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Self-Organization Teaching Reform for Numerical Calculations of Ship Hydrodynamics

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Abstract: Currently, numerous education reform examples have played a vital role in the higher education reform in China. The article adopts the self-organization theory to guide the construction of the course on numerical calculation of ship hydrodynamics. The teaching and learning efficiency can be greatly improved by adopting a linked three-stage teaching methodology, with project design in the first stage, numerical simulation in the second stage, and further, experimental verification in the third stage.

Keywords: Ships; Self-Organization; Numerical Calculations; Teaching Reform

1. Introduction

As socialism with Chinese characteristics enters a new era, deepened reform should be carried out in the development system of higher education in science and engineering course in China. Li (2014) argued that the reform of public physical education based on self-organization theory is of high value in the context of "undergraduate education as the fundamental" and building high level undergraduate teaching and learning. This study played an important role in strengthening the development of students' abilities and improving the situations of outdated public physical education in universities. In view of the current teaching and learning methods and its shortcomings, Li and Shi (2010) explored the scientific nature and the conditions required to apply self-organization theory to ideological and political theory courses in universities by analysing students' learning mechanisms, the self-organization process and the self-organization nature of teaching and learning. Wen (2014) proposed a self-organization teaching and learning model for higher education civics courses in the context of work-integrated learning, which aims to cultivate students' comprehensive vocational skills, employability and competitiveness, and give full play to their enthusiasm, initiative and creativity in learning. In specific teaching activities, teachers create scenarios for students to look up information, research the content and work in teams to help each other complete tasks.

2. Project design in the first stage

The impact lessens as the project progresses, while the cost of design optimisation increases. This shows that in the self-organization model, course design in the initial stage of the project should be targeted, and various details and steps of the curriculum design should be refined. This will enable self-organization to reduce teaching cost, avoid wasting human and material resources and improve teaching and learning efficiency throughout the life cycle of the course on numerical calculations of ship hydrodynamics, which will then enable students to more fully understand the aims of the course. This course is designed to enable students to design their own experimental models, then perform calculations in a numerical hydrodynamic simulation and finally manufacture their own prototype models to carry out experiments in a recirculating water tank.

3. Numerical simulation in the second stage

First, the calculation domain is created in the CFD software. As the ship model is bilaterally symmetrical, only the larboard side of the hull was selected for the simulation to reduce the number of meshes and the simulation time, as shown in Fig. 1. Then, the water and the hull region need to be meshed using CFD software. The triangle mesh was adopted to divide the computation area in order to preferably capture the shape of hull surface, which can improve the accuracy of the solution.

Finally, students will be able to experiment with a variety of computational models for simulation, allowing them to set and modify their own computational parameters. For example, students were asked to carry out simulations on the calculation of ship resistance, to calculate a series of resistance data by themselves and carry out parametric modelling to further investigate the effect of different hull shapes on resistance.

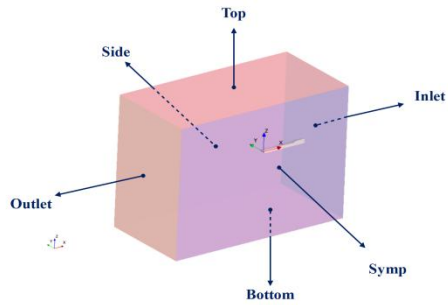

Fig. 1. Schematic diagram of the dimensions and boundary types of the calculation domain

4. Experimental validations in the third stage

The comprehensive experiments will significantly improve students' understanding of the hydrodynamic characteristics of ships, enable them to master basic testing techniques and experimental methods, and improve their hands-on and practical skills. The formation principles of Kelvin waves by ships navigating on the water are complex and therefore difficulties for students to understand. So, they have to solve the wave problems through experiments to experience first-hand the transformation of the theoretical approach into practical results. Students are required to conduct their own literature review, refer to previous research methodology and technical tools, and conduct towing tank experiments using ship models so as to observe the expansion and evolution of wake flow. Students design their own towing tank experimental system, which consists of a ship prototype, propeller, drive shaft, propulsion motor and pressure control valve. Students are required to manually connect the components and test them repeatedly until the system runs perfectly. Figure 2 shows the towing tank experiment.

Fig. 2. Towing tank experiment.

5. Implementation results

After the implementation of self-organization teaching and learning, students used multimedia equipment to complete their pre-study and training before class. The content and pace of learning were controlled by each individual student, thereby giving full play to the flexibility of self-organization teaching and learning, reflecting the education model dominated by student-initiated learning and supplemented by the guidance of teachers. Up to now, a total of 55 understanding points, 113 task points, 96 micro-lesson videos, 74 PowerPoint courseware and 172 videos and animations have been published on the learning platform for the numerical calculation of ship hydrodynamics course. All of the above learning resources are available to students before the start of the course, and students can study independently through the learning platform before the course. According to statistics, the utilisation rate of the above learning resources can reach 82%.

6. Conclusion

The numerical calculation of ship hydrodynamics course that is based on self-organization, with numerical simulation, towing tank experiments, computers and other technologies at its core can become an effective education reform on naval architecture. This provides a major opportunity to promote the transformation of professional naval engineering courses from traditional to intelligent manufacturing, which is also a significant opportunity for the development of naval architecture and shipping industries. This can also designate target for the development and reform of professional education in the field of ship hydrodynamics.

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References

[1] Li JS, 2014. Initial Exploration of Self-organization Teaching of Ideological and Political Education Course of Colleges and Universities. Journal of Anshun University. 16 (3), 48-55.

[2] Li YQ, Shi Y, 2010. Building universities undergraduate teaching management mechanism based on self-organization theory. The 2nd International Conference on Information Science and Engineering, 2010, pp. 2690-2693.

[3] Wen Q, 2014. Exploration on the Self-organization Teaching Model of Higher Vocational Ideological and Political Course under the Background of Work-Study Combination. The Science Education Article Collects. 10, 161-163.

[4] Shachter M, 2000. Talkin' About a Revolution. Again. Consulting-specifying engineer. 27 (3), 40-44.