

Teaching Reform and Practice of Principles of Metals Based on OBE

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Abstract—Principles of Metal Science is an important basic course of metal material engineering. Based on the background of certification of engineering education specialty, this paper analyses the existing problems of the course and the reform measures to adapt to the certification of engineering education specialty according to the three core concepts of OBE (Outcome Based Education), student-centered and continuous improvement, and examines them in the actual teaching process. The implementation effect has been tested in practice teaching.

Key words—OBE(Outcome Based Education); Principles of Metal Science; Reform in Education; Practice

I. INTRODUCTION

Engineering education professional accreditation (EEPA) is an internationally accepted quality assurance system for engineering education. It is also an important basis for achieving international mutual recognition of engineering education and international recognition of engineer qualifications. The core of EEPA is to confirm that engineering graduates meet the established quality standards required by the industry, and is a qualification evaluation oriented to the training objectives and graduation export requirements. The certification of engineering education requires the establishment of professional curriculum system, the allocation of teaching staff, and the configuration of school conditions, whose core task is the achievement of students' graduation ability. Moreover, EEPA emphasizes the establishment of professional continuous improvement mechanisms and culture to ensure the quality of professional education. Engineering education is an important part of higher education in China. As of 2013, the number of engineering graduates in ordinary universities in China had reached more than 2.8 million, the number of engineering students at school had reached more than 4.9 million, and the number of engineering majors were more than 15,000, ranking first in the world. In this context, China has actively requested to join the engineering education professional certification system. Since 2006, the Ministry of Education has taken the lead in certain professions. Until 2016, China became a formal member of the Washington Agreement, and gained a place in the engineering education professional certification system. The engineering education certification work is fully carried out in the universities of science and engineering in China.

Outcome based education (OBE), student-centered and continuous improvement are the three core concepts of engineering education professional certification. Graduation requirements are a quantitative indicator of engineering education professional certification, which is determined by the achievement scale of the various courses. Under the background of the three concepts, this paper is to improve the basic course of metal materials engineering of Harbin University of Science and Technology, "Principles of Metal Science", in the hope of meeting the requirements of EEPA.

"Principles of Metal Science", also known as "Fundamentals of Materials Science", is an important subject course (core class) for undergraduates majoring in metal materials engineering or materials science and engineering. It is a professional course for postgraduate entrance examinations for materials majors, and is also the first professional course that students come into contact with during their studies. The course is hard to understand in theory, abstract in content, complicated in knowledge, and closely related to the follow-up courses, bringing about the obstacles to teach and to learn. Many colleges and universities have done a lot of teaching reform work [1-6], and have achieved gratifying results. As an "old brand" in Harbin University of Science and Technology, Metal materials engineering specialty, whose predecessor is casting and heat treatment, has a history of more than 60 years. From the beginning of the establishment of the profession, the course "Principles of Metal Science" was set up. Although the course name has changed over the years, the overall teaching content has not changed greatly. Compared with the past, it has been reduced and simplified in terms of the number of hours and the depth of content. In 2016, the metal materials engineering specialty applied for the EEPA. According to the general standards and supplementary standards of the engineering education professional certification, the "Metal Science Principles" was reformed, including course objectives, teaching content, teaching methods and assessment forms.

II. COURSE OBJECTIVES AND OPTIMIZATION OF COURSE CONTENT

Principles of Metal Science is the main course of metal materials engineering. It has been taught in this specialty (formerly known as casting and heat treatment specialty) for more than 50 years. With the continuous reform of higher

education in our country, this course has changed from the original 130 hours to the current 64 hours. As the class time reduced, the course content must be adjusted accordingly. The method adopted in the past is to cut down the content of the course according to the discipline and professional development. Facing the certification of engineering education, this method of "simple and rude" deleting the content of the course obviously does not work.

Based on the principle of laying a solid foundation and sticking out the characteristics, we aim at cultivating students to solve complex professional problems. According to the requirements of the three concepts of engineering education certification, we determine the course objectives and content following the order: internal and external needs → training objectives → graduation requirements → curriculum system → curriculum objectives. The relationship between them is shown in Figure 1. Then, the "Principles of Metal Science" course was reformed. Firstly, the training objectives are determined according to internal and external needs, the graduation requirements are formulated by the training objectives, and the course objectives and course contents are determined by the graduation requirements. Secondly, the graduation requirements are decomposed into several index points. According to the index points and the course objectives, different courses support different index points, and then form a measurable graduation requirement index point. This course goal and the process of determining the course content have changed the past practice of determining the course objectives and content by professional and disciplinary development needs, in line with the OBE principles of EEPA. Finally, the professional features are integrated into the course content. After years of development, the specialty has formed characteristics in the preparation and heat treatment of ferrous metal wear-resistant materials, aluminum-magnesium alloys, and melt quality testing. The graduates are mainly employed in the fields of material processing and heat treatment. In response to such professional features, the seven parts of the "Principles of Metal Science" course: crystal structure, metal crystallization, iron-carbon alloy, phase diagram, plastic deformation, recovery and recrystallization, diffusion, mainly focus on methods to improve the strength of metal materials, which is the main line running through the course, namely four strengthening methods - solid solution strengthening, precipitation strengthening, fine grain strengthening and work hardening. In combination with practical production cases, we aim to teach students the application of four methods in practice. In the definition and setting of professional complex engineering problems, this part is also the main content, which not only distinguishes the primary and secondary, but also reflects the professional characteristics, and also meets the requirements of engineering education certification.

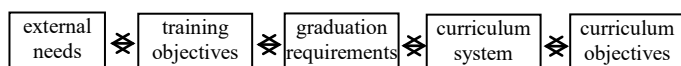


Fig.1 Course content determination map

According to the basic requirements of EEPA, the objectives of the course can be divided into two parts: knowledge learning, knowledge application and ability training. The study of knowledge includes two points: (1)

mastering the influence of composition, organization and structure on the mechanical properties of metallic materials; (2) preliminarily grasping the method of improving the mechanical properties of metal materials. The ability to develop and use knowledge also includes two points: (1) ability to determine performance requirements based on the service conditions of the parts, and the preliminary ability to design metal materials;(2) mastering the preparation of metallographic samples and the use of microscopes, and having the ability to observe and identify metallographic structures. In this way, if the course objectives are achieved, the index points for graduation requirements are also achieved, which provides partial support for the final graduation requirements. The correspondence table between the graduation requirement index points and the course objectives of this course is shown in Table I.

TABLE I CORRESPONDENCE BETWEEN COURSE OBJECTIVES AND GRADUATION REQUIREMENTS INDEX POINTS OF "PRINCIPLES OF METAL SCIENCE "

Graduation requirements	Graduation requirement index points	Course objectives			
		1	2	3	4
1.Engineering knowledge	1.4Mastering the professional knowledge and practical skills in the field of metal materials engineering and solving complex metal materials engineering problems;	√			
2.Problem analysis	2.2Ability to analyze complex metal materials engineering problems using engineering science principles;		√		
3.Design and Development	3.1Ability to design and analyze metal materials for metal material service conditions;			√	
4.Investigation	4.2Based on the scientific principles of metal materials, using scientific methods, selecting a reasonable research route, designing a feasible experimental scheme to achieve metal material preparation or heat treatment.			√	√

III. REFORM OF TEACHING METHODS AND ASSESSMENT FORMS

This course is based on traditional teaching methods. At the same time, it is supplemented by interactive teaching, problem-based teaching, case-based teaching, and heuristic teaching. According to the OBE concept, the student-centered teaching method is the core of the student. The "learning" is the key, and the teacher's "teaching" is the guidance, and "how to teach" is the means. The content of the course is quite abstract difficult to understand, so a combination of teaching methods should be adopted. For example, as an aid to teaching, multimedia is be used to display the animations and graphics. But it is inappropriate to use multimedia in the whole class without writing on the blackboard, it must be a combination of blackboard and multimedia. As we all know, almost all college students now have mobile phones, and mobile phones are an important factor affecting the quality of students'

classroom learning, especially in professional courses. Many students play mobile phones in class and do not attend the lectures. Although the school adopts various means to restrict students from playing mobile phones in class, the effect is not obvious. Since it can't be restricted, it is better to guide it. The "rain classroom" is a way to use mobile phones to teach, so that the mobile phone can be changed from "head-down tool" to "head-up weapon". It combines powerpoint with WeChat, and is easy to learn and use. We can evaluate the student's classroom learning process. The course has been taught in the rain classroom and works well. It is very popular among students. The assessment form and content of the course are carried out around the course objectives, and the assessment is based on the teaching links. The specific scores are: the discussion class 10%, the experiment 10%, the semester assignment 30%, and the final exam 50%. The following table shows the details of the scoring criteria for big assignments.

TABLE II THE SCORING CRITERIA FOR BIG ASSIGNMENTS OF "PRINCIPLES OF METAL SCIENCE" COURSE

Scoring point	Scoring standard			
fulfillment of schedule (weight 0.1)	Complete on time (3 points)	Complete on time (3 points)	Complete on time (3 points)	Not completed on time (< 3 points)
Concept mastery degree (weight 0.3)	Clear (9 points)	80% clear (7 points)	60% clear (6 points)	Not clear (< 6 points)
Program correctness (weight 0.4)	Correct (12 points)	80% correct (10 points)	60% correct (8 points)	Defective (< 6 points)
Analysis or conclusion validity (weight 0.2)	Reasonable and valid (6 points)	Comparatively reasonable and valid (5 points)	Basically reasonable and valid (4 points)	Existing serious errors (< 3 points)

IV. TEACHING EFFECT ANALYSIS

The revised syllabus in accordance with the OBE concept was tried in the 2015 and 2016 students of the Department of Metal Materials Engineering, and the results received were favorable. Specifically, the goal of students learning this course is clear, the content of the course is more closely related to the actual application, and the ability of students to analyze problems is improved. More importantly, because the content of the assessment closely corresponds to the course objectives (graduation requirements), the reasons for the lack of learning are clear, and the content of the course is easy to modify and the teaching methods are improved, thus forming a good cycle. The passing rate of the course assessment scores increased to 90%. The follow-up professional course teachers reflected that the students' basic knowledge is well mastered,

and the ability to analyze and solve practical problems with professional knowledge is enhanced.

V. CONCLUSION

Applying the OBE concept to the teaching of the "Principles of Metal Science" course is consistent with engineering education certification requirements. The "Principles of Metal Science" course is student-centered, and reversely designs the teaching content from the OBE concept. It is implementing the teaching process and confirms that OBE is an effective means for students to acquire their abilities and has achieved good results.

ACKNOWLEDGMENTS

This work is supported by Research and Practice on Innovation of Talents Training Model for Metal Materials Engineering Specialty Based on Engineering Education Certification (SJGY20170544); Research and Practice of Innovation and Entrepreneurship Education for Materials Majors under the Background of Engineering Education Certification (GJC1215111); Research and Practice on the Education of Engineering Characteristics of Metal Materials under the Background of Professional Certification (320150003); Research and Practice on Talents Training Scheme and Course System Reform of Metal Material Engineering Speciality Based on OBE Concept projects; Construction and Solution of Complex Engineering Problems in Metal Material Engineering Specialty--Taking Professional Practice as an Example (520160010); Heilongjiang Excellent Engineer Project.

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