

Construction of a four-dimensional nurturing model for the cultivation of applied innovative talents in inland waterway ship and ocean engineering majors

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Abstract. This study aims to establish a four-dimensional nurturing model tailored for the cultivation of applied innovative talents within the inland waterway ship and ocean engineering majors. By conducting a thorough analysis of the current state of professional talent cultivation and identifying the principal challenges, the study delineates the theoretical underpinnings and constituent elements of the four-dimensional nurturing model. Furthermore, it investigates the model's application in the construction of curricular systems, the reform of practical teaching, the cultivation of innovative capabilities, and the enhancement of humanistic qualities. The research employs case analysis to empirically test the effectiveness of the model and devises an evaluation index system to assess its outcomes. Results indicate that the four-dimensional nurturing model significantly enhances students' comprehensive abilities, offering fresh perspectives and methodologies for professional talent development. Lastly, the study proposes recommendations for policy formulation and future research directions.

Keywords: Four-Dimensional Nurturing Model; Inland Waterway Ship and Ocean Engineering Majors; Applied Innovative Talents; Curricular System Construction.

1. Introduction

Amidst the surging tides of globalization and the growth of international trade, the inland waterway ship and ocean engineering industry is experiencing unprecedented development, leading to a sharp increase in the demand for professional technical talents equipped with innovative and applied skills. The traditional educational model, with its two-dimensional structure that emphasizes knowledge transmission and skill training, is insufficient to meet the rapid talent demands of the industry, particularly in cultivating students' comprehensive qualities and personalized development. Hence, seeking a new talent cultivation model that adapts to industry transformation has become a pivotal aspect of educational reform. This study proposes a four-dimensional nurturing model that integrates knowledge, abilities, qualities, and identity, aiming to construct a comprehensive talent training system. This system not only enhances students' professional and innovative capacities but also strengthens their humanistic qualities and sense of social responsibility. The implementation of this new model seeks to address the deficiencies of the existing talent training approach, cultivating high-quality, innovative talents that align more closely with industry needs, and offering innovative solutions for educational reform.

In the context of medical postgraduate education, Zhou Cui et al. [1] proposed a four-dimensional synergistic nurturing model under the purview of the "Comprehensive Ideological and Political Course," emphasizing the seamless integration of ideological and political education with professional education. Meanwhile, in the realm of higher vocational English education, Huang Minyan [2] examined the "Post-Course-Competition-Certification" comprehensive nurturing model, focusing on enhancing students' overall quality and professional competitiveness. Additionally, Liu Junnan and colleagues [3] applied the "Post-Course-Competition-Certification"

four-dimensional integration nurturing model in the field of higher vocational relay protection, providing valuable insights into talent cultivation for the power industry.

Wang Hui et al. [4] conducted a survey study on the satisfaction levels of marketing students, which corroborated the positive impact of the "Triple Creation, Four-Dimensional" practical nurturing model on enhancing student initiative, mastery of professional knowledge, and practical abilities. Zhai Yingjie [5] and Hou Haishao [6], respectively, implemented the four-dimensional collaborative nurturing model in medical education and the four-dimensional integrated nurturing model in higher education, underscoring the significance of cultivating comprehensive qualities in students.

In the field of art and design, Wang Cai [7] introduced the "Three Fusions and Four Dimensions" curriculum ideology and political education model, highlighting the significance of moral education and the integration of professional and ideological-political education. Li Shoutai and others [8] explored the "Four-Dimensional Integration" model of engineering training against the backdrop of "Internet+Innovation and Entrepreneurship," aiming to nurture "New Engineering" talents capable of undertaking significant national responsibilities.

Zhang Yan [9] and Liu Hongbo [10] have independently explored the "four-dimensional" comprehensive practice education model in vocational ideological and political courses and the "four-dimensional integrated" support education model for minority students, respectively. These models have been shown to effectively enhance practical education approaches. Meanwhile, Li Xiaohan et al. [11] investigated the "ideological and political education + research + teaching + entrepreneurship" four-dimensional collaborative education model for medical postgraduates. They found that the implementation of this model significantly improved educational outcomes, although some issues were also identified. This research contributes valuable insights into the effective cultivation of applied innovative talents within the fields of inland waterway ship and ocean engineering.

Studies on the identification of traditional Chinese medicine [12], the "Chinese Language + Vocational Skills" international education model [13], and the innovative implementation of the "Four Dimensions and Four Synchronizations" ideological and political nurturing model under the "Three-Pronged Education" concept [14] have all achieved notable success within their respective domains. The "Inspiring Women Classes" nurturing model implemented by Ma Yulin et al. [15] in frontier minority regions, Huang Zhijie's [16] secondary vocational education model predicated on career planning, Zhou Yuan et al.'s [17] research on the four-dimensional nurturing model in higher vocational colleges, Huang Yaolin's [18] exploration of the dormitory culture nurturing model in colleges, and the inquiries into the "Four-Dimensional Dynamic" practical nurturing model from the "Three-Pronged Education" perspective by Huang Shizhen [19] and Zhou Gang [20], have all contributed empirical evidence and theoretical backing for the construction of the four-dimensional nurturing model. This model seeks to holistically develop talents in inland waterway ship and ocean engineering majors by enhancing their knowledge, abilities, qualities, and identity dimensions.

2. Current Analysis of Talent Cultivation in Inland Waterway Ship and Ocean Engineering Majors

Firstly, the depth and breadth of collaboration between academia and industry require reinforcement. Although many educational institutions have established partnerships with corporations, these collaborations are often limited to specific projects or short-term internships, lacking a long-term, in-depth, and systematic cooperative mechanism. Insufficient involvement of enterprises in talent cultivation leads to a disconnect between educational content and industry demands.

Secondly, during the implementation of the integration between job positions and coursework, there is an issue of insufficient alignment between vocational qualifications and academic teaching. Some course content does not fully align with vocational qualification requirements, preventing

students from thoroughly mastering the professional knowledge and skills needed while obtaining vocational certificates.

Furthermore, in the integration of teaching and research, although many schools encourage faculty to engage in research activities, a divide between research and teaching still exists. Some educators focus on the output of research achievements, overlooking the positive impact research can have on teaching. Simultaneously, students have limited opportunities to participate in research projects and often lack systematic research training and guidance.

Lastly, in the practice of integrating competition training, there may be inequitable opportunities and resource distribution within academic competitions. Competitions are frequently concentrated among a select group of outstanding students, leaving the majority without the chance to participate and thus unable to enhance their practical abilities and professional skills through such contests.

3. Application of the Four-Dimensional Nurturing Model in the Cultivation of Applied Innovative Talents in Inland Waterway Ship and Ocean Engineering Majors

3.1 Construction of the Professional Curriculum System

The construction of the professional curriculum system is pivotal to the realization of the four-dimensional nurturing model. Key considerations include:

(1) Knowledge Dimension: The curriculum should encompass foundational theoretical knowledge in inland waterway ships and ocean engineering, such as ship structure, ship power systems, and marine environmental science. Concurrently, the curriculum must be continuously updated to integrate the latest industry trends and technological advancements, ensuring that students acquire cutting-edge professional knowledge.

(2) Ability Dimension: Practical teaching components, such as experiments, internships, and project research, should be strengthened to cultivate students' practical skills and engineering capabilities. Additionally, students should be encouraged to participate in scientific research projects and technical competitions to enhance their problem-solving and innovative abilities.

(3) Quality Dimension: The curriculum should incorporate humanities and social sciences, legal regulations, and professional ethics to foster students' sense of social responsibility, teamwork spirit, and professional integrity.

(4) Identity Dimension: Through collaboration with enterprises, industry lectures, and professional internships, students' identification with the inland waterway ship and ocean engineering industry should be strengthened, nurturing their professional identity as specialists in the field.

The curriculum system's construction should focus on the integration of theory and practice, professional knowledge, and vocational skills. Furthermore, interdisciplinary learning and international exchanges should be encouraged to broaden students' horizons and enhance their ability to adapt to diverse working environments.

3.2 Reform of Practical Teaching

The reform of practical teaching is a pivotal component in the implementation of the four-dimensional nurturing model aimed at cultivating applied innovative talents within the field of inland waterway ships and ocean engineering. The purpose of this reform is to enhance students' engineering practice abilities, innovative thinking, and professional skills to better meet the industry's demand for high-quality professional talent. The following are specific applications of practical teaching reform:

1. Increase the proportion of practical courses: Reevaluate and adjust the curriculum system to ensure practical courses are adequately weighted, allowing students more opportunities to reinforce theoretical knowledge through hands-on operation.

2. Establish training bases: Collaborate with industry enterprises to create both on-campus and off-campus training bases, offering platforms for practical training that closely mimic real work environments and strengthen students' hands-on experience.
3. Project-driven instruction: Implement a project-driven teaching model, engaging students in real or simulated engineering projects to learn and apply professional knowledge while solving practical problems.
4. School-enterprise collaboration projects: Deepen school-enterprise collaboration, encouraging students to participate in actual enterprise projects for internships and training, thereby closely integrating their learning activities with the production practices of enterprises.
5. Academic competitions and innovative practice: Encourage student participation in various academic competitions and innovative practice activities, stimulating their interest in learning and innovation capabilities through competitive and creative processes.
6. Real-time updates to teaching content: Regularly update practical teaching content based on industry development and technological advancements to ensure that the curriculum aligns with the latest industry standards and technologies.
7. Teacher team development: Strengthen the construction of the teaching staff by recruiting professionals with rich practical experience to serve as instructors, enhancing the practical teaching capabilities of teachers.
8. Evaluation and feedback: Establish a comprehensive practical teaching evaluation system, collect feedback from students, enterprises, and teachers, and promptly adjust and optimize practical teaching plans.

3.3 Cultivation of Innovative Capabilities

In the discipline of Inland Waterway Ship and Ocean Engineering, cultivating innovative capabilities constitutes a critical dimension of the four-dimensional nurturing model. These capabilities encompass innovative thinking, practical innovation, and innovation management, all of which are indispensable for students to adapt to industry developments and solve complex engineering problems. The following are specific applications for fostering innovative capabilities:

Firstly, students are encouraged to develop innovative thinking. Educators should integrate elements such as critical thinking, problem-solving, and creative thought into the curriculum design. Teaching activities like case analysis, discussion classes, and brainstorming sessions are used to stimulate students' innovative consciousness. Additionally, offering courses on innovation methodology guides students in learning how to think innovatively and generate creative ideas.

Secondly, the cultivation of innovative practical skills requires student involvement in actual engineering projects or research topics. Through collaboration with enterprises, internships, and research assistantships, students can apply their knowledge in real-world settings and tackle practical issues. Moreover, organizing participation in innovation competitions, engineering challenges, and design contests further enhances their practical abilities and teamwork skills.

Thirdly, the development of innovation management capabilities should be conducted through activities such as simulated project management, team leadership, and entrepreneurial training. These activities provide students with knowledge in project planning, resource coordination, risk assessment, and team management, laying the groundwork for future roles as project leaders or entrepreneurs.

Lastly, the cultivation of innovative abilities also relies on high-quality educational resources. Establishing innovation laboratories, research and development centers, and innovation incubation platforms provides students with advanced experimental equipment and research environments. Inviting industry experts and scholars to deliver lectures and provide guidance ensures students have access to the latest industry trends and technological achievements.

4. Evaluation of the effectiveness of the four-dimensional education model

To comprehensively evaluate the effectiveness of the four-dimensional nurturing model for cultivating applied innovative talents in inland waterway ship and ocean engineering majors, a multifaceted evaluation system was developed. This system assesses growth and improvement across the dimensions of knowledge, abilities, qualities, and identity. For knowledge, metrics include course grades, professional exam scores, and the capacity to apply theoretical understanding to practical issues. Abilities are gauged through practical skills, participation in innovation projects, internship performance, and competition results. Qualities are evaluated based on professional certifications, team involvement, leadership demonstrations, and participation in social practices. Identity is measured through clarity in career planning, industry engagement, and alumni network involvement.

The evaluation methods span qualitative and quantitative approaches, from expert reviews and case studies to questionnaires and academic performance analysis. Additionally, mixed methods like balanced scorecards and performance indicator systems offer a comprehensive view of the model's impact. The results indicate significant positive effects on students' professional knowledge, practical skills, innovative capabilities, and professional qualities. However, they also reveal areas for improvement, such as integrating theory and practice more closely and enhancing students' innovation skills as suggested by some industry feedback.

Overall, while the four-dimensional nurturing model has yielded positive outcomes in the specialized field of inland waterway ship and ocean engineering, the evaluation suggests that further refinement is necessary to better meet industry demands and foster holistic student development.

5. Summary

This study, through an analysis of the current state of education in inland waterway ship and ocean engineering majors, proposes and implements a four-dimensional nurturing model. This model is a comprehensive system that cultivates students' knowledge, abilities, qualities, and identities. It aims to develop students' professional knowledge, practical skills, innovative abilities, and vocational qualities to meet the new demands of industry development.

The evaluation results indicate that the four-dimensional nurturing model has a significant positive impact on enhancing students' professional capabilities and overall qualities. There has been a notable improvement in students' professional knowledge and practical skills, as well as their innovative abilities and vocational qualities, leading to better employment rates and job satisfaction among graduates.

However, issues have emerged during the implementation process, such as insufficient integration of theory and practice, and the need for some students to further improve their innovation skills. These issues will require resolution in future work to fully realize the model's potential.

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References

- [1] Zhou Cui, Zheng LongTao, Yang Yunfeng. Discussion on the Four-dimensional education collaborative education mode of medical postgraduates from the perspective of "big ideological and political course". *Journal of Hebei North University (Natural Science Edition)*. 2024, 40(4): 46-48.

- [2] Huang Minyan. Exploration and practice of the "frontline and four Dimensions" comprehensive education Model of vocational college english "job course competition certificate". Jiaoyu Guancha.2024,13(07):51-54.
- [3] Liu Junnan, Han Huarong, Xu Qian, et al. Exploration of the four-dimensional integrated education model of "on-the-job course competition certification" - Taking the training of vocational relay protection professionals as an example. Teaching Reform.2024,(01):81-82.
- [4] Wang Hui, Liu Yalan, Tang Qian. Research on satisfaction survey of marketing majors based on the "three innovations and four dimensions" practical education model. Modern Business Trade Industry.2023,44(23):102-105.
- [5] Zhai Yingjie. Exploration and practice of the four-dimensional coordination education mode for medical majors in universities. Education and Teaching Forum.2023,(35):133-136.
- [6] Hou Haishao. Four dimensional linkage: exploring the transformation of education models through three methods. Teaching and Learning of New Curriculum.2023,(13):66-68.
- [7] Wang Cai. Research on the construction of the ideological and political education model for the "three integration and four dimensions" curriculum of art and design majors in private vocational colleges. New Horizon.2023,(05):110-112.
- [8] Li Shoutai, Yang Ming, Li Yunwu. Exploration of "four dimensional integration" education mode of engineering training teaching, practice, competition and scientific research under the background of "internet plus innovation and entrepreneurship". Sichuan Agriculture and Agricultural Machinery.2023,(02):49-51.
- [9] Zhang Yan. Analysis of the "four dimensional" stereoscopic practice education model of higher vocational college ideological and political courses from the perspective of "great ideological and political courses". 2022,(11):169-172.
- [10] Liu Hongbo. Exploration of the "four dimensions and one body" funding and educational model for ethnic minority students: a case study of changsha civil affairs vocational and technical college. Daqing Social Sciences.2022,(05):138-141.
- [11] Li Xiaohan, Gao Yuan, Ma Shengchao, et al. A study on the collaborative education model of "ideological and political education+scientific research+teaching+entrepreneurship" for medical graduate students: taking ningxia medical university as an example. Western China Quality Education.2022,8(16):17-20.
- [12] Li Shuo, Li Chengyi, Yang Xiujuan, et al. Research and practice of ideological and political education mode based on "four-dimensional integration" mode. Education of Chinese Medicine.2022,41(05):31-3
- [13] Lu Yanxia. Exploration of the international education model of "bidirectional four dimensional and five integration" based on "chinese language+vocational skills". Guangxi Education.2022,(17):41-45.
- [14] Zhao Yuane, Zhao Yafang, Zhang Dongming, et al. Innovation and practice of the ideological and political education model of "four dimensions and four unities" under the concept of "three-wide education": taking kunming metallurgy college as an example. Journal of Kunming Metallurgy College.2022,38(03):11-15+53.
- [15] Ma Yulin, Wang Yanni, Li Chunpeng. The integration of virtue and technology in four dimensions and multidimensional collaboration: practice of the "women's inspiration class" education model in border ethnic areas. Guangxi Education.2022,(11):4-7.
- [16] Huang Zhijie. A four dimensional education model for vocational education based on career planning education. Modern Vocational Education.2021,(39):182-183.
- [17] Zhou Yuan, Wang Xiaomei, Yang Shuang. Research on the four dimensional education model of vocational colleges based on the reform of "three comprehensive education". Journal of Wuxi Institute of Technology.2021,20(04):12-17.
- [18] Huang Yaolin. Exploration of the cultural education model in college student dormitories: taking the "four-dimensional" dormitory culture construction of xinhua business school at minjiang university as an Example. Journal of Yan'an Vocational & Technical College.2021,35(03):11-13.
- [19] Huang Shizhen. Exploration of the "four-dimensional interactive" practical education mode from the perspective of "three-dimensional all-round Education". Teacher.2021, (11):5-6.

- [20] Zhou Gang. Exploration of the "four-dimensional interlocking" practical education mode from the perspective of comprehensive education. University. 2021, (08):155-156.