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Research on the Course Evaluation System of Material Preparation Technology Based on the OBE Concept

Zhao Li*, Jing Cao, Kunyao Wu, Yanan Wang

School of Materials Engineering, Xi'an Aeronautical University, Xi'an, China
**Corresponding author*

Abstract: *Course evaluation guides the direction of course development, practice and reform, and is an important guarantee for improving the quality of talent training. Materials Preparation Technology is one of the compulsory professional basic courses for materials science and engineering, which mainly introduces the development situation, principles, equipment and processes of the preparation technology of monocrystalline, amorphous, thin film, functional ceramics and structural ceramics, as well as the effects of different process parameters on the performance, in order to cultivate students' basic ability to find out the problem, analyze the problem, and solve the problem of related materials synthesis and preparation, and to stimulate students' sense of innovation. This paper puts forward a dual-objective achievement evaluation method of course teaching objectives and graduation requirement index points for engineering education in terms of teaching process in a student-centred manner, and applies the degree of achievement of course teaching objectives to evaluate the achievement effect, so as to improve the quality of teachers' teaching and students' learning effectiveness.*

Keywords: *OBE Concept; Materials Preparation Technology; Course Evaluation*

1. Introduction

OBE (Outcome based education, OBE) education concept, also known as outcome based education, competency based education, goal based education or demand based education[1-3]. OBE education concept is a kind of construction concept of the course system which is outcome based, student oriented and adopts the way of converse thinking. Under the guidance of OBE concept, the course "Materials Preparation Technology" has four course objectives, which are (1) to be able to apply the basic principles of materials science to the analysis of the preparation process, to understand the complex relationship between the synthesis and preparation of materials and their structure and properties, and to understand what effect the specific preparation methods will have on the structure and properties of materials. (2) To be able to select and formulate appropriate material processing plans and processes based on the knowledge of material properties and preparation techniques, and according to the requirements of material structure and properties. (3) To be able to use correctly the various synthesis equipment, forming equipment, sintering equipment, etc. involved in the material preparation process, and to understand the working principle of main equipment and the limitations of its use. (4) To be able to objectively analyze and reasonably evaluate the social, health, safety, legal and cultural impacts of the process of selecting appropriate equipment and routes for the preparation of appropriate materials, and to understand the responsibilities to be assumed. In accordance with the four course objectives, "Materials Preparation Technology" is assessed on a cumulative basis, with a total grade of 100 points, 40% for the process assessment and 60% for the summative assessment. The process assessment is determined by the homework; the summative assessment is determined by the final examination results, which are in the form of a closed-book written examination.

2. Determination of course evaluation samples

The course has been taught in the recent semester to two classes, Material 201 and Material 202, with class sizes of 34 and 33 respectively, and this paper focuses on analyzing the achievement of course objectives in Material 202.

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3. Data Analysis of Learning Outcome

In order to make the analysis clearer and more quantifiable, this paper stipulates that 60%-80% of the number of students who have achieved the objectives of each course is regarded as "basic achievement", and 80%-100% of the number of students who have achieved the objectives of each course is regarded as "satisfactory achievement". The learning outcomes are analyzed as shown in Table 1.

Table 1: Achievement of the objectives of each course

Class	**Material Science 202**	**Number of Students**		**33**	**Sample Size**	**33**
Course Objective	**Index Points to Support Graduation Requirements**	**Evaluation Basis**		**Full marks**	**GPA**	**Evaluation value of achievement**
				A_i	B_i	$K_i = B_i/A_i$
Course objective 1: to be able to apply the basic principles of materials science to the analysis of the preparation process, to understand the complex relationship between the synthesis and preparation of materials and their structure and properties, and to understand what effect the specific preparation methods will have on the structure and properties of materials.	1.4 To be able to apply professional knowledge of principles, processes and mathematical modelling methods in the field of lightweight structural materials and materials surface interface engineering for the comparison and synthesis of solutions to complex engineering problems in the process of materials preparation and development, process design and optimization, and performance testing and analysis.	Process evaluation	Classroom test	3	2.4	0.81
			Classwork	2	1.6	
			Paper work	4	3.5	
		Summative evaluation	II 1	6	5.3	
			II 2	3	2.1	
			II 3	6	5.1	
			II 5	6	4.3	
			II 6	1.8	1.3	
			II 7	3	2.6	
		Subtotal		34.8	28.2	
Course objective 2: to be able to select and formulate appropriate material processing plans and processes based on the knowledge of material properties and preparation techniques, and according to the requirements of material structure and properties.	4.2 To be able to select research routes and design feasible experimental plans for scientific problems in the process of material preparation and development, process design and optimization, and performance testing and analysis;	Process evaluation	Classroom test	3	2.4	0.69
			Classwork	2	1.6	
			Paper work	4	3.5	
		Summative evaluation	II 4	6	5.6	
			III 1	3.6	3.2	
			III 2	4.8	3.9	
			IV 1	6	4.4	
			IV 2	6	1.4	
		Subtotal		37.8	26	
Course objective 3: to be able to use correctly the various synthesis equipment, forming equipment, sintering equipment, etc. involved in the material preparation process, and to understand the working principle of main equipment and the limitations of its use.	5.1 Understand the working principles of engineering tools, Instruments and equipment commonly used in the process of material preparation and development, process design and optimization, and performance testing and analysis, and understand the main functions of information resources and technologies, drawing-aided software and analytical simulation software, and be able to use these hardware and software tools, information resources and technologies, and understand their limitations.	Process evaluation	Classroom test	2	1.6	0.78
			In class experiments	8	6.6	
		Summative evaluation	I 1	5.4	3.8	
		Subtotal		15.4	12	
Course objective 4: to be able to objectively analyze and reasonably evaluate the social, health, safety, legal and cultural impacts of the process of selecting appropriate equipment and routes for the preparation of appropriate materials, and to understand the responsibilities to be assumed. In accordance with the four course objectives.	6.2 To be able to analyze and evaluate the interactions between engineering practices in materials preparation and development, process design and optimization, and performance testing and analysis, and social, health, safety, legal and cultural constraints, and understand the responsibilities to be assumed.	Process evaluation	Classwork	4	3.2	0.78
			Comprehensive assignment	8	6.0	
		Summative evaluation	-	0	0	
		Subtotal		12	9.2	
Evaluation of assessment results		40% for the process assessment and 60% for the summative assessment				
Sample distribution		Excellent: 0 ; Good: 13 ; Moderate: 8 ; Pass: 5 ; Fail: 7				
Achievement of course objectives		0.69				
Conclusion of course achievement		☑Achievement≥0.60； □Achievement＜0.60				

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4. Evaluation of the course and analysis for improvement

4.1 Achievement of the four course objectives

According to the analysis of the total marks, the achievement of three of the four course objectives of the students is evaluated at 0.7 or above. Among them, course objective 1 (to be able to apply the basic principles of materials science to the analysis of the preparation process, to understand the complex relationship between the synthesis and preparation of materials and their structure and properties, and to understand what effect the specific preparation methods will have on the structure and properties of materials) has the highest achievement evaluation value, and course objective 2 (to be able to select and formulate appropriate material processing plans and processes based on the knowledge of material properties and preparation techniques, and according to the requirements of material structure and properties) has a relatively low achievement evaluation value. It shows that the students' mastery of basic knowledge (index point 1.4) is good, but the degree of achievement of higher-order research ability (index point 4.2) is not enough. In addition, the achievement of course objective 3, the ability to use preparation-related instruments, is also relatively low, and this course objective is assessed in fewer ways and with fewer assessment scores, which makes the imbalance of each course objective to be remedied. The overall analysis also found that the achievement evaluation value of process assessment was higher than that of summative assessment in the four course objectives, indicating that the consistency between process assessment and summative assessment is still to be improved in terms of the assessment effect on the effectiveness of students' usual learning.

The analysis reveals that the main shortcomings of the course at present are:

1) The achievement of higher-order abilities, such as research, is not effective, and the higher order and challenge of the course needs to be improved in the regular lectures.

2) The ability to use modern tools, i.e. the achievement of reflecting hands-on practical ability is still weak, in addition to in-class experiments, the theoretical lectures should also be strengthened.

3) The distribution of assessment scores for the four course objectives is not balanced enough, and the assessment of course objectives 3 and 4 is not comprehensive enough to fully reflect the achievement of these two objectives. The difficulty of process assessment, the degree of reflection of the real learning situation and the consistency with the summative assessment still need to be improved.

In view of the above shortcomings, improvements will be made in the following aspects in the next cycle of instruction:

1) The difficulty of course content should be adjusted upward, and the training of students' higher-order ability in research should be strengthened, with the addition of case analysis of engineering practice, comprehensive analysis of knowledge points across chapters, and comparative research abilities of near-identical knowledge points.

2) Add virtual experiments and enhance the combination of offline in-class experiments and theoretical knowledge.

3) Redistribute the assessment score of each course objective, enhance the difficulty of process assessment, and enrich the process assessment mode.

4.2 Achievement of course objectives and analysis for improvement

4.2.1 Achievement of course objective 1 and analysis for improvement

Three out of 33 students (9.0%) did not achieve course objective 1, while 30 students (90.9%) achieved course objective 1. There were 2 students (0.5 and below) who were more than 10% off from achievement (0.6), while there were 20 students with excellent achievement (0.8 and above), and the data showed a more pronounced discrete characteristic. Although most of the students had high achievement values, the scores of those who did not achieve the objectives were also really low. The achievement value of course objective 1 was 0.81, and the overall evaluation was classified as satisfactory achievement.

Item analysis: The overall process assessment in the test questions was higher than the summative assessment, and the average scores of sub-questions 2 and 5 of the second main question in the test paper were low. These 2 questions are more comprehensive in assessment, which require both knowledge of the principles and familiarity with the process, and require students to be more flexible in the application

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of knowledge.

Problem analysis: ① the link between preparation process and principle during the lecture is not enough; ② the degree of mastery of the students vary, the setting of the level of passing the examination is not perfect; ③ the practice of comprehensive topics is not enough.

Improvement measures: ① change the explanation of scattered knowledge point content during class, increase the difficulty of the lecture, highlighting the direct and indirect impact of the preparation process on the microstructure of the material; ② increase the case and practical application analysis; ③ the system for reaching the pass line needs to be reconsidered and fine-tuned; ④ Regularly monitor the learning status of students with poor academic performance and provide targeted guidance to backward students.

4.2.2 Achievement of course objective 2 and analysis for improvement

Five out of 33 students (15.2%) did not achieve course objective 2, while 28 students (84.8%) achieved course objective 2. There was 1 student (0.5 and below) who was more than 10% off from achievement (0.6), and only four students with excellent achievement (0.8 and above). Although the majority of students reached the course objectives, the achievement value was not high. Course objective 2, although with an achievement value of 0.69, was the lowest achievement value among the four course objectives, and the overall evaluation was classified as basic achievement.

Item analysis: The sub-question 2 of the fourth main question in the test paper had a low average score of less than 30 marks. The topic not only requires students to write the relevant knowledge, but also students to give practical examples of application, the following question also requires students to cite another application of chemical vapour deposition reaction. The questions combine theory with practice and test in-depth understanding and detailed mastery of the knowledge. There was also a slightly lower average score for sub-question 2 of the third main question. This question was very comprehensive and fully tested the entire content of the second half of the course for the entire 2 chapters, requiring a relatively strong ability to integrate knowledge.

Problem Analysis: ① difficult and comprehensive knowledge that requires to be thoroughly acquainted with and integration of theory with practice is not well mastered in usual teaching; ② lecture-based, limited training for students' higher-order abilities; ③ insufficient mobilization of students' self-study in the spare time.

Improvement measures: ① Change the traditional cramming method of teaching, add "question and answer" lectures, trigger students' independent thinking, and change the "memory test" teaching; ② assign homework that allows students to think independently and analyze in depth, increase targeted exercises and fully mobilize students' learning time after class.

4.2.3 Achievement of course objective 3 and analysis for improvement

One out of 33 students (3.0%) did not achieve course objective 3, while 30 students (97%) achieved course objective 3. There was 0 students who were more than 10% off from achievement (0.6), while there were 14 students with excellent achievement (0.8 and above). The achievement value of course objective 3 was 0.78, and the overall assessment was classified as basic achievement.

Item analysis: being the only question in the test paper that assessed the course objective 3, sub-question 1 of the first main question in the test paper scored an average of over 70 marks. The difficulty of the question was not high, and the main reason why the students did not do particularly well should be the relative neglect of course objective 3 in the regular lectures, which led to the students' insufficient understanding of this kind of topic.

Problem analysis: ① the theoretical teaching content on the principles, use, and operation of preparation-related instruments and equipment is clearly insufficient; ② the participation of theoretical course teachers in in-class experiments is not sufficient, and the combination of theory and practice is not insufficient; ③ the mode of in-class experimental assessment is still somewhat single. The grading standards for experimental reports may not be able to address and reflect the course objectives.

Improvement measures: ① increase the content of the theoretical class about course objective 3; ② theory teachers shall be more deeply involved in all aspects of in-class experiments. ③ adjust the assessment mode and grading standard of in-class experiments.

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4.2.4 Achievement of course objective 4 and analysis for improvement

One out of 33 students (3.0%) did not achieve course objective 4, while 30 students (97%) achieved course objective 4. There were 12 students with excellent achievement (0.8 and above). The achievement value of course objective 4 was 0.78, and the overall assessment was classified as basic achievement.

Item analysis: This course objective was not assessed in the test paper, only two forms of process assessment were adopted, and the assessment score was the least among the four course objectives, which could not fully and truly reflect the achievement of this ability of the students.

Problem analysis: ① insufficient consideration of how to combine course objective 4 with course content, and insufficient targeted content in the theoretical teaching process; ② the assessment form is single.

Improvement measures: ① increase the content of the theoretical class about course objective 4; ② increase the assessment sessions to provide a more targeted, comprehensive and diversified assessment of course objective 4.

5. Conclusion

The source of data for the analysis of the achievement of the objectives of the course "Material Preparation Technology" is true, complete and valid; the calculation method of achievement is accurate, and there are personalized refinements, such as distinguishing between "basic achievement" and "satisfactory achievement" according to the number of people who have achieved the objectives. This reflects the achievement of course objectives in a more realistic and comprehensive way.

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