

Reform Exploration on Researching Experimental and Practical Teaching

-- Taking the Course "Fundamentals of Elastic-plastic Mechanics A" as an Example

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Abstract. Under the background of first-class course construction and according to the characteristics of the elastic-plastic mechanics course content, through the construction of diversified researching experimental teaching mode, the design of project-based researching innovative experimental content and the construction of hybrid experimental teaching assessment and evaluation system, Breaking through the barrier between the teaching of elastic-plastic mechanics theory and practical application, cultivating students' independent researching and innovation ability to master the theoretical knowledge of elastic-plastic mechanics and its application in practice, improving students' ability to find, analyze, solve and think independently, and providing a strong curriculum teaching foundation for the cultivation of first-class undergraduate talents.

Keywords: Elastic-plastic Mechanics; Researching Teaching; Course Reform.

1. Introduction

"The Implementation Opinions of the Ministry of Education on the Construction of First-class Undergraduate Courses" (Professor-level Senior Engineer [2019] No. 8) pointed out the needing to build first-class undergraduate courses that meets the requirements of the new era and promote the high-quality development of higher education [1]. Curriculum is the core element of talent training, and the quality of the curriculum directly determines the quality of talent training. The overall strategy of the "National Medium and Long-term Educational Reform and Development Plan (2010-2020)" clearly points out that efforts should be made to improve the "innovative spirit of exploration and practical ability to solve problems" of college students, which is not only the inevitable trend of talent training in higher education, but also is the strategy of rejuvenating the country through science and education and the strategy of strengthening the country with talents, and building an innovation driven country and society is an urgent requirement. Innovation comes from practice. The cultivation of college students' innovative abilities not only requires a reasonable knowledge structure, but also depends on the accumulation of direct experience. Practical teaching effectively promotes the combination of college students' knowledge acquisition and direct experience accumulation, and has an irreplaceable effect on the cultivation of college students, especially science and engineering college students' practical ability and innovation ability. Research practice teaching embodies the combination of teachers' research practice teaching and students' research learning, which effectively promotes the combination of college students' knowledge acquisition and direct experience, and plays an important role in improving students' practical ability and innovation ability [2].

The course of elastic-plastic mechanics is the core course of materials science and engineering, which studies the stress and deformation of elastic-plastic bodies under the action of external forces and other external factors [3,4]. It is an important foundation for the study of subsequent mechanics courses such as fracture mechanics and continuum mechanics. The theory is widely used in materials, machinery, civil engineering, construction, aerospace, electronics and other engineering fields. The elastoplastic mechanics course has many and complex mathematical formulas, strict logical reasoning,

and heavy calculation workload. Many formulas involved and calculations mostly appear in the form of partial differential equations, which are very theoretical and abstract, making it difficult to learn. At the same time, in the traditional teaching process, the curriculum theory cannot effectively integrate with practice and guide practice, which is easily lead to students' universal problems such as "unable to understand in class and unable to do homework after class", and cannot effectively use the theoretical knowledge learned in the curriculum to be applied to the undergraduate graduation design link and subsequent scientific research and engineering practice. It is unable to effectively achieve the relationship between curriculum teaching and talent training objectives, which seriously hinders the construction of "four new" majors and the cultivation of outstanding top-notch talents.

In view of the various problems in the teaching of elastoplastic mechanics, many teachers have conducted more detailed and in-depth research and discussion on their teaching methods from different angles. Lin et al. adopted the teaching model of engineering cases, and the teaching effect was significantly improved through the reform of teaching content and teaching methods [5]. Xu carried out the overall teaching design and practice from the aspects of teaching content, teaching methods and assessment, and achieved good teaching results [6]. Based on foreign engineering education and teaching concepts, Du et al. conducted an in-depth discussion on the teaching methods of the course from theoretical teaching, practical teaching, assessment mechanism, modern design and teaching tools, etc. [7]. Yuan et al. explored the teaching reform of this course from the perspective of heuristic and discussion-based teaching [8]. Based on the curriculum structure system, Liu et al. adopted the overall-part-total teaching method, with clear thinking and distinct levels, and achieved initial good results [9].

Research practice teaching has the characteristics of practicality, flexibility, inquiry, comprehensiveness, autonomy, research, diversity and openness. It is a practical teaching model that takes "problem as the center", explores independently and completes independently or cooperatively under the guidance of teachers, and applies the learned theoretical knowledge to practice [10-13]. Yao et al. through the exploratory research on the teaching system, teaching content, teaching methods and teaching management of the circuit principle experimental course, to improve students' keen discovery of problems and scientific problem-solving ability [14]. Zhao et al. rebuilt the research practice teaching system of heat transfer, combined with the scientific research of heat transfer, gave two examples of research practice teaching design to carry out relevant research practice teaching [15]. Jiang et al. introduced research teaching ideas into the practical teaching of mechanical principles to strengthen the effect of practical teaching [16]. Wang and Zhu introduced research teaching into the teaching of ideological and political theory courses, carried out research teaching in two links of theory teaching and practical teaching, and cultivated students' self-development ability, innovation ability and innovative spirit [17,18]. At present, the research practice teaching mainly focuses on setting up individual practice courses or improving and adding research practice content on the basis of the original experimental courses, etc., which is not directly related to the theoretical curriculum system in the syllabus. There is no targeted enhancement to the content of the theoretical courses that students have learned, especially the professional theoretical courses that have a strong theoretical nature and a strong practical engineering application. The teaching effect of "thick foundation, flexible modules, and strong practice" is not well achieved.

This article introduces the reform and practical exploration of the "Fundamentals of elastic-plastic mechanics A"-Shandong Province's first-class undergraduate course research experiment teaching in the School of Materials Science and Engineering, Harbin Institute of Technology at Weihai, and breaks the barrier between the teaching of elastoplastic mechanics theory and practical application. Motivating students' learning enthusiasm and initiative, focusing on improving students' comprehensive ability, improving learning effectiveness, cultivating students' innovative consciousness, improving students' ability to find problems, analyzing and solving problems, thinking independently, and providing a strong curriculum teaching foundation for the cultivation of first-class undergraduate talents.

2. Design for Researching Experimental Teaching Mode and Content

The purpose of experimental teaching is to cultivate students' independent research and innovative ability to master and use theoretical knowledge to carry out practice. In the process of researching experimental teaching, the emphasis is on cultivating students' interest in experimental learning, analysis and problem-solving ability, and scientific literacy of innovative exploration, etc. Therefore, this course reforms from the perspective of diversified researching experimental teaching mode construction, project-based research innovative experimental content design, and hybrid experimental teaching assessment and evaluation system construction.

(1) Construction of a diversified researching experimental teaching model: Combining online+offline+ virtual simulation, taking full advantage of the online, offline, and virtual simulation experimental teaching mode, using advanced information methods to introduce high-quality experimental teaching resources online to the course, building a virtual simulation experiment teaching platform, solving the traditional experimental teaching model's non-standard experimental operation, unsatisfactory experimental results, and insufficient experimental content innovation and research. As well as problems such as the inability to carry out complex and dangerous experiments, improve the enthusiasm and initiative of students to participate in experiments, and achieve the goal of cultivating students' innovative and practical ability.

(2) Project-based research and innovation experiment content design: Based on the theoretical knowledge of the course, setting up the research innovation experiment content divided according to the theoretical knowledge module, guiding students to carry out exploratory experiments, and master the research purpose and method, technical route and feasibility analysis of exploratory experiment design. The research innovation experiment design is guided by practical problems, focuses on the relationship between the basic knowledge and engineering application, guiding students to design research innovation experiment projects, master the methods and means of learning and exploring scientific research, cultivate students' engineering application ability and innovative thinking, and master scientific research methods and ways of thinking, improve the ability of learning, analyzing and solving problems.

(3) Construction of a hybrid experimental teaching assessment and evaluation system: According to the characteristics of the diversified teaching mode and the reform of the researching experimental content, the traditional single evaluation mode will be transformed to the diversified one. Curriculum experimental teaching assessment and evaluation system, optimize the proportion of each part of the experimental teaching assessment component, pay attention to process assessment, and take comprehensive ability assessment as the main line. It aims to cultivate professional and innovative talents with strong professional basic theoretical knowledge, strong practical ability, and excellent professional comprehensive quality.

3. Practice and Effectiveness of Researching Experimental Teaching

Focusing on the reform of the construction of the diversified researching experimental teaching mode of the course, the project-based research and innovative experimental content design, and the reform of the construction of a mixed experimental teaching assessment and evaluation system, relevant researching experimental teaching practices have been carried out, and achieved certain results.

(1) Construction of diversified researching experimental teaching mode

Online + offline + virtual simulation combined experimental teaching mode, online experimental teaching mainly through Yu Class, Tencent conference, MOOC platform, etc., release experimental teaching tasks and online experimental teaching resources before class, including the experimental purpose, principles, steps, precautions and other resources, as well as experimental process videos, and release the pre-class preview effect assessment through the Yu Class, the main assessment of the mastery of the experimental steps, the understanding of the experimental process precautions, etc., can participate after the assessment is passed offline experiment. Taking the tensile experiment as an

example, the relevant materials and video of the experiment process will be released on the online platform before the experiment, and the students ask questions about the experiment through the online platform. Teachers sort out the questions through the online platform for simple or single problems, reply through the online platform, and reply to complex common problems before the unified offline experiment. The online learning increased teacher-student interaction and improved the achievement of the experimental preparatory goal. The offline experiment teaching adopts the traditional experiment teaching mode, based on the effect of online learning, improves the effect of offline experiment, shortens the time, and reduces the proportion of experimental test failures. The virtual simulation experiment teaching is mainly through the virtual simulation teaching instrument system purchased in the laboratory. By constructing a controllable, close-to-real, multi-sensing integrated learning environment, it can complete the Elasto-plastic deformation mechanics analysis of materials under complex stress states, so that students can be passive the recipient becomes the leader of the course.

(2) Project-based research and innovation experiment content design

Focusing on the students' knowledge learning and innovation ability training objectives of the course, project-based researching experiments are carried out based on the preliminary basic experiments, including two modules of teacher proposition and students' independent selection of topics. The choice of teacher proposition modules and typical application cases in major projects such as dieless hydraulic bulging ball, wind tunnel flanges, satellite heat pipes, aircraft skins and generator rotors. The teacher instructs students to conduct researching experiments on designated processes in groups, conducting in-depth analysis of mechanical problems in typical application cases, and consulting literatures, analyzing process issues, designing process paths, and proposing experimental plans according to research projects. Then conducting a feasibility analysis of the plan, and finally carrying out physical simulation experiments, and finally forming a research report and making a reply. Students' self-selection module can combine students' interests and the latest developments at home and abroad, choosing cutting-edge propositions such as the analysis of mechanical problems of the space station's mechanical arm deployment mechanism, and freely forming a team to complete the experimental design, analysis, verification and reply. Through researching experimental teaching, the basic knowledge of Elasto-plastic mechanics course is integrated with the practical problems of technology, to cultivate students' engineering application ability and innovative thinking, and improve the ability of studying, analyzing and solving problems.

(3) Construction of examination and evaluation system of mixed experimental teaching

According to the characteristics of the researching experimental teaching mode of the course, a complete online and offline experimental class evaluation system is constructed to comprehensively assess students' mastery of the course and achievement of learning goals. The assessment system mainly includes online assessment module, offline experiment module and offline project reply module. The online assessment module provides assessments and records scores based on the students' self-completed online learning tasks and corresponding tests. In the offline experiment module, students freely form teams and choose research experiment topics, complete the division of team members, consult literature, analyze problems, solve problems, and complete the research experiment content through teamwork and teacher guidance. In the offline defense module, each experimental group sends representatives to report the group's learning results through slideshow demonstrations and physical demonstrations, accepts teacher and student questions and improves research experiments.

4. Summary

After the research experimental teaching reform and practice, the research experimental teaching effect of the "Fundamentals of elastic-plastic mechanics A" course has achieved obvious results. Through diversified research experimental teaching, the teaching form is enriched and the characteristic experimental teaching system is constructed. At the same time, with the help of

electronic science and information technology, an open, shared, and informatized mobile experimental learning platform will be constructed to achieve diversified and informatized teaching methods. At the same time, teaching resources are saved, and the practical effect is very good. Through the researching experimental teaching design, the theoretical knowledge of the elastoplastic mechanics course can be applied to the application, and the knowledge connection between the theoretical course and the technological course can be strengthened.

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