



Research on the Teaching Reform of Hydraulics Courses

Rui Yin*, Peng Liu

Department of Water Engineering, Kunming University of Science and Technology Oxbridge College, Kunming, Yunnan, China

*386072923@qq.com

Abstract. Hydraulics is a foundational course for many water-related majors, such as Hydraulic and Hydropower Engineering, Water Supply and Drainage Science and Engineering and Water Affairs Engineering. To improve the teaching effectiveness of the hydraulics course, this article analyzed the existing teaching situation and problems, and proposed suggestions on improving theoretical teaching, experimental teaching, and assessment methods based on students' characteristics, providing references for future teaching reform of this course.

Keywords: Hydraulics, teaching reform, learning interests, learning objectives.

1 Background

In the report to the 19th National Congress, President Xi Jinping mentioned [1]: strengthening education is fundamental to the pursuit of national rejuvenation. The country must give priority to education, further reform in education, speed up its modernization, and develop education that people are satisfied with. In 2019, the Implementation Opinions of the Ministry of Education on the Construction of First-Class Undergraduate Courses [2] aimed to build approximately ten thousand national-level and ten thousand provincial-level first-class undergraduate courses in three years. This shows the country's efforts and determination for educational reform. Since then, teaching reform and practice continued to develop. Zhang Rong et al. [3] reviewed the book *Exploration and Practice of University Physics Teaching Reform and the Cultivation of College Students' Innovative Ability*, proposing methods and suggestions for university physics teaching in fostering innovation among students. Liang Yongri et al. [4] implemented teaching reforms in the field of polymer materials and engineering, focusing on ideological and political education, project-based teaching while integrating science and education, diversified innovative practical teaching, and teaching quality management systems, achieving significant results. Shao Jingjing [5], considering the demand for high-quality innovative talents in the chemical industry, proposed teaching reform measures that effectively stimulate students' creativity, striving to cultivate innovative talents that meet market demands.

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2 Introduction to Hydraulics

Hydraulics is a foundational course for water-related majors [6]. It aims to enable students to master the general laws of liquid motion, related concepts, and basic theories; learn necessary analytical and computational methods; and acquire certain experimental operation techniques. This lays a solid foundation for studying more specialized courses, engaging in the workplace, and conducting scientific research. The main objectives of this course are to teach students to distinguish hydraulic phenomena, know their connections, understand the contexts in which these phenomena occur and the conditions for their mutual transformation, and comprehend basic concepts and their physical significance in hydraulics. Students should master the physical significance of the three fundamental equations of hydraulics and be able to apply these equations to solve practical problems; have the ability to analyze and calculate hydraulics-related engineering problems; acquire experimental skills, understand modern measurement techniques, and be capable of processing experiment data and writing reports. The course aims to cultivate students' abilities, particularly their ability to learn independently, apply knowledge to practice flexibly, and analyze and solve problems, laying the foundation for future exploration, development, and innovation.

This course is divided into four modules:

1. The first module focuses on foundational, theoretical knowledge, which includes hydrostatics, stream tube theory of liquid motion, and flow resistance and head loss. This module establishes the foundation for subsequent modules, suitable for all students.

2. The second module emphasizes practical applications in engineering, which include pressurized pipe flow, open channel flow, weir flow, sluice gate outflow, and flow transition and energy dissipation. This module is based on the first module, expanding to specific engineering scenarios and laying an important foundation for follow-up courses. Students majoring in civil engineering should prioritize the learning of pressurized pipe flow, open channel flow, weir flow, and sluice gate outflow. Students studying water conservancy should pay more attention to open channel flow, weir flow, sluice gate outflow, flow transition, and energy dissipation.

3. The third module emphasizes theoretical knowledge, which is re-search-oriented and includes seepage flow and flow field theory of liquid motion. This module is highly theoretical, and its content is more suitable for students who plan to pursue further education.

4. The fourth module focuses on experiment foundations, which is practical and includes the fundamentals of hydraulic model testing. This module lays the basis for experiments within the course, and its content is suitable for all students.

This course is offered in the following majors at the Oxbridge College, Kunming University of Science and Technology: Water Resources and Hydropower Engineering, Water Supply and Drainage Science and Engineering, and Water Affairs Engineering.

The objective of the Water Resources and Hydropower Engineering major is to cultivate professionals with the basic theories, knowledge, and skills of the discipline, innovative spirit, practical abilities, and basic engineering training. Graduates will be

able to work in surveying, planning, design, construction, and management of water resources and hydropower engineering and farmland water conservancy engineering. Students will mainly study a series of courses such as Mechanics, Structure and Design of Water Resources and Hydro-power Engineering, and Construction Technology and Management. Leveraging Yunnan Province's abundant water resources, students in this major have promising opportunities to develop and utilize clean energy for the benefit of humanity. This major is a supporting discipline under the Key Specialty Group Construction Projects for Supporting Industrial Transformation and Upgrading in Yunnan Province. Graduates can work in government administrative departments, enterprises, and institutions, as well as in sectors such as water conservancy, hydro-power, agricultural water, and building construction, engaging in surveying, planning, design, construction, consulting, supervision, research, and management.

3 Teaching Situations and Existing Problems

3.1 Current Situations

Students have studied courses such as Theoretical Mechanics and the first chapter of Hydraulics, meaning they can understand basic concepts related to mechanics and fundamental concepts related to hydraulics. They are able to perform geometric calculations in mathematics and simplification of formulas.

Students, who are sophomores, are at the early stage of learning habit formation, with learning interests and enthusiasm stronger than ever. They have great independent learning abilities and gradually learn to apply theoretical knowledge into practice. However, they lack the motivation for longterm learning and can be easily impacted by the surrounding environment.

3.2 Existing Problems

Firstly, students lack an understanding of the background and origin of knowledge, resulting in no learning interest and learning initiative. Students do not have the habit of pre-class preparation, and their post-class review is often delayed. Few students take notes actively, and some students' textbooks show no signs of reading.

Secondly, experiment teaching has been a mere formality. Many students do not participate, and most of the experimental data is copied from each other. There is little serious thinking about the problems that appeared during experiments.

Finally, the assessment methods need further adjustment, especially the composition of regular grades. Currently, regular grades focus more on attendance and classroom interaction, leading to almost identical grades for many students and a lack of differentiation.

4 Reform Measures

4.1 Theoretical Teaching

1. Cultivating Students' Self-learning Habits

Students are required to complete pre-class assignments on their mobile devices before each class. These assignments typically include simple concepts, parameter symbols, and basic conclusions, with a goal to familiarize students with the upcoming class content and provide a general understanding. Students are encouraged to ask questions based on their learning outcomes.

2. Stimulating Students' Learning Interest

Interesting experiments related to hydraulics are added to the classroom to stimulate students' curiosity and learning interests, prompting them to profound thinking. For example, experiments related to atmospheric pressure allow students to personally experience the existence of atmospheric pressure and guide them to connect it with other related phenomena in daily life. Some students may even try these experiments themselves after class to explore further.

3. Adjusting Students' Learning Goals

Students' learning goals are more than earning credits; they also include preparing for postgraduate entrance examinations, applying for the College Students' Innovation and Entrepreneurship Training Program, and finding research topics for academic competitions. Teachers should constantly remind students to focus on capturing key points during their daily learning and transform the knowledge learned into innovative ideas. Additionally, teachers should highlight that the outcomes from participating in these activities can serve as supporting materials for applying for awards and honors, which will benefit them in postgraduate entrance examination interviews and job interviews.

4.2 Experiment Teaching

1. Pre-experiment Preparation

Before each experiment, students are required to complete pre-experiment assignments on their mobile devices. These assignments typically include experiment objectives, experiment principles, and experiment procedures, aiming to familiarize students with the experiment content in advance and have a general understanding.

2. Virtual Simulation Experiment Sessions

After completing on-site experiments, students can use the virtual simulation experiment platform to review the experiments, analyze the differences between the data from experiments and virtual simulation, and ensure that each student's data is unique by adjusting the initial parameters. This helps to develop students' data processing skills.

3. Expanding Laboratory Use

Except for in-class experiments, students can also use the laboratory for model construction and additional experiments. This can prepare them for College Students'

Innovation and Entrepreneurship Training Program projects and academic competitions, thus enhancing their practical skills.

4.3 Evaluation Methods

The overall grade consists of three parts: regular grades (50%), experiment grades (10%), and exam grades (40%). Among these, regular grades include pre-class self-learning (50%), classroom interaction (30%), post-class learning (5%), Q&A and discussions (5%), and attendance (10%). Experiment grades include pre-class self-operated experiments (20%), check-in (10%), instrument operation (30%), virtual simulation experiments (30%), and experiment report writing (10%).

5 Achievements

5.1 Improved Performance in Students

In the past three years, the pass rate for this course has gradually increased. In the first semester of the 2024-2025 academic year, the overall pass rate for the 2023 cohort of Water Resources and Hydropower Engineering students exceeded 90%, reaching a new high. Students have proposed new approaches to tabular calculations, summarized efficient implementation methods for the trial calculation method, and supplemented their pre-class preparation with numerous video materials not provided by the instructors.

5.2 Increased Teaching Ability in Teachers

The teaching team successfully applied for one Provincial First-Class Course Cultivation Project, won one first prize and one second prize in the 7th National Teaching Competition for Young Teachers in Water Resources-related Disciplines, and received one third prize in the 3rd National College Teachers' Teaching Innovation Competition (Yunnan Division) and the 6th Yunnan Provincial College Teachers' Teaching Competition. The team also led one First Batch of University-Level First-Class Undergraduate Course Construction Projects, and the course Hydraulics A, which they taught, was rated as Domestic First-Class (Grade B) in the course level evaluation during the first semester of the 2023-2024 academic year.

5.3 Increased Innovative Achievements

Over the past five years, the teaching team has guided students in two national-level, three provincial-level, and three university-level College Students' Innovation and Entrepreneurship Training Program projects. They also guided students to participate in the National College Students' Hydraulic Innovation Design Competition, winning two first prizes, three second prizes, and three third prizes. Additionally, they guided students to win one second prize in the College Students' Hydraulic and Water

Transport Prefabricated Technology Design Competition, one second prize and six third prizes in the College Student Social Practice and Science Contest on Energy Saving & Emission Reduction of Yunnan Province, and one second prize in the 12th Yunnan Provincial "Challenge Cup" College Students' Extracurricular Academic Science and Technology Festival.

6 Conclusion

By cultivating students' self-learning habits, stimulating students' learning interest, adjusting students' learning goals, adding pre-experiment preparation, adding virtual simulation experiment sessions, expanding laboratory use, and optimizing the evaluation methods, the effective teaching reform of hydraulics course is carried out, which improves the performance in students, improves the teaching ability in teachers and increases the innovative achievements, and provides reference for the teaching reform of the course.

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