Reform and Practice on the Acoustics Simulation Education

Haitao Wang[a], Xiangyang Zeng[b], Ye Lei[c], Shuwei Ren[d]

{wht@nwpu.edu.cn[a], zenggxy@nwpu.edu.cn[b], lxy_d@nwpu.edu.cn[c], shuwei.ren@nwpu.edu.cn[d]}

School of Marine Science and Technology, Northwestern Polytechnical University, Xi'an, China

Abstract. Existing acoustic simulation courses are mostly heavy on software, light on theory and the practical teaching method is outdated, which leads to the students' single ability to solve complex problems, single problem solving idea, insufficient innovative application ability and other problems. In view of these problems, this course actively carries out teaching innovation, from the content system, the teaching form of two dimensions of innovation to realize the students to master solid acoustic simulation theory, skilled application of acoustic simulation software to deal with the problem, and the ability to use the software to carry out innovative design as the teaching objectives. In terms of content system, this course is centered on the core key point of acoustic simulation - applicable frequency band, respectively, for low-frequency, medium and high-frequency simulation, the establishment of fluctuating acoustics and geometric acoustics, statistical energy analysis of the combination of the content system, through the consolidation of theoretical knowledge, enables students to understand the principles of the corresponding software, and has the ability to expand the complexity of the problem. In the form of teaching, instead of focusing on the explanation of software operation in the classroom, the video of software explanation and real case explanation are carried out before, during and after the classroom, so as to realize the student-centered practice in each section, thus improving the students' ability to solve problems with diversified ideas and innovative applications, and finally realizing the innovative goal of "strong foundation, heavy practice and innovation", The ultimate goal is to realize the innovative goal of "strengthening foundation, emphasizing practice and seeking innovation".

Keywords: acoustics education, simulation courses, course system reform.

1 Introduction

Acoustics is an important research content in natural science and engineering science, and plays an important role in national economic fields. For example, various types of noise pollution control problems, speech recognition used everywhere in life, concert halls, theaters, classrooms and other spaces in the design of sound quality and other issues highlight the close correlation between acoustics and people's lives.

Numerical simulation is an important means of acoustic research and application, which can play a role in reducing research costs, verifying acoustic mechanisms, and predicting acoustic phenomena which is time and resources-consumped in real experiment. Being able to master the correct theory of acoustic numerical simulation and be able to skillfully apply acoustic software to carry out independent simulation of the problem is the basic requirement for

ITEI 2023, November 24-26, Zhengzhou, People's Republic of China

DOI 10.4108/eai.24-11-2023.2343538

acoustics-related practitioners, and the rapid development of related fields and the demand for scientific and technological innovation for the practitioners of the innovative quality of the increasingly demanding, which put forward a higher demand for the training of talents in the relevant specialties in colleges and universities[1].

In response to these needs, we set up the "acoustic software and applications" course[2]. The course aims to let students master solid acoustic simulation theory, be able to skillfully apply acoustic simulation software to deal with problems, and be able to utilize the software to carry out innovative design as the teaching goal. In view of the traditional acoustic software course teaching problems such as "heavy operation, light theory" and "single practice content", this course actively carries out teaching innovation and practice, based on the theory and practice, carry out the real simulation practice and other innovative reform means, to create a new engineering discipline adapted to the requirements of the new engineering discipline[3]. This course actively carries out teaching innovation and practice, based on innovative reform means such as emphasizing both theory and practice and carrying out realistic simulation practice, so as to create teaching methods adapted to the requirements of the new engineering disciplines, thus continuously improving the quality of teaching and achieving excellent teaching results.

2 Teaching Problem Analysis in Current Acoustic Education

In order to improve students' understanding and use of acoustic software, acoustic software teaching courses have been opened, which provide an important platform for students to learn the use of relevant acoustic software. However, in the context of the continuous development of the field of acoustics and the requirements of the new era of human education, these courses and the teaching methods used in these courses have also gradually manifested their limitations, which are mainly reflected in the following aspects.

2.1 Lacking Focus on Basic Theory

In traditional teaching, acoustic software courses are based on the use of acoustic software teaching, less involved in acoustic simulation theory teaching. The result is that after students learn the course, there is a "know what it is, don't know why it is" problem, which is specifically manifested in the use of software for some classroom practice problems simulation, but due to the lack of theoretical knowledge to support, when the problem of the boundaries and constraints of the change, it will not be able to expand and complete the analysis of the problem effectively.

2.2 Lacking Thinking Room for Students

Traditional acoustic software course teaching, classroom teaching most of the time on the interface operation of a software, that is, the teacher through the hands of the way to the students for the operation process teaching. This approach is insufficient for the cultivation of students' creative ability: the existing types of acoustic software actually have more powerful functions, for the solution of the problem can be accomplished in a variety of ways, not limited to a certain way, too detailed process will lead to a lack of students to think for themselves.

2.3 Lacking Real-world Engineering Practice

The simulation cases in the course practice lack of hierarchy and authenticity, and the cases are mostly based on virtual scenes under ideal conditions. Students can't get in touch with the real engineering problems in the course, and thus lack of intuitive understanding of the related problems, which leads to poor promotion and application ability when encountering real problems, and thus can't really use the knowledge to solve the real problems.

3 Course Innovation and Reconstruction

In terms of teaching content, this course has constructed a three-tier system of "basic knowledge--software operation--innovative design" as illustrated in Fig. 1.

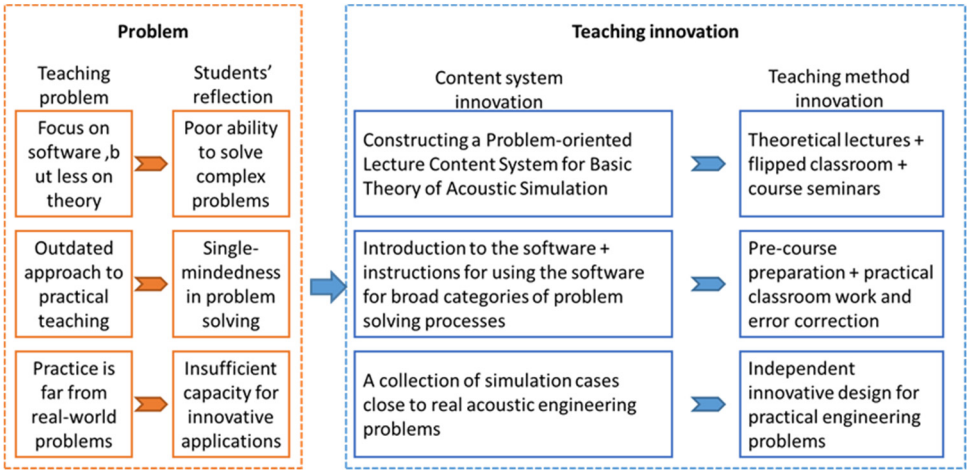

Fig. 1. Architecture of innovation and reconstruciton in our course reform.

3.1 Course Content System Innovation

In terms of teaching content, this course has constructed a three-tier system of "basic knowledge--software operation--innovative design" as illustated in Fig. 2.

In terms of basic knowledge, with the core feature that acoustic research needs to distinguish between frequency bands, the teaching content based on theories such as fluctuation acoustic method, geometric acoustic method, and statistical energy method is established for low frequency and middle and high frequency respectively[4-5]. Through these contents, students can master the basic theories necessary for acoustic simulation, so as to recognize the essential properties of acoustic problems, and have a deep understanding of complex problems under the support of basic theories. In terms of software use, for different types of commonly used software, a certain number of basic cases and advanced practical cases are constructed to form a case set from basic to upgrading, and ultimately form a content system that is rich in content and close to the actual problems of acoustics.

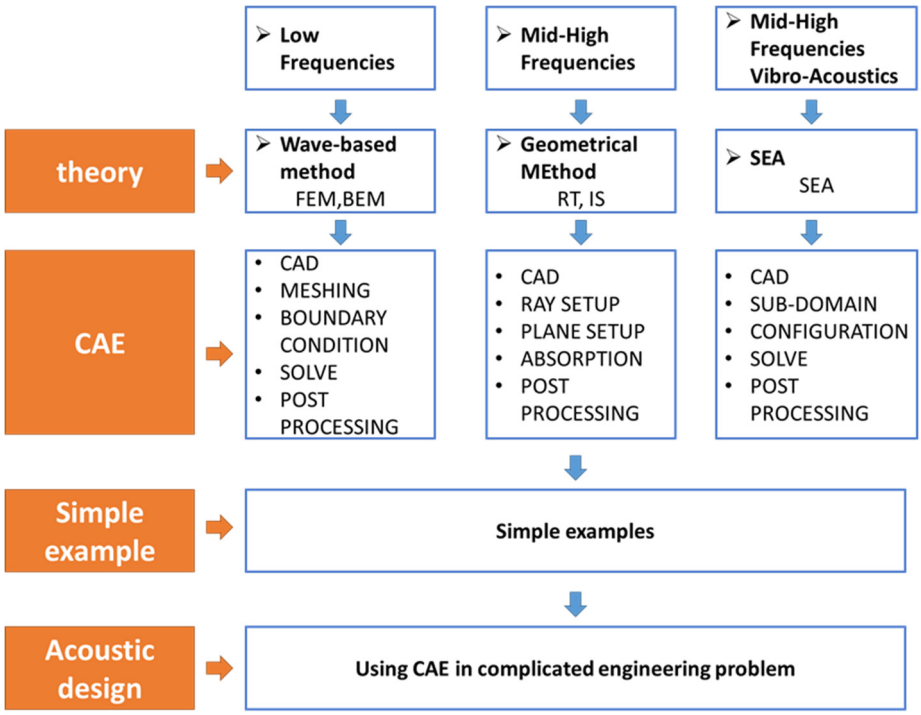

Fig. 2. Content system constructed in the course.

3.2 Teaching Method Innovation

In terms of teaching methods, modern teaching concepts and methods are introduced to form a coherent teaching before, during and after class. In terms of teaching classification, the course emphasizes students' self-study in the pre-study stage. The biggest difference and improvement between this course and the traditional acoustic software courses is that the teaching of software is no longer based on the use of classroom software teaching, but the front of this stage, in the pre-study stage through the way of software video recording to allow students to learn the software and the initial operation, and in the classroom process, through the assessment of students to complete the basic case, to promote their mastery of the software, and finally through the actual case of learning, to realize the realization of specific acoustic design. Similar to the teaching of software operation, the course also makes full use of such whole-process teaching in the part of theoretical knowledge transfer, software application and design to realize the cultivation and enhancement of students' ability[6].

In addition, the course makes full use of modern teaching tools to promote and improve the quality of teaching. In classroom teaching, the tools and modes of classroom and flipped classroom are integrated to allow students to participate in high-frequency and high-density learning of knowledge points, and test their mastery and understanding of knowledge points through the form of flipped lectures, reflecting the student-centered teaching core approach.

Relying on solid and robust professional content support. The course realizes teaching from two dimensions: teaching progress and goal achievement. Firstly, the teaching objectives of the course follow the sequence of "knowledge reception - ability cultivation - ideological cognition", so that the students first have a certain understanding of professional theoretical knowledge, then cultivate the corresponding ability, and finally realize the enhancement of ideology[7]. Each stage is embodied in the three processes of "reception - consolidation - enhancement" of the course. In this process, the information technology means into the teaching, and the ideological construction and professional content of the close integration. For example, the application of acoustic simulation theory needs to be based on the application of various types of acoustic design and the use of software to support, so the course builds up a reserve of knowledge and software understanding. According to the characteristics of this industry, the course in the introduction of professional knowledge at the same time, can naturally lead to the construction of independent industrial software for the country's needs, so that students in the mastery of the relevant knowledge can truly understand the problems we face, rational analysis of our lack of place, inspired by the national demand for contribution to the aspirations of the country, so as to obtain excellent teaching results through the innovation of teaching methods[8].

Through the reform of this course, students have mastered a solid foundation of acoustic simulation through the study of this course, and are able to skillfully simulate all kinds of acoustic problems.

4 Conclusions

This course is aimed at the traditional acoustic software courses focusing on software but not theory, resulting in students' poor ability to promote the application of the problem, to build a comprehensive acoustic simulation of basic theory content system. The construction of the content system from point to point, in the basic theory, combined with the core characteristics of needle acoustic simulation is greatly affected by frequency, through the sound line tracking, finite element method and other representative methods to lead to the general process of geometric methods, fluctuation methods, so that students can build up a deeper understanding of the various types of low-frequency, medium and high-frequency bands of the method, so as to guide the application of the software in the process of dealing with the problem.

The practical content of this course is characterized by authenticity and closeness to actual engineering problems. In the simulation practice of various acoustic problems, the actual problem case set is constructed, for example, in the geometric acoustic software practice, the real hall sound quality design is the practice content, while in the fluctuation acoustic software practice, the case of the real problem of the underwater vehicle sound radiation, muffler design and other real problems is constructed. Through the development of authenticity practice, students can have a deeper understanding of the actual problems, and also improve their understanding of complex problems and knowledge expansion ability.

References

[1] Xie, X., Zheng, H., Jonckheere, S., et al.: Acoustic simulation of cavities with porous materials using an adaptive model order reduction technique. Journal of Sound and Vibration. pp. 115570 (2020)

[2] Guelker, G., Salimbeni, R., Hinsch, K. D., et al.: Large-scale investigation of plaster detachments in historical murals by acoustic stimulation and video-holographic detection. International Society for Optics and Photonics, 2001, 4402:184 (2001)

[3] Lenz, R. L.: The modern sophistication of acoustics in education environments. The Journal of the Acoustical Society of America. pp. 1772-1772 (2018)

[4] Chen, K., Yang, Y., Liang, Y.: Acoustic education and its exploration at NPU. Journal of the Acoustical Society of America. pp. 3254-3254 (2012)

[5] Wild, G., Swan, G.: Acoustic education: experiments for off-Campus teaching and learning. Proceedings of Ica. pp. 1-5 (2010)

[6] Sakamoto, S., Ueno, K., Tachibana H.: Visualization of resonance phenomena for acoustic education. Proceedings of Ica. pp. 1-5 (2004)

[7] Suda, H.: Interactive simulators for acoustic education. The Journal of the Acoustical Society of America. pp. 3314-3314 (2016)

[8] Jinlei, Z., Amp, W. Y., Baohui, Z.: Introducing a new teaching model: flipped classroom. Journal of Distance Education. (2012)