents for domestic marine science and technology self-reliance, and provides feasible practical references for education reform of marine technology majors in universities across China.

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References

1. CPC Central Committee, *Secure a Decisive Victory in Building a Moderately Prosperous Society in All Respects and Strive for the Great Success of Socialism with Chinese Characteristics for a New Era*, Beijing: People's Press, 2017.
2. Q. Wang and F. Z. Li, "Problems and countermeasures of marine talent training in China," *Science and Management*, vol. 31, no. 2, pp. 30–36, 2011.
3. J. A. Liu and X. G. Sheng, "Dynamic mechanism, governance dilemma and breakthrough path of science-education integration—A case study of University of Chinese Academy of Sciences," *Chinese Higher Education Research*, no. 11, pp. 26–30, 2020.
4. Q. Ma, J. J. Guo, B. S. Zhang, et al., "Research on the '5333' education and training mode of naval architecture and ocean engineering talents," *Navigation Education Research*, vol. 37, no. 1, pp. 20–26, 2020.
5. Q. G. Huang, G. Pan, and X. Y. Zeng, "Specialty construction and practice of marine engineering general training under the background of emerging engineering—Taking School of Marine Engineering, Northwestern Polytechnical University as an example," *Education Forum*, no. 1, pp. 48–51, 2022.
6. W. Chen and Y. T. Xue, "Chinese logic of specialty construction," *Higher Education Exploration*, no. 4, pp. 11–17, 2021.
7. H. J. Li and Y. Liu, "Forging ahead toward the ocean: Constructing a future-oriented comprehensive marine discipline system," *Guangming Daily*, p. 15, Sep. 2, 2025.
8. P. H. Barber, D. E. Gawlik, M. G. Haygood, et al., "Re-envisioning undergraduate research experiences to increase diversity, equity, and inclusion in ocean sciences," *Oceanography*, vol. 34, no. 2, pp. 45–58, 2021.
9. K. Doulougeri, C. Panayiotou, and E. Michailidis, "Building interdisciplinarity in engineering education," *European Journal of Engineering Education*, vol. 45, no. 3, pp. 389–405, 2020.
10. T. Sato and K. Yamamoto, "Industry-university collaboration in marine engineering education in Japan," *Maritime Policy & Management*, vol. 49, no. 5, pp. 621–638, 2022.
11. L. Smith and M. Taylor, "Government-university-research cooperation mode of marine science talent training in Australia," *Ocean & Coastal Management*, vol. 209, p. 105678, 2021.
12. H. Tian, "Elite marine talent training practice of Blue Dream Cultivation Program," *China Higher Education*, no. 23, pp. 56–58, 2025.
13. J. M. Yang, H. X. Xue, S. X. Fu, et al., "Exploration on marine engineering talent training under interdisciplinary joint supervisor system," *Research in Higher Education of Engineering*, suppl. 1, pp. 189–191, 2024.
14. H. M. Qiu, P. P. Fan, X. Y. Li, et al., "Research on construction of '2+2' engineering talent training curriculum system under science-education integration—Taking marine technology major of Qilu University of Technology as an example," *Shandong Higher Education*, vol. 13, no. 2, pp. 45–51, 2025.
15. W. D. Zheng, "Driving high-quality development of marine economy with talent engine," *Economic Information Daily*, p. 001, Apr. 15, 2026.

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