International Journal of Latest Engineering and Management Research (IJLEMR)
ISSN: 2455-4847
www.ijlemr.com || Volume 09 – Issue 04 || April 2024 || PP. 72-76

Construction and Practice of Superior Quality Course Teaching System of Advanced Fluid Mechanics

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Abstract: As an advanced course of fluid mechanics, advanced fluid mechanics provides students with more in-depth and comprehensive knowledge of fluid mechanics, which is an important link in training fluid mechanics professionals. However, there are some problems in the teaching process of this course, such as boring content, single way and weak experimental links. Therefore, it is particularly important to improve the teaching quality and train relevant talents through the reform of the teaching system. Based on this, this paper puts forward the reform idea of strengthening the cultivation of students' application and innovation ability with practice and application as the guidance. Through optimizing the content of teaching materials, setting up individual experimental courses, expanding teaching resources, adopting a variety of teaching methods and paying attention to the combination of practical teaching and scientific research, we can stimulate students' interest, and achieve the purpose of teaching and learning, improving quality and cultivating excellence.
Keywords: Advanced fluid mechanics, Teaching system reform, Practical teaching, innovation

1. Introduction

Advanced fluid mechanics is a technical discipline derived from practice and applied to practice. It is also an interdisciplinary field of physics, mathematics, engineering and other disciplines. It mainly studies the motion state of the fluid itself under the action of various forces and the interaction and flow law between the fluid and the solid boundary wall when there is relative motion. Under the current educational background, the traditional teaching system of advanced fluid mechanics has been difficult to meet the needs of the current society. With the emergence of numerical simulation software and the deepening of interdisciplinary crossing, the theory and application range of fluid mechanics are constantly expanding, and it is necessary to constantly update and expand the teaching content, which also puts forward higher requirements for teachers and students to use computer technology to conduct numerical simulation and prediction of fluid flow. It is difficult for traditional teaching methods to meet the learning needs of modern students, so it is necessary to adopt more flexible teaching methods and means to stimulate students' learning interest and initiative. Therefore, it is an important task for higher education to reform and practice the teaching system of higher fluid mechanics, improve the teaching quality and adapt to the current development.

In order to study the reform path of the high quality course teaching system of advanced fluid mechanics, scholars have carried out extensive research. Liu Meili et al[1] discussed how to integrate ideological and political elements into the course of fluid mechanics, and proposed discussion, case and flipped classroom teaching activity design and diversified evaluation methods to achieve the organic unity of knowledge imparts and value guidance. Sun Zhanpeng et al[2] proposed a hybrid teaching model of convection physics course in Internet + smart classroom, and used BOPPPS teaching design method to make course activity design and course assessment closely focus on significant teaching objectives. Zhu Kan et al[3] introduced six teaching methods, including hypothesis deduction method, inductive reasoning method and simulation teaching method. Gao Jie et al[4] discussed specific measures for the construction of high-level core courses for graduate students from the aspects of course content and textbook construction, teaching and assessment method construction, course internationalization construction exploration, and teaching team construction of advanced fluid mechanics.

Based on the analysis of the characteristics of advanced fluid mechanics and the current situation of experiment and virtual simulation, this paper explores the teaching mode that attaches equal importance to theory and practice, emphasizes theory updating and practical teaching, and lays a foundation for training innovative practical talents.

2. Characteristics and challenges of advanced fluid mechanics courses

Advanced fluid mechanics has the characteristics of strong theory, difficult practical application and interdisciplinary. The strong theory is reflected in its relatively perfect theoretical system, rigorous and complex formula derivation, and high mathematical foundation requirements. After many years of development,

advanced fluid mechanics has formed a theoretical system including hydrostatics, fluid dynamics and other branches. Each branch theory is related to each other and constitutes a complete theoretical framework. Students need to fully grasp this theoretical system in order to better understand and apply the knowledge of fluid mechanics. There are many formulas and theorems involved in this subject, and the derivation process is complicated. At the same time, advanced fluid mechanics also pays attention to the application of experimental research and numerical simulation methods. In recent years, although colleges and universities have gradually realized the importance of experimental teaching of fluid mechanics, the construction and development of fluid mechanics laboratories have been severely restricted by the limitation of laboratory area and funds. At present, the experimental teaching of fluid mechanics in many domestic universities is only used as auxiliary teaching, and the traditional fluid mechanics experiments focusing on demonstration have been difficult to attract the interest of college students in the new era[5]. It is impossible to carry out laboratory teaching because of the flow problem under large-scale, high-speed and high risk environment conditions. The virtual simulation experiment of fluid mechanics transfers the laboratory to the online, and students can expand the research content with the help of simulation software, save experiment time, and improve students' hands-on and practical ability. The learning process of numerical simulation software is a challenge in itself. Users need to have rich and solid theoretical knowledge and professional quality, and only through systematic and professional training can they make accurate and effective simulation[6].If students do not have a certain theoretical basis, they cannot judge whether the parameters are reasonable, and can only achieve the purpose of learning software by imitating teaching cases.

From the perspective of the content of the textbook, the development of advanced fluid mechanics has gone through multiple stages, but the content of the textbook is relatively old and fails to reflect the latest scientific research results and technological progress in time, which makes it difficult for students to access the latest fluid mechanics theory and technology, and also affects their learning interest and innovation ability. The single teaching method is also a problem facing the current teaching system of advanced fluid mechanics. The traditional teaching method is still mainly taught by teachers. Although the teaching design of flipped classroom has been introduced in recent years, the teaching quality has not been greatly improved. The weakness of practice is also a shortcoming of the current advanced fluid mechanics teaching system. In the existing teaching system, practice accounts for a small proportion, many schools lack experimental facilities and teaching resources, and practice opportunities are limited, which makes it difficult for students to combine theoretical knowledge with practice and truly master the application skills of fluid mechanics. The traditional assessment method emphasizes the investigation of theoretical knowledge, and lacks the evaluation of students' practical ability and innovative thinking, resulting in students relying too much on test-taking skills and neglecting the improvement of practical ability.

3. Advanced fluid mechanics teaching system reform ideas

The high quality course of advanced fluid mechanics is the core of the teaching system, which needs to pay attention to the systematicness and integrity of the course, while emphasizing the practicability and innovation of the course. In the reform of the teaching system, it is necessary to pay attention to the principal position of students, give play to the guiding role of teachers, and strengthen the cultivation of practical teaching and scientific research innovation ability. Practice is an indispensable link in the teaching system. It is necessary to strengthen the practice teaching links such as experiment, practice and course design to improve students' practical ability and innovative ability. At the same time, it will strengthen cooperation with enterprises and industry, provide practical opportunities for students, and promote the combination of industry, university and research. Teaching effect is an important criterion to test the success of teaching system reform. It is necessary to formulate scientific and reasonable assessment standards and methods to comprehensively evaluate students' learning results and teachers' teaching effects. Through the evaluation and feedback of the teaching effect, the reform plan of the teaching system is constantly optimized to improve the quality of teaching and talent training.

4. Reform of the teaching system of advanced fluid mechanics

(1) Optimize the content of teaching materials and set up separate experimental courses

Optimizing the content of teaching materials is the main measure to solve the outdated content of advanced fluid mechanics teaching materials. On the basis of ensuring the integrity of the basic knowledge of fluid mechanics, the content of the textbook should keep pace with The Times, and timely introduce advanced theories and the latest scientific research results to ensure the timeliness and practicability of the teaching content. At the same time, in view of the wide application range of fluid mechanics, the course content should also pay attention to the cross-integration with other disciplines to broaden the scope of students' knowledge. At the same time, teachers are encouraged to write textbooks or handouts with characteristics to meet the needs of different majors and levels.

In order to cultivate talents with innovative qualities, colleges and universities must change the teaching concept of theoretical teaching as the main and experimental teaching as the supplement, and set the experimental course as an independent course into the professional teaching plan as much as possible, so as to form the teaching concept of attaching equal importance to experiment and theory[5]. According to the development orientation of the school's major, relevant teachers make reasonable teaching goals and plans, and arrange the course order and class time allocation reasonably to ensure that students can gradually master knowledge and skills. The separate setting of the experimental course is helpful for students to realize the importance of the experimental course and correct their learning attitude. At the same time, exercises and engineering problems closely related to basic theories should be arranged for students to train, so that students can deepen their understanding and digestion of theories and improve their ability to apply theoretical tools to solve practical problems.

(2) Co-construction and sharing of teaching resources

Digital teaching resources provide students with opportunities and platforms for independent learning, and rich teaching resources both inside and outside the school and at home and abroad help broaden students' horizons and stimulate students' interests. Through MOOC (massive open online courses) and other online learning platforms, the school can produce and publish advanced fluid mechanics course videos, exercises and other resources for students to learn independently. Introduce fluid mechanics simulation software, such as ANSYS, Fluent, etc, so that students can better understand the knowledge of fluid stability, dynamics, etc. The virtual simulation platform is established to make it have the necessary teaching and experiment functions. Teachers should become important participants in the co-construction and sharing of teaching resources. Schools can organize teachers to conduct training on the production and sharing of teaching resources, provide necessary technical support and resource support, and encourage teachers to share their own teaching experience, teaching cases, teaching videos, etc., on the platform for other teachers' reference and learning. Different schools can establish cooperative relations to jointly build high-quality teaching resources and realize the co-construction and sharing of resources. Through inter-school cooperation, the complementary and optimization of teaching resources can be realized, and the utilization efficiency and teaching quality of teaching resources can be improved.

(3) Reform of teaching methods

Teaching is a kind of mental work, and the art of teaching is mainly reflected in the choice of teaching methods. Traditional teaching methods often pay attention to the instillation and memory of knowledge, while modern teaching methods pay more attention to the cultivation of ability and the improvement of quality. Therefore, the reform of teaching methods should aim at cultivating students' innovative spirit, practical ability and comprehensive quality, and design teaching methods and means that meet students' actual needs.

Teachers can adopt a problem-oriented approach, introducing real-world problems and engineering challenges as the core of the curriculum, and have students learn and research around these problems. For example, by introducing the problem of how to reduce pipeline flow resistance to improve transportation efficiency, students can be stimulated to think about the factors affecting fluid resistance, and further inspire students to explore ways to reduce fluid resistance. Combined with traditional face-to-face teaching and online learning, blended teaching makes full use of digital teaching resources and presents abstract concepts and principles through multimedia means, making it easier for students to understand and accept. "Only learning without using" is often half the result with twice the effort. Combining with the scientific research accumulation of teachers, engineering cases are refined and case teaching is introduced into teaching in real time[7]. By showing the results of simulation cases, teachers guide students to observe and analyze the characteristics of fluid flow, and help students to deeply understand the basic principles of fluid mechanics by comparing the theoretical and simulation results. On the basis of theoretical teaching, students do simulation practice by themselves, which not only improves students' hands-on ability, but also helps teachers to master teaching situation and optimize teaching methods.

(4) Encourage the combination of practical teaching and scientific research

The close combination of practical teaching and scientific research can not only improve students' practical ability and scientific research accomplishment, but also promote academic exchange and innovation. In the teaching process, students have access to the latest scientific research results and practical experience through participation in scientific research projects and practice bases. The following specific measures are proposed from the perspective of schools, colleges and teachers: Schools establish fluid mechanics laboratories or practice teaching bases to provide places for students to practice learning. On these platforms, students can conduct experimental operations, data processing and result analysis, combining theoretical knowledge with

practical operations to deepen their understanding of convection mechanics. The College organizes students to conduct academic exchanges and achievements display activities, such as academic presentations, exhibitions and competitions. Through exchange and presentation, students can share their research results and practical experience, promote academic exchange and cooperation, and improve self-confidence and expression skills. Teachers encourage students to actively participate in faculty research projects, work as research assistants or participate in laboratory work. By participating in scientific research projects, students can gain an in-depth understanding of the problems and challenges in the practical application of fluid mechanics, develop the ability to solve practical problems, and accumulate scientific research experience.

(5) Teaching team construction and optimization

Teachers are important forces in the teaching system of advanced fluid mechanics. Strengthening the construction of teachers is the key to improve the teaching quality, and also the guarantee to promote the development of the subject and cultivate talents. First of all, schools should pay attention to the selection and introduction of teachers, strengthen the academic exchange and cooperation of teachers, and improve the teaching level and scientific research ability of teachers. When the fluid mechanics virtual simulation experiment project team is set up, attention should be paid to introducing excellent teachers with fluid mechanics background, rich teaching experience and scientific research ability, and it is necessary to cooperate with software companies to build a strong and professional team. Secondly, a sound incentive mechanism should be established to encourage teachers to participate in scientific research projects, publish high-level papers and share teaching experience, so as to stimulate teachers' work enthusiasm and creativity. A good communication mechanism should be established among team members, and the college can organize regular teaching and research activities, so that teachers have the opportunity to share their teaching experience, discuss the problems encountered in teaching, and jointly find solutions. This kind of exchange and cooperation can not only broaden the vision of teachers, but also stimulate their innovative thinking, and inject new vitality into the teaching reform of advanced fluid mechanics. Thirdly, the teaching evaluation system should combine peer evaluation and student self-evaluation to reflect the teaching quality and effect comprehensively and objectively. At the same time, scientific methods and technical means are adopted to monitor and evaluate each link in the teaching process. Finally, the College should provide teachers with training and development opportunities, including participation in high-level training, seminars and academic conferences, so that they can constantly update their knowledge and grasp the latest teaching methods and technologies.

5. Conclusion

The reform of the teaching system of advanced fluid mechanics needs the joint efforts of schools and teachers, and every teacher is a key driving force to promote the reform. The content of teaching materials, the establishment of practical courses and the optimization of teaching resources, the innovation of teaching methods and the combination of practical teaching and scientific research are very beneficial to improve the teaching effect. The content of teaching materials, the establishment of practical courses and the optimization of teaching resources make the teaching content closer to the subject frontier and engineering practice. By introducing the latest research results, engineering cases and practical problems, the course is made more practical and engaging, enabling students to better understand and apply fluid mechanics knowledge. The reform of teaching methods improves students' learning enthusiasm and participation. The advanced and suitable teaching mode enables students to learn in practice and master the core knowledge of fluid mechanics in problem solving, which effectively improves the teaching quality and effect. The combination of practical teaching and scientific research can improve students' practical ability and scientific research accomplishment, and promote academic exchange and innovation. In addition, the construction of teaching team provides strong support for teaching reform. In the future, we will continue to deepen the teaching reform and constantly improve the teaching system to better train high-quality and high-level fluid mechanics talents.

Acknowledgement

This work is supported by the Postgraduate Education Quality Improvement Project of Henan Polytechnic University (2024YJC04), the Graduate Education and Teaching Reformation Project of Henan Polytechnic University (2023YJ22), the Research and Practice Project of Educational and Teaching Reformation of Henan Polytechnic University in 2022 Year (Normal Finance-44), the Industry-University Cooperative Education Project of Ministry of Education (220901665160408), the Research and Practice Project of Higher Educational and Teaching Reformation of Henan Province (Undergraduate education) (2024SJGLX69), the Integration Research Project of Industry and Education of Undergraduate University of Henan Province (No.85), the Research and Practice Project of Research Teaching Reformation of

Undergraduate University of Henan Province (No.37), the Graduate Education and Teaching Reformation Project of School of Civil Engineering in Henan Polytechnic University (2022TM01).

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