Exploration and Practice of the Digital Transformation of Teaching in the Teaching and Research Section of *Port Hydraulic Structures*

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Abstract: In 2025, nine departments including the Ministry of Education jointly issued the Opinions on Accelerating the Digitalization of Education, marking that the national strategic action for educational digitalization has entered a new stage of high-quality development, bringing new opportunities and challenges to the digital transformation of teaching in university teaching and research sections. Taking the construction of the Teaching and Research Section of Port Hydraulic Structures for the Port, Waterway and Coastal Engineering major at Guangdong Ocean University as an example, this paper systematically analyzes five major challenges faced in the digital transformation of teaching: insufficient depth of technology application, lagging digital literacy of teachers, fragmented resource construction, institutional and mechanism barriers, and rapid changes in industry demands. On this basis, the practical paths of digital transformation of teaching are elaborated from four dimensions: digital capacity building of teaching staff, development of digital teaching resources, innovation of teaching modes, and construction of evaluation and guarantee mechanisms. Research shows that measures such as the construction of "dual-qualification" teaching teams, the development of virtual simulation experiment platforms, the innovation of the "four-in-one" closed-loop teaching mode, and the construction of a diversified assessment system have effectively improved teachers' digital teaching capabilities and students' engineering practice literacy. The research results can provide a reference for the digital transformation of port and waterway engineering majors under the background of emerging engineering education.

Keywords: Teaching and Research Section of Port Hydraulic Structures; Digital Transformation of Teaching; Virtual Simulation; Emerging Engineering Education

1. Multiple Challenges in the Digital Transformation of Teaching in Teaching and Research Sections

In April 2025, nine departments including the Ministry of Education jointly issued the Opinions on Accelerating the Digitalization of Education to implement the strategic deployment of the Outline for the Construction of a Powerful Country in Education (2024–2035). Taking educational digitalization as a key breakthrough, it fully supports the construction of a powerful country in education. Against this background, the key role of digital transformation of teaching in university teaching and research sections in improving the quality of talent training has become increasingly prominent, but multiple challenges still exist in practice.

First, insufficient depth of technology application. Although campus networks and digital management systems are currently popular[1], intelligent means such as precise user profiling and intelligent resource matching have not been widely used[2]. Digitalization in teaching and research sections mostly stays at the level of resource sharing, failing to achieve in-depth cross-time and cross-space collaborative teaching and research[3]. Second, teachers' digital literacy and teaching concept transformation lag behind. Most teachers enter higher education institutions directly after graduation with insufficient practical experience; graduation and performance assessment tend to focus on scientific research. Some teachers have low acceptance of digital

teaching and still adhere to traditional teaching and research modes[4]. Third, fragmented construction of digital teaching resources. There is a lack of standardized and modular resource libraries matching the professional curriculum system[5], and problems such as redundant resource construction and low reusability coexist. Fourth, prominent institutional and mechanism barriers, manifested as insufficient motivation for cross-university collaboration, imperfect evaluation systems, poor connection with existing training programs[6], and scattered research forces in the open university system[7]. Fifth, rapid changes in industry demands under the background of emerging engineering education, leading to disconnection between traditional teaching content and engineering practice[8], lack of up-to-date cutting-edge engineering case materials, and the urgent problem of how digital teaching and research can timely respond to industrial digital upgrading.

Existing studies mostly focus on single-course reform or the conceptual discussion of virtual teaching and research sections, while research on the overall transformation of teaching and research sections for specific professional courses under the background of digital strategy is insufficient. Taking the construction of the Teaching and Research Section of Port Hydraulic Structures for the Port, Waterway and Coastal Engineering major at Guangdong Ocean University as an example, this paper systematically expounds the challenges and paths of digital transformation of teaching, so as to provide a reference for similar majors.

2. Practice of Digital Teaching Capacity Building for Teaching Staff

As a university-level teaching and research section at Guangdong Ocean University, the Port Hydraulic Structures Teaching and Research Section consists of 15 full-time in-school teachers, including 8 "dual-qualification" teachers. In addition, a number of part-time supervisors from leading industry enterprises and port and waterway management departments are employed as course consultants, who can provide online dynamic guidance as needed. This forms a two-wheel drive of "theory + practice" and builds a solid learning support system for students.

Through enterprise secondment and participation in practical projects, in-service teachers have obtained front-line practical experience and cutting-edge industry insights, realizing the transformation from "theory-oriented" to "deep integration of theory and practice", making classroom teaching more practical and cutting-edge. Through digital teaching training, teachers are proficient in using digital platforms for teaching, master the ability to integrate online resources and implement efficient online teaching, and become core designers and implementers of the digital teaching environment for port and waterway engineering majors. They continue to develop toward "dual-qualification" teachers with solid theories, rich practice and exquisite digital teaching skills, truly achieving "solid, innovative and effective" digital transformation in teaching.

3. Practice of Digital Teaching Resource Development

Through industry-education cooperation and the role of enterprise supervisors, the latest industry codes and cutting-edge practical engineering cases are collected. Teaching design integrates cutting-edge engineering scenarios, the latest industry specifications and construction techniques to build an "industry-education integrated, human-computer interaction" experiment platform covering the whole process of design and construction. Through high-precision three-dimensional simulation, structural details are dynamically displayed, stability is checked in real time, and the construction process is visually simulated, realizing the "coexistence of virtuality and reality" and concretizing abstract theories.

Three platforms have been successively built: the Virtual Simulation Experiment Platform for Structural Stability of Gravity Caisson Wharves (https://www.ilab-x.com/list3?sid=51), the Virtual Simulation Platform for Port, Waterway and Coastal Engineering of Guangdong Ocean University (https://admin.navigacloud.net/login), and the Online Teaching Platform of Port Hydraulic Structures on Chaoxing Learning Platform (https://mooc1.chaoxing.com/course-ans/ps/251130078). Among them, the Virtual Simulation Experiment Platform for Structural Stability of Gravity Caisson Wharves was completed in 2018, obtained software copyright certification in 2020, and completed digital work registration in 2022, gradually forming a

complete intellectual property protection system. It was launched on the National Smart Education Platform in 2021 and successfully approved as a national first-class course in 2023, realizing the national sharing of teaching resources.

4. Practice of Digital Teaching Mode Transformation

Virtual simulation courses on digital teaching platforms adopt a "four-in-one" closed-loop teaching method: "explanation and prompt – interactive operation – online test – feedback and clarification", running through the whole process of "teaching, learning, practice and evaluation". Firstly, the working principles and learning objectives of port hydraulic structures are accurately explained. Then, in a highly interactive virtual environment, the structural stress, stability check, scheme comparison and whole construction process of port hydraulic structures are dynamically simulated, allowing students to experience the complex influences of multiple working conditions. The effect of modular learning is evaluated in real time through instant online tests. Finally, personalized feedback and in-depth guidance are provided based on test data and experiment reports, realizing knowledge internalization and improvement of practical ability.

The course has a strong teaching team. In addition to the university-level dual-qualification teaching team for Port Hydraulic Structures, there are a number of part-time industry supervisors as course consultants who provide cloud-based dynamic guidance when necessary to ensure that teaching content keeps pace with cutting-edge industry trends, forming a closed loop for immersive engineering ability training.

5. Construction of Digital Teaching Evaluation and Guarantee System

Relying on digital teaching platforms and integrating online and offline blended emerging engineering modes, a diversified assessment system covering the whole teaching process is constructed. Evaluation indicators include operation duration of digital modules, scores of periodic tests, quality of simulation experiment reports, and other dimensions, systematically assessing students' mastery of theoretical knowledge, specification retrieval ability, simulation practical ability (including proficiency and innovation), report standardization and engineering collaboration performance.

Through the whole-process data collection and analysis, the limitation of the traditional single assessment of "one final exam determining the grade" is broken through, realizing multi-dimensional and precise evaluation of the learning process and comprehensive ability, accurately quantifying students' real levels, and guiding students to actively improve engineering literacy and teamwork ability. An industry-education collaborative evaluation mechanism is established: enterprise experts are regularly invited to participate in the evaluation of digital teaching effects and students' learning outcomes, providing professional feedback from the perspective of industry practice and forming a virtuous cycle of "evaluation – feedback – improvement".

At the institutional guarantee level, Guangdong Ocean University collects typical cases and papers on educational digital transformation across the university, organizes expert reviews, commends outstanding achievements at the university's educational digital transformation conference, and gives priority to recommending them to provincial and above-level case and paper collection activities, effectively improving teachers' enthusiasm for participating in digital transformation. Meanwhile, to solidly promote the national strategic action for educational digitalization and implement the deployment of the Opinions on Accelerating the Digitalization of Education issued by nine departments including the Ministry of Education, the Center for Educational Technology and Resource Development of the Ministry of Education (National Center for Educational Technology) holds the 2025 National Practice Activity for Improving Teachers' and Students' Digital Literacy (29th Teacher Activity), providing a display, exchange and demonstration platform for basic teaching units. Through the coordinated efforts of diversified evaluation and institutional guarantee, the demand for cultivating high-quality engineering and technical talents required by the industry is effectively ensured, realizing the educational value of digital transformation of teaching.

6. Conclusion

The digital transformation practice of the Port

Hydraulic Structures Teaching and Research Section shows that the deep integration of technology empowerment and teaching reform can effectively solve the practical teaching problems in talent training for port and waterway engineering majors under the background of emerging engineering education. Through continuous exploration, the Teaching and Research Section of Port Hydraulic Structures at Guangdong Ocean University has gradually formed a digital transformation characteristic with virtual simulation as the core and industry-education collaboration as the support. Teachers' digital teaching ability has been significantly enhanced, high-quality teaching resources have been co-constructed and shared, and an immersive engineering teaching closed loop has been basically formed.

In terms of educational effectiveness, the construction of a digital teaching environment has substantially improved students' engineering practice ability. Graduates have outstanding performance in engineering problem identification, specification application and scheme innovation, and are widely recognized by employers and postgraduate supervisors. The integration of ideological and political elements in course construction has further enhanced students' professional identity and industry mission[9].

In the future, the teaching and research section will continue to deepen the application of artificial intelligence technology in teaching and research decision-making and teaching processes, explore intelligent resource matching and precise analysis of learning behavior based on large models, inject new momentum into the high-quality development of port and waterway engineering majors, and provide referential experience for the digital transformation of teaching in similar majors.

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